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ORGANISED BY:

Kerala Agricultural University,
Centre for Advanced Studies in Poultry Science,
College of Veterinary and Animal Sciences
and World's Poultry Science Association (India Branch)
under the auspices of Asia Pacific Federation of WPSA

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PREFACE

I am indeed honoured in welcoming you all at Thrissur, the cultural capital of Kerala, India for the Fourth World Waterfowl Conference on 'Waterfowl Production for Food Security' being organized from 11th to 13th November 2009. I would also like to express my happiness that the World's Poultry Science Association under the auspices of Asia Pacific Federation of WPSA has chosen India as the venue for this important Conference.

The theme of the conference was chosen to highlight the importance of waterfowl in food security in the changing scenario. This conference addresses research, new developments and experience related to waterfowl. The WPSA (India Branch) and Kerala Agricultural University are setting a platform for effective interactions and exchange of knowledge on recent tenets amongst scientists, academicians, industry and the farming community. In the present context of agriculture and the problems faced by duck farmers, the topic of the conference is timely and appropriate in quest of enhanced duck production not only for lush productivity but also improvement in sustainability, stability and lastly quality and value addition.

On behalf of the Organising Committee, it is my pleasure to present before you the compendium of the Fourth World Waterfowl Conference. The contributions presented in this volume consist of Theme and Lead papers, Full articles and Abstracts accepted for presentation at the conference submitted from 15 countries. Given the time limit for editing, all submissions were just corrected for typographical errors. This compendium probably would be the first of its kind featuring all aspects of waterfowl production and research. The coverage of the contributions is very wide, which is one of the distinguishing features of this conference. This volume also contains lead papers by prominent subject matter experts in different arenas of waterfowl research.

The major areas covered at the conference and presented in this volume include: (1) Genetic Resources and Breeding, (2) Nutrition, Physiology and Reproduction, (3) Production Systems, (4) Housing and Management, (5) Biosecurity, Diseases and Welfare and (6) Product Processing, Quality and Food Safety.

I sincerely hope that the deliberations made in the scientific congregation would yield meaningful suggestions/ recommendations leading to further strengthening of waterfowl production. In closing, we would like to thank all authors for submitting their work and all members of the organizing committee, scientific committee, and conference committee for their co-operation. My sincere thanks are due to Sri. K.R. Viswambharan, Vice Chancellor, KAU, Dr. A.L. Bhagwat, Secretary, WPSA- India Branch, Dr. Roel Mulder, General secretary, WPSA, Dr. Alan Gibbins, President, Asia Pacific Federation of WPSA and Dr. Gerard Guy, Director, INRA without the unstinted support of whom an event of this scale would not have possible.

Prof. A. Jalaludeen
Organizing Secretary
IV World Waterfowl Conference 2009

WATERFOWL PRODUCTION FOR FOOD SECURITY.

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The production of waterfowl can contribute to the improvement of the nutritional standards of the human population. Feed for waterfowl is not commonly used for human consumption and there is no strong competition between waterfowl and human nutrition.

In comparison with chicken ducks and geese play a minor role in production of meat and egg. But in certain parts of the world significant amounts of meat and eggs are produced from ducks and geese and there was a sharp rise in waterfowl production in the last decades. Duck meat production was increased from 1991 with 1.3 million tons to 3.6 million tons in 2007; geese meat output was 0.76 million tons in 1991 and 2.2 million tons in 2007, both together makes 6.6 % of total poultry meat. The biggest duck and goose producer is China with 65 % and 94 % of the world production. Duck egg consumption has a long tradition in China and South-East Asia with 10-30 % of total egg consumption. Waterfowl is also widely used as source for feathers and downs.

Large-scale production of ducks and geese need more efforts for higher efficiency and for improving product quality by breeding, nutrition and management according to the requirements of animal welfare and environment protection. Family poultry farmers (small-scale production) with low levels of inputs (housings, feeds, breeds, vaccines, drugs, equipment and time/attention) contribute significantly to food security, poverty alleviation and the ecologically sound management of natural resources. They should have more access to improved birds, appropriate technologies and support services, which could substantially improve productivity, income and food security. Efficient waterfowl farming requires such conditions favourably for health status, utilization of genetically performance capacity, performing natural behaviour and maintaining welfare of birds.
Waterfowl is more convenient for regions with hot and humid climate than chickens. Under such conditions waterfowl shall have the main contribution to food security. .

Keywords: duck, goose, meat, egg, increase of production, food security.

Introduction

Domestic ducks and geese trace back to two species of waterfowl each: the mallard duck (Anas platyrhynchos) and the Muscovy duck (Cairina moschata) as well as the greylag goose (Anser anser) and the swan goose (Anser cygnoides).

Ducks and geese were known in ancient China and Egypt and they had already achieved considerable status at that time. The use of meat of duck and goose and also eggs as well as feathers and downs goes back to very early times in the history.

Meat and eggs of waterfowl belong to the food with high nutritional quality. People eat meat of ducks and geese for its high nutritional value because of the optimal composition of essential amino acids and the favourable composition of fatty acids with a high percentage of polyunsaturated fatty acids and a favourable ratio of omega 6- to omega 3-fatty acids. Duck and geese meat has a unique flavour and a delicious taste. It is economical, and quick and easy to prepare and serve. The utilization of eggs of waterfowl for processing as salted eggs, thousand year eggs (pidan) and balut has a long tradition in some Asian countries. Waterfowl is also widely used as a source of down feathers

Feed for ducks and geese is not commonly used for human consumption and there is no strong competition between waterfowl and human nutrition. Waterfowl is well suitable to utilize cheap feed

resources in rural farms. When waterfowl is kept on fish ponds, the amount of plankton is increased as feed for fishes. In the future ducks and geese should become increasingly important in meeting the challenge for reducing hungry people and for food security.

Generally, poultry convert feed to human food efficiently and need only short periods to adjust to market demands. Duck layers provide a steady source of food. Meat ducks and geese need only a short period of time before a usable product can be attained.

Development of waterfowl meat production

Millions of people in the world are today suffering from starvation or malnutrition. Can waterfowl production contribute to the improvement of the nutritional standards of the human population and to food security? In certain parts, especially in the eastern and southern parts of Asia, significant amounts of meat and eggs are produced from ducks and geese and are important for the economy of these countries.

The development of waterfowl production will be characterized from 1991 to 2007. In *Table 1* the global meat production of waterfowl from 1991 to 2007 will be shown.

Table 1: Development of waterfowl meat production in the world (million tons) (FAOSTAT 2009)

	1991	2001	2007
Total Poultry meat	43.1 (100)	71.5 (166)	87.6 (203)
Duck meat	1.33 (100)	2.98 (224)	3.58 (269)
Share to poultry, %	3.09	4.16	4.09
Goose meat	0.77 (100)	1.91 (248)	2.23 (290)
Share to poultry, %	1.78	2.67	2.54

The data in the brackets show the change against 1991 in per cent..

The global poultry meat production increased from 43.1 million tons in 1991 to 87.6 million t in 2007 or by 203 %. Duck meat increased in the same time from 1.33 million t to 3.58 million t or by 269 % and goose meat increased from 0.77 million t to 2.23 million t or by 290 %. Therefore, the percentage of ducks and geese of the total world poultry meat production also increased from 4.87 % (3.09 + 1.78) in 1991 to 6.63 % (4.09 + 2.54) in 2007, but the percentage was 2001 with 6.83 % higher. That means the speed of upwards tendency has lost a little against total poultry meat.

Although ducks and geese are generally well known all over the world their economical importance varies between the continents and the countries. Therefore, there are big differences concerning the contribution to food security. If we want to look for the role of waterfowl meat and eggs for food security, we have to consider the growth of production in total and *per capita* and the change of production from 1991 to 2007. In addition it was compared the share of waterfowl production to total poultry production. Especially the change in per head production characterizes the role in the contribution for food security, because it considers the growing human population. In *Table* 2 and 3 it will be demonstrated the contribution of each continent to duck and goose meat production.

Asia is the leading continent in duck meat production with a share of 82.2 % followed by Europe with 12.4 %. Asia has also the highest increase of total and of per capita duck meat by 308 % and 244 %, respective. Almost 10 per cent of poultry meat in Asia is produced by ducks compared with 4.1 % in the world. Duck meat production in Africa and Latin America is very low and the annual per capita production amounts only to 60 and 66 g and is decreasing to 83 and 64 %, respective.

Table 2: Development of duck meat production in the continents between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

	Duck, 1000 t	Change to 1991, %	Duck per head, g	Change to 1991	Share of poultry, %	Change to 1991, %
World	3,580	269	540	215	4.09	133
Africa	58	127	60	83	1.60	70
North America	91	191	270	169	0.43	110
Latin America	38	84	66	64	0.21	28
Asia	2,942	308	733	244	9.68	112
Europe	445	194	606	192	3.21	165
Oceania	11	238	320	180	1.09	114

Also for goose meat the regional pattern varies considerably (*Table 3*).

Table 3: Development of goose meat production in the continents between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

	Goose, 1000 t	Change to 1991, %	Goose per head, g	Change to 1991, %	Share of poultry, %	Change to 1991, %
World	2,230	290	336	233	2.54	143
Africa	56	147	59	97	1.57	82
North America	0.9	106	2.7	90	0.004	57
Latin America	1.03	112	1.8	86	0.006	40
Asia	2,104	323	525	256	6.92	117
Europe	72	90	97	88	0.52	75
Oceania	0.12	150	3.4	113	0.012	75

With a share of 94 % global goose production Asia dominates the goose meat production. The goose production in Europe was reduced to 90 % between 1991 and 2007, but in Asia it was increased to 323 % and contributed 6.9 % to poultry meat. Goose production of America and Oceania is with only a few g annual per capita very low and has no commercial importance.

Because of the dominating role of Asia the development of duck production in the Asian countries is listed in *Table 4* and shows a remarkable growth. China alone has 65 % of the global duck meat followed by Malaysia (3.1 %), Thailand (2.4 %) and Vietnam (2.3 %). Except Thailand and Bangladesh duck meat production was increased in all mentioned countries, especially in Laos (800 %), Myanmar (617 %), and Korea (570 %). The highest per head production is found in Malaysia with 4.4 kg, Taiwan with 3.4 kg and China with 1.8 kg. Myanmar, Thailand and Republic of Korea have more than 1 kg per capita. But the highest increase of duck per head production was observed in Laos with 508 %, followed by South Korea, Myanmar, Indonesia, China, India and Malaysia (200 %). In Thailand and Bangladesh the duck production per head was reduced because of the impact of Avian Influenza in Thailand and the preference for duck eggs in Bangladesh. The share to poultry shows the great role of duck meat in Cambodia (32.5 %), North Korea (25 %), Vietnam and Laos (19 %) and China (15.5 %).

Table 4: Development of duck meat production in Asian countries between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

Country	Duck meat, 1000 t	Change to 1991, %	Duck per head, g	Change to 1991, %	Share to poultry, %	Change to 1991, %
China	2329	348	1800	310	15.5	104
Malaysia	111	285	4400	200	10.7	118
Thailand	85	88	1300	75	7.9	71
Vietnam	84	210	970	162	19.0	79
Myanmar	74	617	1400	483	9.2	64
India	73	252	70	206	3.2	43
Taiwan[2]	73		3370		9.8	
Korea Rep.	57	570	1160	504	10.0	322
Indonesia	44	400	190	317	3.6	189
Philippines	31	238	380	181	4.5	180
Bangladesh	14	101	100	77	8.7	51
N. Korea	11	190	440	157	25.0	128
Cambodia	8.3	198	670	140	32.5	135
Laos	4.0	800	610	508	18.7	275

[2]) TAI (1999)

The non-Asian countries with high duck meat production are listed in *Table 5*.

Table 5: Duck meat production in the top non-Asian countries between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

Country	Duck meat, 1000 t	Change to 1991, %	Duck per head, g	Change to 1991, %	Share to poultry, %	Change to 1991, %
France	234	198	3700	179	15.7	222
Germany	56	267	680	262	5.0	125
Hungary	51	165	5200	174	13.5	153
UK	35	152	600	150	2.4	109
Netherland	15	167	915	153	2.2	138
Ukraine[3]	60		1200		24.0	
USA	83	198	290	171	0.42	114
Canada	7.4	145	225	123	0.6	87
Argentina	7.5	129	190	107	0.6	42
Mexico	21	117	200	95	0.8	39
Egypt	39	170	520	88	5.9	55
Madagascar	11	150	550	90	15.3	89
Reunion	3.3	122	4325	96	16.4	73
Australia	10	267	490	188	1.2	120

[3]) ZAKHATSKY, 1999.

The leading country in Europe is France because of the fast development of production with Muscovy and Mule ducks which are also used for fatty liver production by forced feeding. The same can be said for Hungary with the highest *per capita* production in the world of 5.2 kg. In both countries ducks play a great role with 14-15 % share of poultry meat. Also USA and Australia have doubled their duck meat production, but it

shared only 0.42 and 1.2 % of total poultry meat. Remarkable is the high duck meat production per head of 4.3 kg in Reunion with 16.4 % share of poultry meat. After Reunion Egypt and Madagascar are the African countries with appreciable duck meat production.

With regard to geese production China has a share of 93.9% of the world, followed by Ukraine and Egypt. The goose meat production in the world was increased by 293 %. This was caused by the high share of China with a growth to 328 % (*Table 6*).

Table 6: Development of goose meat production in the top countries between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

	Goosemeat, 1000 t	Change to 1991, %	Goose per head, g	Change to 1991	Share of poultry, %	Change to 1991, %
World	2230	290	336	233	2.54	143
China	2,092	328	1580	287	13.9	98
Ukraine[3]	97.2	-	1900			
Egypt	43	148	570	110	6.8	71
Taiwan[2]	29.8	-	1290		4.0	
Hungary	27	61	2800	67	7.16	57
Poland	19	231	500	238	2.09	88
Italy	12.8	-	220	-	1.24	-
Madagascar	12.6	137	630	86	17.5	81
Israel	3.4	79	520	57	0.64	29
Iran	2.5	96	30	75	0.17	30
Myanmar	2.5	156	50	125	0.31	16
UK	2.4	77	40	80	0.16	53
Czech Rep.	2.3	-	230	-	3.1	-
France	2.3	33	40	33	0.15	11
Germany	2.1	37	30	50	0.18	17
Turkey	2.0	57	30	50	0.18	21
Ireland	1.2	188	270	147	0.86	134
Canada	0.90	106	270	87	0.07	58
Thailand	0.8	67	12	55	0.07	50
Argentina	0.54	104	40	88	0.045	40

[2]) TAI, 1999; [3]) ZAKHATZKY, 1999

With regard to the goose meat production per head the leading countries are Hungary with 2.8 kg, Ukraine with 1.9 kg and China with 1.58 kg, but an increase was observed in China, Egypt, Poland, Myanmar and Ireland only. The share of goose meat to poultry meat decreased in all countries, except China and Ireland. Ukraine and Taiwan were not mentioned by FAO-Statistics. Therefore, it was not possible to inform on changes.

But the FAO-Statistics has been given a ranking of the top 20 countries in duck and goose meat production as well as on the value of the production (*Table 7).*

Table 7: Ranking of the share and value of duck and goose meat production of the twenty leading countries in 2007 (FAOSTAT, 2009)

Duck meat			Goose meat		
Country	Share, %	Prod. Mill. $	Country	Share, %	Prod. Mill. $
World	100	4,485	World	100	4,254
China	65.0	3,028	China	93.9	3,997
France	6.5	303	Egypt	1.88	80.1
Malaysia	3.5	162	Hungary	1.63	69.5
USA	2.4	111	Poland	0.83	35.1
Viet Nam	2.3	109	Madagascar	0.54	24.0
Thailand	2.3	108	France	0,27	11.4
India	2.1	97	Israel	0.15	6.5
Myanmar	1.85	87	Iran	0.11	4.8
South Korea	1.58	74	Myanmar	0.10	4.3
Hungary	1.48	69	UK	0.09	4.0
Germany	1.18	55	Turkey	0.09	3.8
Egypt	1.09	51	Germany	0.08	3.3
UK	1.0	47	Ireland	0.05	2.0
Philippines	0.86	40	Canada	0.04	1.7
Indonesia	0.71	33	Thailand	0.04	1.5
Bangladesh	0.61	29	Bulgaria	0.03	1.3
Mexico	0.57	27	Croatia	0.03	1.1
Poland	0.51	24	Argentina	0.02	1.0
Netherlands	0.35	17	South Africa	0.02	0.9
North Korea	0.31	14	Philippines	0.02	0.7
	96.1			99.92	

The top twenty countries produce 96.1 % duck meat of the world production and 99.9 % global goose meat with a value of 4,485 and 4,254 million Dollar ($), respective. China alone contributes 65 % of the duck production, followed by France, Malaysia, USA, Vietnam and Thailand, and 93.9% of the geese production, followed by Egypt, Hungary, Poland and Madagascar.

Development of waterfowl egg production

Processing of duck eggs to produce "salted eggs" and "thousand year eggs" or alkalized eggs has a long tradition in China and other Asian countries. In some countries like Philippines pre-incubated eggs (Balut) are used for consumption. In the other continents waterfowl eggs are used more or less for incubation only.

Between 1991 and 2007 the global production of other eggs for consumption (mainly eggs of waterfowl) increased from 2.57 million t to 4.59 million t or by 173 %, while the increase of total eggs was 162 % only (*Table 8*). Therefore the share of other eggs to total eggs has been increased from 6.57 % to 7.02 %.

Table 8: Development of production of other eggs in the world (million tons) between 1991 and 2007 (FAOSTAT 2009)

	1991	2001	2007
Total eggs, mill. T	39.1 (100)	56.4 (144)	63.4 (162)
Other eggs (duck)	2.57 (100)	4.14 (161)	4.45 (173)
Share to total eggs,%	6.57	7.34	7.02

About 95 % of the other eggs have been produced in Asia. China alone contributed 83.2 % (*Table 9).* The *per capita* production in the world was increased from 0.47 to 0.69 kg or to 147 %..

Table 9: Development of production of waterfowl (other) eggs in Asian countries between 1991 and 2007 (Calculated based on data of FAOSTAT, 2009).

Country	Total other eggs, 1000 t	Change to 1991, %	Other eggs per head, g	Change to 1991, %	Share of total poultry eggs, %	Change to 1991, %
World	4,590	178	692	147	7.2	109
Asia	4,354	182	1085	144	11.3	83
China	3,821	204	2899	155	14.9	75
Thailand	310	105	4720	89	36.5	96
Indonesia	208	175	900	138	15.0	63
Bangladesh	76	317	510	232	29.7	108
Philippines	73	133	820	92	12.1	79
Vietnam	70 ?	-	820	-	27.5	-
Rep. Korea	28	712	570	633	5.2	577
Myanmar	18	300	330	94	7.0	49
Malaysia	11	110	410	75	2.3	77
Pakistan	7	140	43	102	1.5	58
Cambodia	3.8	146	310	103	21.9	100
Laos	0.3	88	50	63	2.3	29

Except Laos all mentioned Asian countries increased waterfowl egg production, but the *per capita* production shows a broad variety. Thailand, Philippines, Myanmar, Malaysia and Laos reduced the *per capita* production. China ranked second with 2.9 kg behind Thailand with 4.7 kg per head. The biggest jump made the republic of Korea with an increase of 712 % for total duck eggs and of 633 % of duck eggs per head. China with 83.2 %, Thailand with 6.75 %, Indonesia with 4.5 %, the Philippines, Bangladesh and Vietnam with 1.5-1.6 % have more than 99 % share of the world production of other or duck eggs. In these countries duck eggs gained a high share of poultry eggs, like Thailand with 36.5 %, Bangladesh with 29.7 %, Viet Nam with 27.5 % and Cambodia with 21.9 %.

Trade of waterfowl products

The comparison of export and import of duck and goose meat between 2001 and 2007 shows some changes (*Table 9*). China could increase duck and goose meat export to 141 and 108 %, respective. Netherland doubled duck meat export, but France, Hungary and Thailand reduced duck meat export to 81 %, 66 %% and 23 %, respective. Japan and Hong Kong have been the main importer for duck meat in Asia. In Europe Germany und UK are the main duck meat importer.

Table 9: The leading duck meat (tons) exporting and importing countries in 2007 (FAOSTAT, 2009)

Country	Export	Country	Import
World	123,433	World	127,818
China	30,844	Hong Kong	41,583
Thailand	4,630	Japan	6,620
Netherlands	16,,827	Germany	14,896
Hungary	16,059	UK	8,835
France	12,511	Spain	5,441

With regard to goose meat Poland, China and Hungary are the main exporter and Germany is the main importer (*Table 10).* The main exporter to Germany for ducks are France and Netherlands, but for geese Hungary and Poland. Self-sufficiency of duck and goose meat in Germany amounts to 60 % and 13 %, respectively.

Table 10: The leading goose meat (tons) exporting and importing countries in 2007 (FAOSTAT, 2009)

Country	Export	Country	Import
World	44,092	World	31,341
China	13986	Germany	20,543
Hungary	10583		
Poland	18,015		

Eggs are not traded over long distances. Therefore there are no data on import and export of other or waterfowl eggs.

In some countries, especially France, Hungary and China geese and ducks are used for forced feeding to produce fatty livers. In Europe forced feeding is discussed concerning animal welfare, but it utilizes the ability of waterfowl to take in large amounts of feed and to deposit a lot of fat in the liver. This is essential for wild migrating ducks and geese. In France more than 30 million Muscovy and Mule drakes per year are used for fatty liver production. In 2007 France had an export of 2510 tons fatty liver (*Foie Grass*), followed by China and Thailand with 712 tons each (FAOSTAT, 2009).

Waterfowl is also widely used as a source of feathers and downs. They are obtained at the time of slaughter of waterfowl as a valuable by-product. The harvesting of feathers and downs from live ducks and geese during the partial moulting at intervals of about seven weeks can be an additional source of income from fattening geese kept on pastures until the age of more than 22 weeks and from breeding or laying ducks and geese in small-scale farms. In 2000 the value of world trade of 55,000 tons downs and feathers was 600 million $ (WEZYK and CYWA-BENKO, 2002). *Table 11* shows the most important exporters and importers of feathers and downs.

Table 11: Trade of waterfowl feathers and downs in 2000 (WEZYK and CYWA-BENKO, 2002)

Country	Export, 1000 tons	Country	Import, 1000 tons
China	22,5	USA	19.2
Taiwan	9.0	Taiwan	14.3
Thailand	3.0	Germany	7.9
Hungary	3.0	Japan	7.7
Singapore	2.3	France	4.7
Vietnam	2.0		
Poland	1.1		
Total	42.8		53.8

Contribution of waterfowl production for food security

From the preceding analysis it has become obvious that there are extreme differences in the contribution of waterfowl production for food security between continents and countries.
In industrialized countries with a long tradition in waterfowl, duck and goose meat production may be further developed to diversify the offer of poultry meat despite of the higher price, especially to meet the seasonal demand for special products, for example the Christmas goose or smoked goose breast in Germany and in central Europe and the Peking duck in East Asia. The increasing number of Chinese

restaurants with a wide offer of special Peking duck dishes in Europe and North America contributes to a growing demand for duck meat. Also in China and other Asian countries with a high percentage of Chinese people, a growing production of duck meat and duck eggs based on intensive production systems can be expected.

Intensive production systems have been developed during the last 50 years through activities of breeders, nutritionists and specialists for management and health. Fully integrated duck production operations have been established, with parent-stock, hatcheries, growing farms and processing plants. Modern hybrids achieve high performance. Also in the future it can be expected a breeding progress in feed efficiency, meatiness, egg number, fertility, hatchability and incidence of disorders by selection for "robustness" (HALL, 2006). Intensive waterfowl production of meat and eggs shall be as effectively as possible to utilize the genetic potency and to improve product quality by breeding, nutrition and management according to the requirements of animal welfare and environment protection. The feeding standards will be adapted to increasing genetic potency.

Consumers in developed countries are not only interested in the price and quality of the final product, but also in the manner in which meat is produced. That means that intensive production systems for ducks and geese have to be organized in such a way that there is no negative influence on welfare of birds and on environment (RODEENBERG *et al*., 2005). Some people with high buying power prefer meat from organic or ecological production systems. Apart from commercial farms with intensive production systems, traditional system of keeping ducks and geese in free range with access to water for bathing will stay popular.

In the developing countries extensive production in small-scale or family farms is dominating. In some countries of south-east Asia more than 80 % of poultry is kept in small-scale family farms. DINESH *et.al,* (2008) reported on a project of FAO, carried out in Cambodia. In almost 100 duck farms in five provinces of Cambodia the production systems and the genotypes have been characterized. Almost 80 % of the ducks were common ducks in laying type and about 20 % belonged to Muscovy ducks. The ducks are reared under free range systems and survive mainly by scavenging, but most of the farmers give extra feed, mainly grain from the own farm. The average flock size in the provinces was between 204 and 10.4. Very few farmers used improved breeds for upgrading the flock. More than 40 % of the farmers used to hatch the ducklings in their own farm using a Muscovy duck or a brooding hen. Others bought ducklings from the neighbor or local market. The housing constructions were mainly made of on-farm material but 7 % did not provide shelter. More than 70 % of the farmers did not use veterinary service and vaccination program. The average egg number per duck was less than 50. The average body weight of the females from different provinces was between 1.3 and 1.4 kg. After meeting the family requirement, 57 farmers sell the surplus eggs and 53 sell growers, drakes and spent ducks either at the local village market or to local trader.

Extensive waterfowl production in small-scale farms plays a vital role in rural areas in Asian countries for utilization of cheap natural feed resources by scavenging, like insects, worms, snails and snakes. But the productivity under these conditions is low. The availability of low-cost or gratis feed might compensate the disadvantage of low performance. But any supplement of concentrate with minerals and vitamins will be adequate to provide a balanced ration. This is important also under scavenging conditions to increase the production for food security.

GUEYE (2009) has written:" Family poultry represent an appropriate system for supplying the fast growing human population with high quality protein and providing additional income to resource-poor small farmers, especially women. Although requiring low levels of inputs (housings, feeds, breeds, vaccines, drugs, equipment and time/attention), family poultry farmers contribute significantly to food security, poverty alleviation and the ecologically sound management of natural resources,"

However, small-scale producers are often constrained by poor access to appropriate technologies and information, as well as markets and support services, which could otherwise substantially improve productivity and income generation. Along with these basic problems outbreak of diseases like, Highly

Pathogenic Avian Influenza (HPAI) etc. made the life of the rural duck farmers more miserable (DINESH *et.al,* 2008). Despite of high increase of waterfowl meat and egg per head between 1991 and 2007 some countries in south-east Asia with high share of small-scale farms have a low level of waterfowl production. The following measurements could support family waterfowl farms to achieve higher productivity as presupposition for more meat and eggs.

- Providing of ducklings and goslings of improved genotypes from parent-stock farms.
- Offer of concentrate as additional feed for better utilization of natural feed resources and to ensure a balanced nutrition. Free-range ducks can suffer from a shortage of vitamins and minerals. Mould growth in paddy rice, maize and peanuts has to be prevented..
- Management has to be improved, especially for protecting ducklings and goslings in the first weeks of life by providing an additional heat source as well as drinking water and protein rich feed.
- Using of veterinary service, vaccination programs and disease control,
- Improving education, training and extension by radio programs and demonstration farms

SHELDON (2000) has emphasized adequate education and training at all levels, including agricultural extension, full involvement of women at all stages of the development, provision of low-cost credit facilities, and development of suitable marketing systems, including cooperatives. HUQUE (1996) has described the improvement of the small-farmers skill and how to participate women.

Duck farming in the most south and south-east Asian countries consists of large numbers of small farms and only few intensive commercial farms. Where integrated waterfowl production operations have been established, family farms should be included and supported. By introducing the contract purchase and sales system family farms can be helped to increase their production capacity with access to the market. Also Non-Governmental Organizations (NGO) can play a significant role in support of backyard duck production as mentioned by PEETHAMBARAN and JALALUDEEN (2005).

The fact that Africa and Latin America has only a modest contribution to waterfowl production (see Table 2 and 3) is not fully understandable, since the climatic conditions in the humid areas are similar to those in south-east Asia. In most African countries more than 70-80 % of poultry is kept in family farms (SONAIYA, 2007). But the share of waterfowl is low. Duck meat and eggs are not accepted and there is only little demand for eating waterfowl products. Perhaps, there is a lack of information on the nutritional value of these products. Geese are mostly kept as pets or guards. In Latin America chicken meat production has been increased in the last decades and is much cheaper than duck meat. BONINO and VELEZ (1992) reported that in Argentina farmers have changed from Peking ducks to broiler because of the consumer preference for leaner meat and the higher efficiency of the vertically integrated broiler operations companies.

Due to its good foraging and incubation behavior, Muscovy ducks are especially suitable for scavenging systems and they have a better adaptability to hot climate than chickens. The Muscovy duck would be suitable for small–scale rural farmers in these areas in Africa and Latin America and could contribute to food security. In rural tropical areas where meat cannot be conserved for a long time ducks provide a good protein source for one or two day consumption by a family. The eggs are naturally incubated and the ducklings are reared by the duck mother with high safety.

Generally, waterfowl is more convenient for regions with hot and humid climate than chickens. In countries with such climatic conditions more support should be given for waterfowl production in family farms to ensure an increase in productivity and an important contribution to food security.

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LEAD PAPERS

WATERFOWL GENOME RESEARCH: CURRENT STATUS AND FUTURE DIRECTIONS

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Duck and other waterfowl are of great importance for food security of mankind. As a major natural reservoir of influenza virus and an important food source, the duck is of great biological interest. Compared with species such as humans, mice and chickens, molecular genetic research in the duck has just made its first steps. The first genetic map and QTLs for carcass, meat quality, body weights and conformation traits, marker-assisted selection in the duck were published recently. Microarrays, and other new technologies such as marker-assisted selection, transgenics and RNA interference, give scientists the opportunity, for the first time, to use molecular genetics to modify the phenotype of the poultry including duck and geese to meet previously defined production goals. These genetic tools have been used to detect QTLs related to growth, carcass and meat quality traits of duck and geese. Hundreds of SNPs were detected in this exercise and, by themselves; these are a rich resource for genomics applications in waterfowl breeding. These new resources will be used in the battle against infectious diseases, such as avian influenza.

Key words: Waterfowl, genomic research

Introdution

Ducks, belonging to the order Anseriformes, diverged from the chicken (Galliformes) ~110 million years ago (Tuinen and Hadly, 2004). According to paleontological data, the main radiation of the modern duck took place during the Miocene, 5–23 million years ago (Olson, 1985). As breeding deals with identifying and exploiting the genetic basis of phenotypes, the use of breeding of knowledge of molecular genetics, i.e. molecular breeding, can greatly supplement the previous practices of selective breeding in poultry including waterfpowl. Studies of developmental biology, physiology, immunology, oncology, and virology have traditionally capitalized on the amenable nature of the chicken and related species to genetic studies, and these investigations will now be greatly enhanced by the availability of the chicken genome sequence (International Chicken Genome Sequencing Consortium, 2004). Researchers are now able to accelerate their efforts through the use of microarrays, which allow scientists to examine changes in the expression of all of any bird's genes simultaneously, rather than one at a time. Ducks and other waerfowl, together with the ostrich, emu, peacock, turkey, quail, and other birds, play a major role in studies of bird evolution. Up to now, most available molecular data concerning ducks have come from evolutionary studies based on the analysis of mitochondrial DNA sequence (Donne-Gousse et al., 2002). However, information about duck genome is limited. The first genetic map and QTLs for carcass, meat quality, body weights and conformation traits, marker-assisted selection in the duck were published recently (Huang et al., 2008). Compared with species such as humans, mice and chickens, molecular genetic research in the duck has just made its first steps. This paper deals with the advances made in molecular research of duck and other waterfowl research and their potential applications in the genetic improvement programmes.

Historical developments

The application of poultry genetics and artificial selection began with the domestication of the chicken in Neolithic times. Following the rediscovery of Mendelism in 1900, genetics became an important science of 20th century. Long before Mendel wrote his seminal paper in 1865, the poultry had a proud history as the subject matter of practical genetics. Bateson and Punnett, whose experiments with

poultry offered the first demonstration of Mendelian heredity in the animal kingdom (Punnett, 1905-1908). Poultry breeding always led in the exploitation of knowledge of single genes such as those for plumage colour and for sex linked traits that can be used for sexing of day old chicks. Tremendous genetic improvement has been achieved in the quantitative characteristics of poultry by conventional methods of selective breeding. Molecular genetics is now opening this black box by elucidating the effect of single genes on the phenotypic expression of traits. There exist molecular methods to understand the complex genetic control of biological traits in poultry. Study on candidate genes is the direct approach, one way of using the genome information. Another way could be to use an intermediate ("gray box") approach by exploiting the information on huge numbers of genetic markers that was indirectly derived from the sequencing effort. Microarrays, and other new technologies such as marker-assisted selection, transgenics and RNA interference, give scientists the opportunity, for the first time, to use

molecular genetics to modify the phenotype of the poultry including duck and geese to meet previously defined production goals. The 'practical' use of genetic markers was in the establishment of linkages between these landmarks on the chromosomes and the genetic variability of traits of interest. Linkages were established through extensive "QTL mapping" experiments.

Structural Genomics

Genomic information about the duck is limited to a few linkage and physical mapping studies. Huang **et al**. (2006) produced a preliminary genetic map based on 240 microsatellite loci and assigned to 19 linkage groups. The sex-averaged map spanned 1,353 cM, with an average interval distance of 15 cM. Sex-specific maps have also been constructed. The length of the male map is 1,415 cM with an average intermarker distance of 16 cM, whereas the female map is 1,388 cM, with the average intermarker spacing of 17 cM (Huang et al., 2006). Assuming that the genetic maps between chicken and mallard are similar in length, then these maps only represent ~36% of the total predicted length of 3,800 cM (Groenen et al., 2000). Cross-species chromosome painting and G-banding studies have suggested one interchromosomal difference between the chicken and duck karyotypes – the ancestral chromosomes 4 and 10, fused in the chicken lineage to give GGA4q and GGA4p respectively, remain separate in duck (Griffin et al. 2007). This interchromosomal rearrangement presumably explains the difference in diploid chromosome number between the two species, which is 2n = 78 in chicken and 2n = 80 in duck. FISH mapping of 57 chicken BACs revealed small intrachromosomal rearrangements in APL2, 7, 8 and Z and confirmed synteny for GGA9, 11, 13–15, 18 and 28 in the duck genome (Fillon et al., 2007). Skinner et al. (2009) provided a molecular cytogenetic map of the duck genome through FISH assignment of 155 chicken clones. They identified one inter- and six intrachromosomal rearrangements between chicken and duck macrochromosomes and demonstrated conserved synteny among all microchromosomes analysed. Array comparative genomic hybridisation revealed 32 copy number variants, of which 5 overlap previously designated "hotspot" regions between chicken and turkey.

Cytogenetics is a branch of genetics that is concerned with the study of the structure and function of the cell, especially the chromosomes. It includes routine analysis of G-Banded chromosomes, other cytogenetic banding techniques, as well as molecular cytogenetics such as fluorescent in situ hybridization (FISH) and comparative genomic hybridization (CGH). Recently, a preliminary cytogenetic map of the duck was constructed by FISH using duck and chicken BAC clones (Huang et al., 2006; Yuan, 2007). Nine of the 19 linkage groups were assigned to nine pairs of duck chromosomes. The map was extended further by Yuan (2007) using eight BAC clones isolated from a duck library using duck microsatellite primers and assigned to duck chromosomes (Table 2). In total 22 microsatellite loci from 12 genetic linkage groups have been assigned to 10 duck chromosomes.

Genetic diversity analysis

Genetic diversity refers to the variation at the level of individual genes (polymorphism), and provides a mechanism for populations to adapt to their ever-changing environment. Microsatellites have proved to be useful polymorphic markers for the analysis of genetic diversity. Pierson *et al.* (2000) compared data from seven microsatellite DNA loci and 143 base pairs of the control region of mitochondrial DNA and found Aleutian geese were genetically differentiated from one another in terms of mitochondrial DNA haplotype and microsatellite allele frequencies.Williams *et al.* (2002) studied nuclear DNA-based markers for Mottled Ducks and determined levels of subdivision among populations in Florida. They screened 13 microsatellite primer pairs and identified six microsatellite loci that were variable in Mottled ducks. These markers revealed a low level of genetic differentiation and a high level of genetic exchange among four Mottled duck subpopulations within Florida. Williams *et al.* (2004) assessed genetic variation among 225 mottled ducks and mallards using five microsatellite loci. In contrast only 3.4% of mallards were inferred to have been hybrids, suggesting asymmetric hybridization. Populations from different geographic areas within Florida exhibited hybridization rates ranging from 0% to 24%. The genetic diversity of six goose breeds (White Goose, Zi Goose, Huoyan Goose, Wanxi Goose, Rhin, Landoise) was analyzed using microsatellite markers. Results showed that 7 microsatellite sites were highly polymorphic, and could be used as effective markers for analysis of genetic relationship among different goose breeds. Among six goose breeds, the lowest was Rhin goose (0.6617) and the highest (0.8814) was Zi goose (Shuang *et al.,* 2006). Yunjie *et al.* (2006) examined the genetic structure of 13 indigenous grey goose breeds using 31 polymorphic microsatellite markers. Of the 13 goose breeds, the highest mean heterozygosity was observed in the Shitou (0.6727), whereas the lowest heterozygosity was found in the Yan breed (0.4985). Tu *et al*. (2006) studied the genetic structure research of 14 indigenous grey goose breeds using 19 developed and 12 searched microsatellite markers with middle polymorphism. The results indicated that 25 out of 31 microsatellite sites showed polymorphic at medium level. The mean heterozygosity was between 0.4985 and 0.6916. A study on genetic structure of Pekin and Moscovy duck populations in north of Iran, Mazandaran province using 6 polymorphic microsatellite markers revealed an observed allele number in each locus as 1 to 4, effective allele number from 1 to 3.78, heterozygosity from 0 to 0.98 and the genetic distance between two populations was measured as 0.59 percentages (Ahmadi et al., 2007). The low of genetic distance between two populations and the low level of mean heterozygosity index indicate that the genetic diversity is low in within and between populations. The first AFLP genetic linkage map in ducks was constructed by Amplified fragment length polymorphism (AFLP) (Huang et al., 2009). The AFLP linkage map included 260 co-dominant markers distributed in 32 linkage groups. Each linkage group contained three to 63 molecular markers and their size ranged between 19.0 cM and 171.9

cM. This AFLP linkage map provides important information for establishing a duck chromosome map, for mapping quantitative trait loci (QTL mapping) and for breeding applications.

QTL mapping

Quantitative trait loci (QTL) are stretches of DNA that are closely linked to the genes that underlie the trait in question. QTLs can be molecularly identified (for example, with AFLP and microsatellites) to help map regions of the genome that contain genes involved in influencing a quantitative trait. This can be an early step in identifying and sequencing these genes. Many QTLs that affect a broad range of phenotypes including growth, body composition and fertility, have already been mapped with high confidence in many livestock species. However, the lack of genomic resources and a high-density genetic map in the duck has hampered progress in gene mapping and identification of QTL in this species. Research on QTL mapping in duck has been initiated only in recent years. For detecting and mapping QTL, the construction of a genetic linkage map is a prerequisite and in duck genetic map data are very limited. Huang et al. (2007a; 2007b) investigated QTLs for carcass, meat quality, body weight and conformation traits using 95 microsatellite markers distributed over 1,237 cM. Half-sib analysis in Pekin ducks using a multiple QTL model revealed a total of 45 QTLs for 21 traits on 10 linkage groups. In another study, Huang et al. (2009) have chosen the AFLP technique to develop a duck genetic map. They have used the **Taq**I/**Eco**RI restriction enzyme combination and selective PCR primers to generate molecular genetic markers and to establish a duck genetic linkage map from a resource population originating from a cross between two outbred selected lines of laying and meat type ducks. The AFLP linkage map included 260 co-dominant markers distributed in 32 linkage groups. Each linkage group contained three to 63 molecular markers and their size ranged between 19.0 cM and 171.9 cM. This AFLP linkage map provides important information for establishing a duck chromosome map, for mapping quantitative trait loci (QTL mapping) and for breeding applications.

Genomic selection

Marker assisted selection or marker aided selection (MAS) is a process whereby a marker (morphological, biochemical or one based on DNA/RNA variation) is used for indirect selection of a genetic determinant or determinants of a trait of interest (i.e. productivity, disease resistance, abiotic stress tolerance, and/or quality). In molecular selection, a unique DNA sequence occurring in proximity to the gene or locus or QTL of interest, can be identified by a range of molecular techniques such as RFLPs, RAPDs, AFLP, DAF, SRAP, SNP, SCARs, microsatellites etc. However, the application of MAS for genetic improvement relies on the level of precision at which a QTL has been identified, which in turn requires high resolution maps of genetic markers of great utility. Using a preliminary genetic map of the duck, QTL have been mapped in the Beijing duck (Huang et al., 2007a and 2007b). The single nucleotide polymorphism (SNP) of *growth hormone* gene was investigated in various breeds of duck, including Beijing ducks, Xihu mallards, Jinding ducks, Shan Partridge ducks, Jingjiang ducks and Shaoxing ducks. The SNPs were detected by PCR-SSCP method in intron 3. The analytic results showed that the frequencies of genotypes in different breeds were significantly different. Based on these SNPs, Beijing ducks and Shaoxing ducks represented their own unique conservativeness, indicating that these SNPs may have relationship with some productive traits of duck (Xu et al., 2007). Dong et al (2007) concluded that *adiponectin* gene had a high level of SNP in different duck breeds, and could be used as a candidate gene to analyze the correlation between its polymorphism and fat traits in duck. Polymorphisms have also been detected by DNA sequencing, in exon 7 of the *lipoprotein lipase* gene and it was associated with abdominal fat weight and percentage of abdominal fat weight of native Peking duck and with percentage of subcutaneous fat plus skin weight and abdominal fat weight of Cherry Valley Peking duck (Wu et al., 2008). The relationships between two SNPs, T179C and C195T of *preproinsulin* gene and the traits of carcasses in Peking duck and Cherry Valley duck had significant influence on carcass weight, carcass net weight and breast muscle weight (Kong et al, 2008).A T/C mutation at the position of the 1326 bp of the *duck prolactin* gene was found to influence egg number, clutch days, and the body weight at first egg in Gaoyou duck, a Chinese indigenous breed famous for double-yolked egg (Li et al., 2009).

Comparative Genomics

Comparative genomics allows the transfer of genomic information from a well-characterized species to another that is less well described. It can be applied at all levels from that of the chromosome to the genome sequence. However, despite the recent advances in sequencing technologies, the considerable effort involved in producing a genome sequence assembly is reflected by the small number of vertebrate genomes that have been sequenced to date. In birds, there is only one published genome sequence, that of the chicken, with the zebra finch genome due to be published soon. Combining cross-species fluorescent in-situ hybridization (FISH) and microarray analysis using resources developed in the chicken provides a powerful tool for the identification of gross genomic rearrangements, gene gains/losses, copy number

variants (CNVs) and gene order in other bird species. Huang *et al*. (2006) produced a preliminary genetic map based on 240 microsatellite loci and assigned 11 out of 19 linkage groups to ten duck (APL) chromosomes by FISH mapping of 28 BACs. Cross-species chromosome painting and G-banding studies (Schmid et al., 2005) have suggested one interchromosomal difference between the chicken and duck karyotypes – the ancestral chromosomes 4 and 10, fused in the chicken lineage to give GGA4q and GGA4p respectively, remain separate in duck (Griffin et al., 2007). A molecular cytogenetic map for the duck based on comparative FISH mapping of 155 chicken BACs, which revealed several hitherto undescribed

intrachromosomal rearrangements. This study also provided an analysis of CNVs in the duck genome by array comparative genomic hybridisation (array CGH) of duck DNA to a commercially available chicken whole-genome oligonucleotide tiling path microarray. The analysis of CNVs supports the hypotheses that bird genomes contain fewer CNVs than mammalian genomes and that some CNVs appear to be consistently shared across species, forming CNV hotspots.

Genomics of immune system

Studying the variability in key immune genes/regions like Ig receptors, T-cell receptors, MHC genes and cytokines between and within species can provide insights on the immunity. Ducks and chickens have different susceptibilities to avian influenza viruses. Ducks are often asymptomatic carriers of influenza virus strains that are lethal to chickens. A comparison of the genetic makeup between chicken and duck may provide important insights into the molecular basis for this difference in susceptibility. The sequence and genomic location of genes in these other species has been exploited to clone immune-related genes in duck, such as those coding for B cell activating factor (BAFF), interleukin-2 (IL-2), CD40 ligand (CD54) and interferon gamma. Almost one-third (1,763) of the chicken gene probes cross hybridized to the duck spleen-derived mRNA (Keeler et al., 2007). Xia et al. (2007) have sequenced 3,168 clones from a spleen cDNA library of a Beijing duck, and identified 208 genes relevant to the duck immune system. Recently, MacDonald et al. (2007) have used a targeted approach to clone specific immune-related genes from the duck genome involved in antiviral immune responses, including the immunoglobulin locus, the MHC class I genomic region, the leukocyte receptor complex genes, lectin-like immunoreceptors and Toll-like receptors. Compared to four in other avian species (Shiina et al., 1999), MHC class I region of the duck contains five genes that show a high level of overall similarity.. Despite an expanded number of genes in the genome, the duck MHC class I region functionally resembles the minimal MHC of the domestic chicken (Moon *et* al. 2005)

Future Directions

The chicken genome has become the "foundation reference genome" for assembly and annotation of genome sequences for all archosaurs. Both turkey and zebra finch are undergoing genome sequencing (turkey because of its importance as an agricultural species and as a biomedical model for aging, while zebra finch is a biomedical model for behaviour and vocalization). Genome sequencing of these avian species utilizes chicken genome information to facilitate assembly and annotation. EST projects are already underway for additional bird species (eg. Quail and condor) and in the three to five year timeframe, it is likely that sequencing of additional bird genomes such as duck and other waterfowl will be undertaken. The voluminous information generated will provide insight into the genome to assess genetic variability at the genome level. This will affect the structure of breeding programmes and also impact the integration of breeding in the production system. The new knowledge of the molecular basis of poultry phenotypes that is generated along the way will be used to engineer and re-design the poultry genome with novel technologies, and genetically engineered breeds ducks and geese may be marketed within twenty years. Extensive usage of genome-wide marker coverage by SNPs and QTL mapping will become an essential part of every poultry breeding programme. As any other animal, waterfowls will also witness elucidation of gene structure through gene function, gene expression, protein interactions,

biochemical and signaling pathways, cellular function and cell to cell communication towards a complete understanding of how phenotypic performance of the waterfowl is regulated. Delivery of a transgene or gene construct to an avian embryo is much more complicated than in a mammalian system. However, perseverance for more than twenty years in this area by several research groups has created definite progress and will come out with breakthrough from academic-private partnerships. Although current transgenics are focusing on applications in the pharmaceutical domain, these achievements do open the way to exploitation in poultry breeding for agricultural purposes. The tools of molecular genetics will generate datasets of unprecedented size for animal agriculture, such as those resulting from studies of genomic sequence and sequence polymorphisms and from large scale gene expression analyses using microarrays. Thus, development of new statistical theory and methodology and, especially, bioinformatics tools to address these genomic data analysis will also evolve.

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HOW ACTUAL RESEARCH CAN OPTIMIZE WATERFOWL PRODUCTION IN ACCORDANCE WITH SUSTAINABILITY.

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Summary.

Modern production of waterfowl, as other animal productions, is changing progressively in accordance with the need for sustainable systems. Whatever field of investigation considered, actual research programs are set to improve the waterfowl production but at any time with concern for the sustainability. The aim of this report is to estimate how recent research has tried to reach this goal in various fields of investigation.

Key words.

Waterfowl, production, research, sustainable systems.

Introduction.

Even if some waterfowl species were recognized as domesticated a long time ago, at least 2500 BC (Guémené and Guy 2004), they were scarcely investigated as research topics comparatively to other avian species. The way current programs focus on waterfowl can easily enhance the general knowledge on these species and contribute to noticeable improvements. However there is still a lot to do in this field and the objective of this report is to evaluate how science can influence positively the management and the production of waterfowl in the future, while respecting the social demand.

Genetics.

Selection progress is obviously established, and it was initiated a long time ago. Indeed for example pekin duck in its modern form is phenotypically strongly different from his ancestor the wild mallard duck considering either the colour of the plumage, the laying performances or the live body weight. Breeders have progressively modified these animals, improving characteristic interests like meat yield, growth rate, number of eggs first or even final meat quality. All these programs have lead to strains which are considered adapted to the present market demand. Although selection programs are still consistent to improve most of these classical parameters, nowadays the main objective of the breeders has changed in accordance with the social demand. Thus all the characters which influence the productivity are not solely taken into account any more, besides those which are in accordance with the social demand, which ask for sustainable production are now considered foremost. Among these parameters, those which influence animal welfare are now taking a large place in the selection programs. For example, after the European Scientific Committee on Animal Health and Animal Welfare (scientific report 1998 dec 16th) asked to avoid the use of genetic strains whose welfare was poor in relation to foie gras production, it was decided to initiate a new program to select birds better adapted to the specific process of force feeding (Arnaud *et al* 2008 a,b, Brun *et al* 2008, Basso 2008 *et al*). The challenge is not easy in that it needs to select quiet and docile hybrid mule ducks, after considering the response of tested and selected pekin duck females. Contrary to the previous schedule of selection, this program has no direct effect on improvement of productivity or income, but was solely set to follow social demand.

Genetics is also taken into consideration to reduce feed consumption by selecting birds with good feed efficiency. This kind of program is not fully new in that genetics has yet to contribute to reduce feed conversion ratio (Larzul *et al* 2003), but until now the goal was rather focused in reducing the alimentary

cost. Now, the demand is also based on the fact that producers have accepted that meat production requires too much cereal and raw material in relation to what is available. In spite of reducing the total amount of vegetables consumed by animals the aim of this work is also to intervene positively in favour of the environment by reducing bird output.

Additionally to classical quantitative genetic programs, molecular genetics is dramatically progressing, and is supposed to enhance greatly the waterfowl production in the next few years. The availability of new markers developed everywhere at a world scale is increasing quickly, they constitute a great help in research of quantitative trait loci after a specific program was created with the aim to improve various characteristics (Marie Etancelin *et al* 2008). All these examples illustrate at least partly the influence of genetics on waterfowl production.

Physiology.

Although studies of physiology lead to a better knowledge of the waterfowl in a field of fundamental functions, they can also contribute to concrete and finalized scientific advances. The previous paragraph has shown that genetics has allowed modern strains to be adapted to the needs, and that it was likely that these strains will evolve in the future, in accordance with the market demand. To allow this, there is a need to store genetic diversity. Until now this was achieved by preserving locally old strains managed as small populations. A number of factors like cost, deleterious imbreeding, failure of management or

epidemic diseases constitute a major risk of loss for these genetic material. In this way a number of domestic breeds of waterfowl, particularly the old ones are endangered. These elements clearly justify the relevance of gene stock storage in a totally secured system. Cryoconservation of the semen was the first and main way to bring a concrete response to this challenge. Various freezing techniques specific to different waterfowl species have led to ensure spermatozoa preservation in such conditions (Dubos *et al* 2008). A stock of sperm straw issued from the most interesting breeds of ducks and geese whose cells are fully able to stay alive and fertile after thawing are preserved in a national cryobank. However this method seems to be not sufficient as far as it allows preserving only half of the genome. Indeed waterfowl genome as other birds is characterized by a ZW system where males appear haploids ZZ. An elaboration of a new method of preservation of the whole genome is requested to fill the aim of secure biodiversity storage for a long term. Based on the general knowledge of embryonic development, and studies on stem cells, a new and complementary program is envisaged. It will deal with culture, freezing, and transfer of blastodermal cells, and is supposed to bring an opportunity of integral and secure preservation of the genetic diversity. At the moment, we're waiting for a concrete use in any other areas.

Nutrition.

The nutritional aspects of waterfowl production have been quite widely investigated and the diets are most of the time well balanced to fill requirements, to ensure normal growth of the birds and to minimize as far as possible alimentary cost and feed intake. Nevertheless there is still a great interest in this kind of work. Again the need originates partly due to the demand to produce in a specific way of sustainability. Related to a programmed failure in the availability of gasoline originating from petrol issues, a number of countries have developed production of bio-fuel. Among the different local processes the use of corn for bio-ethanol production is found on one hand, and oilseeds on the other hand for the production of oil methyl ester. Additionally some raw co-products issued from the processing: respectively brewer's corn, and meal from rapeseed and sunflower. All these new local resources should be incorporated in diets and tested for duck nutrition (Bernadet *et al* 2008).

Corn production occurs nearly everywhere in the world since the ambient temperatures are warm enough. This cereal has as a great advantage the fact that it is well adapted to almost all avian species; a high level of incorporation is possible, since no nutritional limit is known instead of the filling of nitrogen

requirements. Furthermore the yield of this crop is particularly high and justifies the interest in producing this cereal. However this plant has a disadvantage in that its requirement for water is one of the biggest amongst vegetable productions. Considering the native failure of water at the world scale enhanced by climatic changes and a general increase of the temperature, cereal producers are envisaging to replace corn by sorghum, a plant less demanding in water but with the chemical analysis closed to that of corn grain. Obviously, sorghum utilisation for duck nutrition has to be evaluated before general use.

Modern avian production including those of waterfowl is based on intensive design, and use almost all of the time food concentrate, besides diets produced by mills factories. But there is now a tendency to produce poultry in another more extensive way. These changes are justified both by a reduction of the alimentary cost, and a high demand for farm products instead of industrial ones. The waterfowl, especially the geese appear well adapted to such feeding systems which integrate the raw production of the farms. Depending on the area of production farmers cultivate cereals like corn, wheat, barley or triticale or local sources of proteins like faba beams, lupine or field peas. A large number of raw materials have been tested with the aim to balance the diets for energy and protein content, but it was assumed that three or four of these components are sufficient to ensure a consistent and normal growth. In addition these basic diets are well accepted by waterfowl either as whole grain form or sometimes roughly crushed. It reduces the energy consumption associated with pellet manufacture.

Environment.

For a long time nutritionists who were involved with diet formulation had as an unique goal to meet the requirements of birds whilst using raw materials of the lowest cost. Nowadays stakes have changed, and they must be aware of environmental consequences when establishing the composition of a diet. The first effort towards protecting the environment was focused on reduction of nitrogen output. This was achieved in two steps, the first one being the complete knowledge of the bird's requirement for each species and at each step of age. In a second time nutritionists succeed to decrease the level of crude protein of the diets by using synthesis amino acids (Robin *et al* 2002 a,b,c). The second element to be investigated was phosphorus, according to the dramatic negative effects of its spewing into the environment. As for nitrogen control in the outputs the first step was to establish the waterfowl requirements in terms of phosphorus. After this, further studies were set to improve the availability of phosphorus coming from raw vegetable material by the use of specific enzymes: the phytases (Bernadet *et al* 2002 a,b Bernadet *et al* 2003, Bernadet *et al* 2004, Bernadet *et al* 2006). Subsequent to these two main elements, various programs were set to reduce to the lowest, the introduction of oligo minerals like copper, zinc, cobalt,… (Ducamp *et al* 2008).

In terms of the environment two fields are currently subject to economical as far as their availability is supposed to be less evident. We have already mentioned the failure of water in the nutritional chapter; we now want to deal with the energy reduction which is possible besides number of actions. For example, in a number of farms which breed waterfowl the land is used for corn production. This corn is frequently used for geese and ducks produced locally but before they are submitted to various treatments but all are consuming energy at different levels. When harvesting corn around October the water content in

cereal is currently ranging from 25 to 35% of moisture. Under the classical method of storage this water content does not allow us to preserve the corn at the optimal condition for sanitary product. This explains why the new harvested corn has to be transported to factories where it is heated in order to reduce the water content to a maximum level of 15%. The corn is sometimes stored in the factories, which lead to further expense for the producer, whatever the moment corn is always brought back to the farm before being delivered to waterfowl. It is noticeable that corn should be used for feeding ducks and geese during the breeding period as well during the force feeding period when this practice occurs on the farm. For this last purpose before use, corn must be rehydrated. All the steps of this process are obviously expensive in terms of energy, either for transport or to dry the cereal. A new method is starting to develop; the

principle is to harvest and to keep the corn at a quite high level of moisture. To avoid fungi development, the storage occurs in a specific pliable fodder silo. The principle is that after filling this silo with grain all the oxygen is consumed by bacteria in less than 24 h, subsequently the atmosphere in the silo is oxygen-less including during the process of corn removal. Under such conditions of storage the corn with about 30% water can be preserved for one year at least without any detriment of its quality (Ducamp *et al* 2008).

In spite of these programs which have noticeably contributed to a decrease in all forms of spillage, the amount of waste remains at a high level consistent with an elevated breeding activity. As in other animal or poultry productions, waterfowl producers have integrated in their facilities new systems devoted to manage better and if possible to value their waste production. Several ways exist depending on the size of the farm and the objective, it can be by a direct and rational use by fertilizing the land on the farm. But some specific processes to adapt the best solutions are developing, for example composting the entire waste product on the farm or even fermentation in order to produce bio-gaz. All these parameters play a positive role in the goal of setting sustainable breeding productions.

Animal health and welfare.

A number of experiments have been set to investigate duck welfare, especially in relation with force feeding practice (Guémené *et al* 2004). Successively, physiology, behaviour and nociceptive aspects have been investigated. Regarding physiology, it was shown that force feeding does not give an increase of corticosterone level when birds are housed in individual cages. Functionality of corticotropic axis, and reaction to other physical constraint gives a positive response by contrast, it ensures that force feeding, is not considered stressful for mule ducks (Guémené *et al* 2001). In addition, it was demonstrated that in force fed birds the liver was fully able to recover its initial state, same weight and no histological changes. It indicates that contrary to liver diseases like hepatitis, steatosis is a transitory and non pathological form of lipid storage. Behaviour studies on their own have shown an absence to aversion for the procedure and for the welfare of birds (Babilé *et al* 1998, Bénard *et al* 1998), and that the time schedule was not greatly modified during the force feeding procedure (Faure *et al* 1998, 2000). Lastly, investigations for nociceptive markers at the level of the digestive tract (crop) or at a neuronal level (brain, medullar) do not support the evidence that birds have felt any pain during the force feeding procedure (Servière, *et al* 2002, 2003, 2004). All together these elements resulting from more than fifteen years of research seem sufficient to ensure that force feeding when practised in adequate conditions of production is globally not detrimental to animal welfare. As a consequence, this kind of investigation is now no longer necessary.

Animal health is a major element of animal welfare, and this gives one explanation of research in this field. Modern husbandry practice including good management of waterfowl, prophylactic and vaccine programmes can greatly reduce the incidence of many diseases affecting waterfowl. In spite of the effect of disease on animal welfare, there are other measures to prevent as far as possible the occurrence of diseases. Diseases according to their gravity are detrimental to the income of producers by simply affecting growth rate in a first time, but they can also lead to morbidity or mortality at a higher or lower level. Besides these economical purposes which justify investigations for controlling waterfowl diseases, there is another reason for it, the fact that some of the waterfowl diseases are classified as potentially susceptible to affect humans. Probably the most important disease of poultry (waterfowl) recognized as dangerous for human is avian influenza on both its pathogen character, and its potential ability to spread all over the world in a pandemic form. Avian Influenza is now attracting much attention and enormous human and financial means are dedicated to investigate this disease. In addition, although they are not such a favourite target for the Media, other waterfowl diseases regularly affecting humans are also topics of research. They are of great importance, even if in most of case they look unnoticed in

birds themselves, the most common are: chlamydiosis, (Guérin *et al* 2006, Laroucau *et al* 2006), salmonella (Sellier *et al* 2008) or campilobacterium.

Conclusion.

In this text, we have tried to speak about the research programs focused in waterfowl in France. A number of fields depending on various scientific disciplines have been investigated, but they are all more or less related to sustainable productions. Nowadays the way of thinking has changed and research to improve productivity is not in fashion any more. There is a social demand to set new breeding systems whose aims are to respond to three major areas: economic, environmental and social. Each of these areas has to be taken in consideration with the principle that any choice in the

breeding system is required to be consistent with the respect of the others sustainable areas. The economic require that the production should allow a sufficient income to the producer. The environmental area must take in account a lot of things, the agricultural practices, the diversity, the water management, the waste recovery and animal welfare. The social area integrates at the same time quality products, demand of the consumer, life quality for the producers, employment and must also manage the alimentary equilibrium on a world scale. To produce better is also to produce more sustainably, it is imperative to respect this principle if we want to transmit a good situation to future generations.

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THE RISKS TO HUMAN HEALTH AND FOOD SECURITY FROM THE WATERFOWL/AVIAN INFLUENZA CONNECTION

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Abbreviated title: Waterfowl/avian influenza connection risks

Abstract

Global human health and the food security of millions of the world's population are seriously threatened by the highly pathogenic avian influenza (HPAI) H5N1 virus. Most at risk are the rural poor, 80% of whose livelihoods depend on small-scale livestock farming. Waterfowl form a large part of this sector, particularly in Asia. Unfortunately, waterfowl are natural hosts of AI viruses. Farming operations that concentrate large numbers of waterfowl in unconfined conditions can become virus reservoirs opening a pathway for transmission to other farmed poultry.

Little structurally co-ordinated preventive effort has been made to stamp out or at least control the H5N1 virus at the baseline avian level at the expense of efforts toward therapeutic vaccines and antiviral explorations for humans.

It is urgent that an all-out effort is made to stop the virus in its tracks and eliminate the disease from poultry. After all, it is the avian host that is largely responsible for the threat to the human population.

Continuous global virus surveillance and control are a tall order and can only be achieved through a multi-level approach to education in poultry industries, from basic skills instruction to poultry producers, small scale village subsistence farmers and commercial operators alike, through to wider dissemination of information to professionals and decision makers in government. A structured approach based largely on education could build on foundations that already exist in most countries.

It is conceded at the outset that the world is engaged in battle with the H5N1 virus. Already it has destroyed many millions of poultry and over two hundred and sixty humans. The tools are available to fight back and win this battle, but it will require long-term cooperation and determination of many people from many disciplines.

Keywords: avian influenza; waterfowl; human health; food security; surveillance; education

Introduction

Global human health and food security are seriously threatened by the highly pathogenic avian influenza (HPAI) H5N1 virus. Those most at risk are the rural poor, 80% of whose livelihoods depend on small-scale livestock farming, predominantly of poultry. Failure to protect this sector of the population and their livestock from viruses such as H5N1 will aggravate the food security and health of many millions of people.

Officially, 15 countries have confirmed human H5N1 cases, 12 reporting deaths to date. Indonesia with 115 deaths from 141 known cases and Vietnam with 56 from 111 cases are the two that have suffered the most serious human health consequences. Furthermore, 75% of all human infections and 85% of human deaths have occurred in Asian countries. Globally, 433 people have reportedly contracted

the disease with 262 fatalities. There are probably many more unconfirmed cases and deaths in the region, the data understating the magnitude of the problem.

Moreover, many millions of poultry have been slaughtered across affected regions in an attempt to control the virus. Recently, 148 outbreaks of HPAI in poultry have been officially reported in the month of July 2009. The damage continues even though the effects of HPAI appear to have waned. It is critical to understand that the risks posed by the virus are still very real. The aim in presenting this paper is (1) to raise awareness that the world needs to reduce the dual threats of an influenza pandemic and destruction of poultry protein supplies by the H5N1 virus, and (2) to effect these through multi-level education about the avian influenza virus problem particularly for veterinarians and poultry extension officers.

The Avian Influenza Problem

It is clear that the world currently faces yet another unprecedented danger – the possibility of a rapid, catastrophic influenza pandemic caused by the HPAI H5N1 virus or a derivative of it. Heightened awareness can be traced back 12 years to Hong Kong by the recognition for the first time of a possible pandemic virus, viz. H5N1/97 virus, in chicken and humans. A possible pandemic was averted by the slaughter of poultry across the HK SAR. Since then, other descendants of the parental goose H5N1 virus have become endemic in Eastern Asia in China, Vietnam and Indonesia and possibly elsewhere, spreading across the Eurasian land mass to Western Europe and Northern Africa. While a pandemic has not eventuated 12 years on, one could erupt at any time particularly from the Asian arena.

This situation is not so much a consequence of global benign neglect, rather that so little structurally co-ordinated preventive effort has been made to stamp out or at least control the virus in avians at the expense of efforts toward therapeutic vaccines and antiviral explorations for humans. True, international agencies, NGOs and governments have done much but the cold, hard reality is that the virus is still with us, "popping up" unexpectedly in different places and still causing disease outbreaks in chicken and human deaths.

Ideally the world should strike at the heart of the problem and stop the virus in its tracks. This can only be achieved by an all out effort to eliminate the disease from poultry. After all, it is the avian host that is largely responsible for the threat to the human population. But it is the unimpressive reaction of the global human community that is allowing it to happen.

Unless the world can come to grips with HPAI H5N1, all the gains made in pandemic preparedness from the 1997 warning will be lost. It must quickly build upon those gains and re-think the structural approach to the problem, a problem that has probably had an Asian focus over two millennia. Colleagues in Asia are now called upon to support more fundamental approaches toward the control of AI at the baseline avian level in Asia to set the ball rolling.

Controlling Avian Influenza

There is a pressing need to beef-up virus surveillance within H5N1 positive zones to curtail spread there and to prevent spread beyond to negative zones. Very few places do proactive virus surveillance responding only to "surprise" outbreaks or occasionally examining dead wild birds. Hong Kong lies in a "red hot" HPAI H5N1 zone. Continuous virus surveillance there with an emphasis on poultry populations showing excess deaths and on all dead wild birds has been highly effective in dealing with the H5N1 threat.

Continuous global virus surveillance and control is a tall order and can only be achieved through a multi-level approach to education in poultry industries, from basic skills education of poultry producers, small scale village subsistence farmers and commercial operators alike, through to wider education of professionals and decision makers in government. While there has been much effort in dealing with the H5N1 problem in recent years particularly in Asia, our connections with the poultry industries there, as well as anecdotal information suggest that understanding is not getting through notably in biosecurity.

Instruction delivered sometimes lacks quality and is not always effectively targeted. There should also be better instruction in avian medicine in veterinary and other curricula worldwide and more solid instruction for poultry extension officers who act as a link between veterinarian and poultry farmer. The focus needs to be on delivering appropriate education into the hands of the people who need it most. The challenges are great, but so is the opportunity for progress.

Building on Existing Foundations

Education

The educational need is complex, requiring firstly education in poultry husbandry involving farmers, extension and veterinary officers, and secondly upgrading the technology of virus surveillance and diagnosis for both avian and human hosts. All are critically interconnected.

While much is known about HPAI H5N1 disease and its causal virus, it is unfortunate that this knowledge has had only limited spread to the people who are in closest contact with poultry flocks, mostly rural dwellers and their families. It is here in the rural areas, at village and farm levels, that practical application of knowledge can have maximum effect against the virus. It is unfortunate that the flow of information very often stops short of the "grass roots" level. This situation probably results from a number of factors. One might well be the socio-economic position these people hold in the overall economy of the country. Another might be that the delivery of education is not broad enough to reach this level of society. In summary, education often does not reach the people in the very place it is needed most. So in order to make progress in the fight against AI, knowledge and education are critical. To reverse this situation, a thorough study of existing education delivery is necessary.

Veterinary Surveillance and Diagnostic Capability

The key person is the poultry extension officer who may or may not exist in some places. He or she is the link between the farmer and both the diagnostic and regulatory sectors of the veterinary services. They are responsible for initial field diagnosis, referring samples to the diagnostic laboratory, monitoring the disease situation and on-site implementation of control measures. The combined efforts of extension services and veterinary diagnostic laboratories are central to disease surveillance. This implies the need for good diagnostic laboratories especially as they will need to distinguish quickly between diseases caused by HPAI H5N1 virus and Newcastle disease virus, the traditional scourge of the poultry industry and other avian pathogens for that matter. The status of both the veterinarian and the extension officer in the community and industry is crucial to implementing the value added dimension toward H5N1 control in countries of the region.

It is also important to recognize the need for differential diagnosis of human infection caused by H5N1 virus (or any other novel AI virus subtype) from, say, dengue, typhus or other infectious diseases. The interconnectedness of the avian and human dimensions is reflected in the figure highlighting the need for veterinary and medical personnel and diagnostic services to work together to deal with a common problem. First and foremost is the prevention of human disease and mortality through the awareness that pandemic influenza is a zoonosis requiring early recognition of AI viruses in avian hosts.

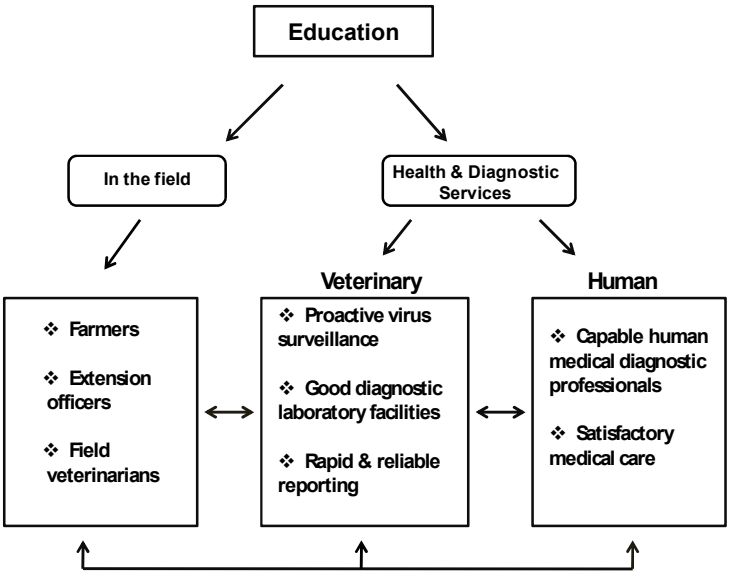

Figure. Two branches of AI virus education. Note that 'Health & Diagnostic Services' are further divided into veterinary and human services.

Where to from here

Unlike climate change which is demonstrating change as it progresses, the potential impact of AI will not be not easily understood or recognized until there are critically unmanageable human health issues. By this time, it may be too late to prevent a pandemic. Vastly improved understanding of events taking place at the animal-human interface particularly through on-going virus surveillance would be a major step forward. Resolving this will require long-term political will and long-term financial support.

Extensive country-by-country reviews need to be undertaken by specially appointed teams. Results of each study should indicate the changes that need to be made to existing systems to produce better outcomes. Elements of these reviews should focus on:

- Identifying the educational needs of the poultry industry in a multilevel approach
- Identifying the veterinary needs of the poultry industry in a multilevel approach
- Meeting the educational and veterinary needs of the poultry industry
- Delivery of practical (on job) and theory based (off job) learning
- Monitoring the quality of training and assessment of trainees.

The outcomes from each review will be useful in setting future requirements and direction. For each country, a second group of appointed specialists with an advisory role should function as the hub of all future activity, overseeing, advising and monitoring AI related operations.

Armed with the recommendations of the study group, the advisory group's function is to mould a strategic plan which should incorporate the following tasks:

- Identifying resources required to satisfy the needs indicated by the study group cognizant of the country's geographic and demographic features
- Adapting the resources to suit each region
- Implementing systems based on these resources
- Building local capability to carry on without outside assistance
- Carrying out follow-up assessment and evaluation
- Handing over to locals when local capability is sustainable

Cautionary comments

- While H5N1 events have provided the blueprint for this document, it should not be forgotten that H7 subtype viruses can be highly pathogenic for chicken and can cause human disease including death as evidenced by the HPAI H7N7 outbreak in The Netherlands in 2003.

- It should not be assumed that because an AI virus is highly pathogenic in chicken that it will consequently cross the species barrier to humans to cause a pandemic. Anecdotal information provided to K.F.S. has indicated that there was no recorded infectious disease outbreak in chicken, any other land-based poultry or animal before or during the 1957 (H2N2) Asian and 1968 (H3N2) Hong Kong pandemics. Moreover, these two pandemic viruses would seemingly have lacked the molecular attributes necessary for pathogenicity in chicken.

- It would be absolute folly to ignore the current H5N1 situation given the vast increase in chicken population globally in the last 40 or so years and the many stressors to which the birds are now subjected. The HPAI H5N1 virus now resides asymptomatically in ducks in some regions and is a continuing threat to chicken production and human health.

Conclusion

It is conceded at the outset that the world is engaged in battle with the HPAI H5N1 virus. Already it has destroyed many millions of poultry and over two hundred and sixty humans. The tools are available to fight back and win this battle, but it will require the cooperation and determination of many people from many disciplines. It is time to place HPAI disease prevention in poultry and pandemic prevention in humans as global priorities alongside other critical priorities such as population growth and human food supply. These, individually or together, contribute to the jigsaw of survival into the future. This is a challenge for humankind. But it must be done.

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Background information on H5N1 (and H7N7) events can be obtained through:
www.who.int
www.fao.org

ARTIFICIAL INSEMINATION IN GEESE

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Most goose breeds and lines currently in use at a commercial scale are derived from two wild species: the swan goose *Anser cygnoides* L. and the true geese - greylag *Anser anser* L. Interestingly, local selections performed for centuries from these two ancestors have resulted in strains or breeds expressing large differences for a range of phenotypic traits including size, body weight, feather colour, behaviour, physiology including reproductive performance, along with carcass characteristics, flavour and chemical composition of the meat.

When compared with other poultry species, the main factors having limited goose production and goose meat consumption in Europe are the seasonality of its reproduction and the low fertility of breeder flocks (egg production, fertility and hatchability rates, low sex ratio, poor semen quality) associated with, on average, relatively high proportions of lipid tissues in their progeny. Some of the above problems can be eliminated or at least reduced by the application of artificial insemination procedures.

The present paper reviews the main specificities of artificial insemination techniques developed in goose with regards to male morphology and physiology. The main characteristics of ejaculates along with some morphological aspects of sperm morphology, semen collection procedures and semen quality assessment are also described. Finally, goose insemination procedures along with their interests and limits are discussed.

Keywords**: goose, artificial insemination**

Introduction

For near a mid-century, poultry species have demonstrated their interest as sources of proteins of animal origin dedicated to feeding a growing world population. This rapid success has resulted in a rapid shift of poultry meat production towards the second place after swine meat (FAO sources). Such a huge progression in poultry productivity is a consequence of several biological, genetical and management factors, including short inter-generation intervals, high heritability of several genetic traits (ex: egg production, growth...) associated with rapid progress in management systems and feed availability and quality. However, a continuous selection for growth rates, high meat yield and feed utilisation has also, significantly impaired reproductive performances including semen quality, egg fertility, embryo survival and more general, the number of chicks hatched per hen (Renema *et al*,. 2007). In the case of goose reproductive efficiency has also been impaired, but at a lesser extent than in more intensively selected species such as chicken or turkey.

In contrast with most poultry species and despite the fact that goose was probably the first domesticated avian species, its reproductive characteristics are still relatively comparable with wild geese regarding traits such as reproductive seasonality, low sex ratio, social and sexual behaviour, and high adaptivity to various environments. A consequence of this is, that some of the fertility problems observed in goose parent stocks at different periods of their reproductive cycle may require other approaches than those used in species expressing traits issued from domestication (ex: chicken breeders). For example, the partial or total replacement of males in the course of the cycle ("spiking") or separate sex feeding of naturally mated broiler breeder flocks cannot be of practical value in the case of geese.

Another specificity of the goose deals with its digestive tract which can ingest and digest large quantities of relatively cheap and easy accessible, high fibre feedstuffs. Despite this and, also, despite the facts that juveniles grow rapidly and are easy to manage (Romanov, 1999), goose production has, up to date, been limited to a few Asian and European countries.

Philogenetically, geese are represented by 35 species, but the most popular commercial breeds have been selected from only two wild species:

- the swan goose *Anser cygnoides* L.
- the true goose - greylag *Anser anser* L, itself represented by two subspecies:
  - the western type (*A. a anser*) and,
  - the eastern type (*A. a. rubrirostris*) (Crawford, 1990).

Both, wild ancestors and derived breeds, differ in size and body weight, feather colour, behaviour, physiology (ex: reproductive performance), as well as in the quality of carcass, flavour and chemical composition of the meat. Such differences result from the local availability of the breeds and, also of consumers' habits regarding meat-type products.

Regarding reproductive characteristics, the various breeds of domesticated geese share some specifications which may act as limited factors to their development as poultry species. Thus, compared with other poultry species, domesticated geese are characterised by a quite low reproductive performances and a quite strict seasonality of their reproduction, making it difficult to produce goose meat the year around for a given market. In contrast with other poultry species, goose breeders may,

however, be kept for several seasons (usually 3-4) as routinely practiced in European countries (Behr and Hartmann, 1992; Nitsan *et al.*, 1988; Rosiński *et al.*, 1986; Toth *et al.*, 1988) but, depending on economical conditions, fertility performances may remain at acceptable levels up to 6 season (Bielińska and Rosiński, 1988). According to data published by the National Poultry Council - Chamber of Commerce (2009) White Koluda® geese (derived from *Anser anser* L.) produce on average, from 49 (2nd reproductive cycle) to 40 hatching eggs (4th cycle) with a laying intensity varying from 29 to 33%; egg fertility from 79% (in 4th reproductive cycle) to 82% (in 2nd cycle), while hatching success of set eggs ranges from 60 to 65%. According to Nitsan *et al.* (1988) goose egg fertility in naturally mated flocks varies from 48 to 79%.

Interests of artificial insemination in geese

As in other species raised for economical purposes, an important aspect of goose reproduction is to maintain reproductive performances at acceptable levels for a prolonged period of time. Under natural mating conditions, this objective is often difficult to reach as a number of uncontrolled factors may alter fertility and embryo mortality. Thus, poor semen quality is often observed in most breeds while behaviour problems such as preferential mating of a male with a single female may cause durable alteration of reproductive performances. Other causal factors known as impairing fertility in these flocks include male leg disorders, excessive body weight, and copulatory organ malformation, low biological value of eggs and low efficacy of sperm acceptance in the oviduct of aging females.

In order to circumvent these problems, artificial insemination (AI) has been proven a powerful alternative to natural mating conditions as it provides a range of possibilities to control, replace or improve the defective factor causing fertility problems. Of practical use for decades in turkeys, ducks and guinea fowl, AI know-how has, over the past years, also demonstrated its interest in geese and chickens, thus emerging as a significant achievement of poultry physiologists transferred to the industry. In addition to providing alternative solutions to control fertility and reduce gosling costs by reducing the male/female ratio, AI is also of practical interest in selection, as this technique creates favourable conditions for a more efficient use of the best sires in pedigree farms (ex: 1♂:10-12♀ in AI flocks compared with 1♂:3-4♀ in naturally mated flocks). Overall, this results in stronger selection pressure on favourable traits and additional genetic gain at each generation. Another profitable and promising

advantage of AI is crossbreeding or integeneric crossing leading to increase the meat content and lowering fatness of the progeny carcass. Such improvement can be obtained by crossing commercial goose breeds with goose from conservation flocks of local origin (Mazanowski and Smalec, 1998), wild goose *Anser anser* L. (Chrzanowska and Chełmońska, 2000; Mazanowski and Chełmońska, 2000) or *Branta canadensis* L. (Kowlaczyk *et al.*, 2007a,b; 2008).

In addition to pre-cited advantages, AI practice in goose selection and multiplication should also been considered as an interesting and relatively cheap way to limit the risks of transferring pathogens during copulation. Thus, ejaculates may be either checked individually for the presence of pathogens and the correspondent male(s) treated or, semen can be diluted in diluents containing *ad hoc* antibiotics, thus suppressing the transfer of pathogens to the female oviduct (however, not every type of antibiotic allows optimal sperm survival *in vitro* storage).

Another interesting aspect of AI and semen technology is to facilitate the transportation of male gametes from a male to a female site. This has, indeed, been of practical interest to the turkey industry ('stud farms') to optimize production costs and facilitate yield management in breeder flocks. In geese, the duration of *in vitro* sperm storage remains relatively limited (1-2 hour), but recent progress in semen cryopreservation offers new pathways to protect gene pools and limit the risks of extinction in endangered breeds.

Assuming the above, it appears that AI practice in goose breeding and multiplication offers several definite advantages including:

- general improvement of fecundity levels,
- more efficient use of ganders with high genetic potential,
- acceleration of genetic progress due to higher selection pressure,
- risk limitation of pathogens and diseases transferred during natural mating,
- possibility of transferring genes from point A to point B without moving birds,
- facilitates integeneric/interbreed crosses if natural mating proven unsatisfactory, or in order to produce progeny of different meat taste and quality,
- cryopreserved semen allows gene pools preservation.

Difficulties and limiting factors to perform AI in geese

Despite recent progresses, AI technology (which includes semen collection, assessment and handling, as well as semen deposition in the female tract) remains relatively complex to perform in the goose. In practice, semen collection is currently performed using one of the two following methods:

- dorso-abdominal massage (Burrows and Quinn, 1937), as routinely used in turkeys, chicken, and several feral species (ex: Blanco *et al.*, 2000; Klimowicz *et al.*, 2005; Saint Jalme *et al.*, 2003; Siudzinska and Lukaszewicz, 2008); this method was first transferred to ganders by Johnson (1954),
- stimulation of the male by the presence of a teaser female (technique also known as artificial vagina method (Chełmońska *et al*., 2008; Rybnik *et al.*, 2007).

From the two above cited methods, the dorso-abdominal massage, although usually applied for gander semen collection, remains quite inefficient, in contrast to other poultry. Its success rate is relatively limited (ex: only 40% Landes ganders respond to semen collection procedure under these conditions with ejaculates averaging 0.3ml in volume and $150x10^6$ sperm/ml (Sellier *et al.* (1995). Meanwhile, it appears that the response to this solicitation may be breed dependent as studies by Chełmońska and Łukaszewicz (1995). Mentioned authors indicated that the frequency of positive reactions of non-selected White Italian ganders (*Anser anser* L.) ranges between 60 and 70%, while Kuban ganders (*Anser cygnoides* L.) respond positively in about 90% of the cases. Despite these

encouraging observations, it remains however, that only 30% and 50%, respectively, of the positive responses result in ejaculates classified as 'valuable' for insemination.

Overall, it appears from our experience that the success of goose AI depends mainly on the genetic origin of male and female breeders, along with the semen collection and handling procedures, AI equipment and insemination techniques. However, the basic criterion for successful AI operations is the reproductive value of male and female breeders, associated with a thorough expertise of the staff at controlling flock environment (light, feed, floor surface allowance and preparation).

Factors affecting semen quantity and quality

Compared with males from other poultry species such as chickens, ducks or turkeys, ganders have a relatively limited testicular development at adulthood, which results in fewer sperm produced by time unit than in other species (Chełmońska, 1972). As a consequence, sperm populations present in ejaculates are themselves limited along with the main other quantitative characteristics of ejaculates: ex. 1: ejaculate characteristics of *Anser anser* derived ganders: volume = 0.15 to 0.3 ml; sperm concentration: 340-1020 $x10^6$/ml (Łukaszewicz, 2002); ex. 2: ejaculate characteristics of *Anser cygnoides*: volume = about 0.4 ml; sperm concentration: 700 $x10^6$/ml (Liu *et al.*, 2008).

Interestingly, one characteristics of goose sperm making it distinguishable from other poultry, it is extremely low percentage of morphologically normal sperm which, depending on many situations (age, breed, reproductive season, etc…), may vary from only 27 to 50% of the total population when, it is in the 80-85% range in chickens and turkeys. Thus, values above 50% of morphologically normal and viable sperm are only sporadically observed in gander semen (Liu *et al.*, 2008; Łukaszewicz, 2002), while percent of viable sperm is generally within 90-95%, a range similar to that observed in turkey or chicken. This indicates that gander sperm should be assessed for parameters, which, besides viability/motility, should also include microscopic observation to assess their morphology. This explains why the author have been interested in developing a global test known as Semen Quality Factor (SQF), which comprises three, the most important semen characteristics: volume, cells concentration and percentage of live normal spermatozoa (Łukaszewicz and Kruszyński, 2003), which has since revealed valuable to predict the potential of fertilization of collected semen. It allows to precise the number of cells expected to become candidates for the fertilization of an ovum and how many insemination doses can be made from a particular semen sample. In ganders it varied from 26 (Łukaszewicz, 2002) to 84 (Liu *et al.*, 2008) (Fig. 1), while it reaches values over 130 in the chicken (Siudzińska and Łukaszewicz, 2008). Moreover, Liu *et al.* (2008) found high ($P<0.01$) correlation between SQF and fertility in *Anser cygnoides* ($r=0.985$).

The quality of fresh semen is one of the most important feature both, from fresh semen insemination and its short- or long-term storage viewpoint. The quantity and quality of semen collected manually from ganders depend on: species (Chełmońska and Łukaszewicz, 1995; Stasko *et al.*, 1973), male age (Bielińska and Rosinski, 1988; Csuka and Ledec, 1984; Merritt and Leman, 1963) (Tab. 1), reproductive cycle (Guangxi *et al.*, 1988; Łukaszewicz, 2002) (Tab. 2; Fig. 1), management system (Brun *et al*., 2003; Sellier *et al.*, 1995; Rosinski *et al.*, 1995; Willin and Kovats, 2000), feeding (Sauveur *et al.*, 1988), semen collection technique and collection frequency (Grunder and Pawluczuk, 1991; Łukaszewicz, 2000), as well as on individual gander properties (Łukaszewicz, 2002; Tsarenko *et al.*, 1979).

During the semen collection procedure a few facts have to be taken into consideration. First, due to difference in copulatory organ structure of *Galliformes* and *Anseriformes*, as well as the way of ejaculation, in order to maximise the semen quality, particular care has to be taken during collection to avoid any semen contamination with the cloacal products. Gander erection centre, as in all bird males', is located near cranial end of kidneys, therefore properly performed massage has to stimulate both, dorsal part of the gander body and simultaneously the abdomen, as female does during the natural mating.

Moreover, avian male reproductive tract, unlike mammal one, does not posses any accessory sex gland. Seminal plasma (known as "transparent fluid") is excreted from vascular body of cloacal wall during the copulatory organ erection and semen ejaculation. Thus, proper and sufficient stimulation has to be made in order to provoke the gander for spontaneous ejaculation which, together with slight pressure applied above the receptaculum, should help to collect the dense, good quality semen. To maximise the percentage of ganders producing semen and semen quality, males should be kept individually and their feed should be removed 12 hours before semen collection.

Table 1. Effect of gander age on fresh semen characteristics evaluated within the same reproduction cycle (x ± SD; each group represented by 10 males) (Łukaszewicz, 2002)

Evaluated traits		Age group of ganders			
		1-year-old	2-year-old	3-year-old	4-year-old
Number of semen collections during entire reproduction cycle		42	53	53	51
Single ejaculate volume (ml)		$0.15^{A1)}$±0.05	0.20^{B}±0.05	0.16^{BC}±0.06	0.16^{BC}±0.06
Spermatozoa concentration (x10^6/ml)		409.64^{A} ± 134.29	550.47^{Ba} ± 161.63	655.47^{Bb} ± 203.34	833.04^{Bb} ± 243.45
Semen Quality Factor per male		26.47^{A} ± 17.91	45.56^{B} ± 18.91	51.65^{B} ± 20.34	68.33^{C} ± 24.95
Forms of spermatozoa (%)	Live in total	91.79^{A} ± 2.67	94.08^{B} ± 2.72	94.77^{B} ± 2.57	93.7^{B} ± 3.38
	Live normal	39.28 ±7.0^{A}	40.42 ±7.14^{A}	50.46±6.2^{B}	50.01 ±9.38^{B}
	Macrocephalic	22.80^{A} ± 5.26	21.31 ± 5.18	20.90 ± 4.12	19.35^{B} ± 4.88
	Bent-neck	15.83^{A} ± 3.67	16.30^{A} ± 3.44	10.46^{Ba} ± 2.7	12.86^{Bb} ± 4.36
	Midpiece deformed	4.91 ± 2.61	5.82^{A} ± 2.23	4.11^{Ba} ± 1.76	5.12^{b} ± 2.27
	Spermatids (Immature)	2.92 ±1.67^{A}	6.36 ±3.05^{Ba}	5.35 ±2.6^{Bb}	3.16 ±1.90^{A}
	Other deformities	6.05^{A} ± 2.96	3.86^{B} ±2.74	3.48^{B} ±2.67	3.27^{B} ±2.85

[1)] Values with different superscripts within rows differ significantly (A, B - P ≤ 0.01; a, b - P ≤0.05)

Ganders subjected to semen collection for the first time, as well as the older males at the onset of every reproductive cycle, have to be trained for holding and massage once or twice a week, as well as selected on the basis of their positive reaction to massage, i.e., reaction ending with ejaculation, the appearance of the copulatory organ and quality of the first ejaculates. These characteristics determine the degree of gander usefulness as reproducers. High significant correlation (r=0.80) between the number of positive reaction during the first three weeks of the reproductive cycle and the results of the total amount of semen and average ejaculates volume during the entire season, were stated (Chełmońska, 1972). This correlation enables an early pre-selection of males. The experiments of Kurbatov *et al.* (1976) indicated that selecting ganders for AI purposes is significant and therefore worth performing. With the heritability of h^2=0.24, the selection can be effective (Stasko *et al.*, 1973).

Despite the gander age, a decline in semen quality can be observed about six weeks before the end of the reproduction cycle. Also, during the first month of reproduction, 1-3-year-old ganders produce ejaculates of lower quality. There also occur unfavourable changes in the spermatozoa morphology, which significantly affect the effectiveness of insemination, particularly in the second half of the reproduction period. The results of experiments (Łukaszewicz, 2000; Łukaszewicz *et al.*, 2000) suggest

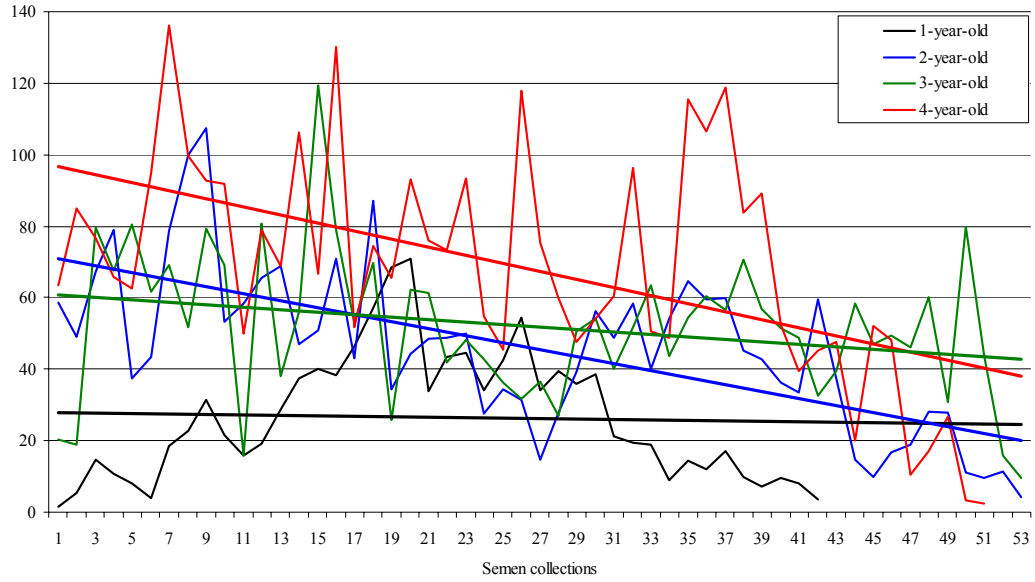
semen collection twice a week during the periods of lowered fertilising potency of ganders and three times in the middle of the cycle. Moreover, a decline in semen quality of ganders of different age occurred in different months of the reproductive cycle and was male age dependent. In case of AI, this problem can be overcome by pooling semen of age-differentiated males. It can be supposed also, that differences in fertility rate of naturally mated geese, observed within the entire reproductive cycle and resulting probably from fluctuations in semen quality, can be eliminated by differing the age of ganders in the goose flock.

Table 2. Characteristics of fresh gander semen in the I, II and III reproductive cycle (x ± SD) (Łukaszewicz, 2002)

Evaluated traits		I cycle	II cycle	III cycle
Number of semen collections in one reproduction cycle		41	48	53
Single ejaculate volume (ml)		0.23^{A} ± 0.06	0.18^{B} ± 0.06	0.16^{B} ± 0.06
Spermatozoa concentration ($x10^6$/ml)		323.41^{A} ± 93.451	483.33^{B} ± 174.15	655.47^{C} ±203.34
Sperm Quality Factor		33.44^{A} ± 17.16	45.32^{B} ± 26.38	51.65^{B} ± 20.48
Sperm forms (%)	*Live in total*	91.37^{A} ± 4.41	93.78^{B} ± 2.56	94.77^{C} ± 2.57
	Normal	42.87^{A} ± 10.98	50.64^{B} ± 11.12	50.46^{B} ± 6.24
	Macrocephalic	26.51^{A} ± 10.09	23.07 ± 7.53	20.90^{B} ± 4.12
	Bent-neck	10.33 ± 3.24	10.05 ± 3.18	10.46 ± 2.71
	Midpiece changed	6.22^{A} ± 2.33	3.89^{B} ± 1.89	4.11^{B} ± 1.76
	Spermatids	4.36 ± 2.06	4.71 ± 2.29	5.35 ± 2.55
	Other deformities	1.24^{A} ± 1.15	1.43^{A} ±1 .03	3.48^{B} ± 2.67

[1)] Values with different superscripts within rows differ significantly (A, B - P ≤ 0.01; a, b - P ≤0.05)

Fig. 1. Semen Quality Factor of 1, 2, 3 and 4-year-old White Koluda ganders



Goose insemination

In practice, artificial insemination in the goose is most often used throughout the entire reproduction cycle at a frequency of two inseminations/wk. Alternatively, it is also performed once or twice a wk as a complement of natural mating, at periods when fertility is impaired. Techniques to introduce semen into the lower oviduct may vary from farm to farm, depending on inseminator experience and skills. Since it is difficult to evert the goose oviduct, the safest and most effective way for semen deposition is, to our view, the finger guided method (also known as a palpation method) (Johnson, 1954; Grunder and Pawluczuk, 1991; Łukaszewicz, 2002; Tai, 1984). Alternatively, the finger can be replaced by a speculum. Finger or speculum-guided palpation is required to determine the opening of the oviduct. At most occasions, semen is deposited intravaginally and, as suggested by Kurbatov *et al.* (1976), at a depth of 3-4 cm. For intergeneric crosses semen may be deposited deeper (i.e., closer to the utero-vaginal junction) to limit the high intensity of sperm selection in the lower part of vagina. An alternative to deep intravaginal insemination is intra-magnal insemination: it is, indeed, more effective and seems to have little impact on the number of oviposited eggs. Depending on the technique in use, artificial insemination is performed by either two (intravaginal) or three (intramagnal) persons.

As in other species, for AI success, it is very important to maintain fertilizing potency of spermatozoa kept *in vitro*. Therefore, unless insemination is performed within 20-30 minutes of semen collection, the diluents have to be added (Bakst, 1990). No decrease in fertility rate was observed after geese insemination with semen diluted 1-fold with EK diluent (Łukaszewicz, 2002) and stored for 3 hours, at 4^{o}C.

The percent of fertile eggs depends on spermatozoa number introduced into the female reproductive tract, its frequency, and the insemination technique. For fertility, particularly important is the proper timing for insemination, so that critical periods coinciding with the ovulation stage, egg-shell formation, or oviposition can be avoided (Raud and Faure, 1990). Moreover, it is well known that as the reproductive cycle progresses, there is an increasing demand for spermatozoa to be deposited in the oviduct in order to sustain high and persistent fertility rate, whereas the male's reproductive capacity decreases (Brillard, 1993). This phenomenon is particularly well seen in fertility rates of geese mated naturally (Behr and Hartmann, 1992; Chełmońska, 1972). It can be overcome, however, by the use of AI.

Opinions on the frequency of geese insemination and number of inseminated spermatozoa necessary for satisfactory fertility level are not univocal. However, one observation seems to be clear – goose do not need as many spermatozoa to be deposited in order to gain satisfactory fertility rate, as fowl and turkey. For domestic fowl hens a dose consisting of 100 mln of progressively motile cells is recommended for weekly fresh semen insemination. For geese insemination Davtian and Pimenow (1970) suggested 30-40 mln spermatozoa every 6 days, while Grunder and Pawluczuk (1991) inseminating geese once or twice a week with 14 mln cells obtained respectively 54% and 83% of fertile eggs. According to Borys *et al.* (1978), fresh gander semen dose should contain 2.7 mln spermatozoa per day and 2-year-old and older geese can be inseminated in 12 days intervals, while 1-year-old flocks, every 9 days. In the experiments of Łukaszewicz (2002), 9 mln live normal spermatozoa inseminated weekly with fresh semen resulted in 89% fertility, while the increase in cells number to 20 mln resulted in 95.5% of fertile eggs.

Conclusions

Artificial insemination can now be considered as an efficient method of reproduction in goose breeding and multiplication. Studies conducted over the past decade have, indeed demonstrated its interest to improve the effectiveness of commercial goose production by increasing the number of goslings but, also, by facilitating the feasibility of performing crossbreeding and intergeneric crosses for genetic purposes. Despite this, goose reproduction remains relatively complex to handle due to the physiological and behavioural specificities of the species. This, indeed, justifies additional research to

better comprehend the underlying mechanisms which can infer on sperm quality. Regarding this aspect, research on goose spermatogenesis and on genetic x physiological interaction at this level may be of major interest in the future.

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PATHO-EPIDEMIOLOGY OF LOW PATHIOGENIC AVIAN INFLUENZA IN WATER FOWL AND COMMERCIAL POULTRY

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Introduction :

Influenza viruses are enveloped, segmented, single stranded, negative sense RNA viruses of the family Orthomyxoviridae, and are divided into types A, B, and C. Type A is seen in man, birds, pig, horses and many other animals while B and C are only seen in man. Influenza A viruses isolated from birds are known as avian influenza viruses (AIV) and are further divided into 16 haemagglutinin (HA) and nine neuraminidase (NA) subtypes. AIV vary in their ability to produce infection, disease and death in different bird species. Based on the pathobiological effects in chickens AIV are categorized as low pathogenic avian influenza (LPAI) virus or highly pathogenic avian influenza (HPAI) virus. LPAI virus cause asymptomatic infection in wild aquatic birds but when introduced into domesticated poultry may be asymptomatic or produce clinical signs and lesions in respiratory, digestive and reproductive systems. Among various LPAI virus sub types H9N2 has become the most important infection throughout the world. HPAI rarely infect wild water fowl but cause severe morbidity and mortality in chicken. However, Eurasian-African H5N1 HPAI virus has evolved over the past decade with unique capacity to infect and cause disease in domestic ducks and wild birds (Patin-Jackwood and Swayne, 2009).

Reservoirs of influenza A viruses in nature

AIV are widely distributed throughout the world in many domestic birds, including chicken, turkeys, guinea fowl, quail, pheasants, geese, and ducks and in wild species, including ducks, geese, sandpipers, sanderlins, ruddy turnstones, terns, swans, shearwaters, herons guillemots, puffins, and gulls. Wild aquatic birds serve as a reservoir of all known subtypes. The gene pool of AIV in aquatic birds provides all the genetic diversity required for the emergence of pandemic influenza viruses for humans, lower animals and birds. In these species the virus shows antigenic shift and antigenic drift. Rapid evolution in influenza A viruses in man and animals has continued since long and is dependent on periodic introduction of gene segments or entire influenza viruses from the avian influenza gene pool. This is very much evident from the last three human pandemic and recent pandemic of swine flu. In aquatic wild birds these viruses appears to be fully adapted to its host and causes no disease signs. However, subtype H5N1 did cause disease and mortality in this population indicating extremely high pathogenicity of this subtype. In wild ducks influenza viruses replicate in the cells lining the intestinal tract, cause no disease signs and excrete in high concentration in the feces. Several possibilities have been suggested for the perpetuation of this virus in aquatic bird population. It is possible that AIV are preserved frozen in ice or in lake water and reinfect ducks in spring. The infectivity in water is dependent on the virus strain, salinity, pH and temperature of the water. At 17^0 C some strain remain infectious for up to 207 days, and at 4^0C they remain infectious for still longer time, raising the possibility of persistence of AIV in water when ducks are absent. Continuous circulation in aquatic bird species is maintained because of their migratory nature. There is also circulation between different avian species and the regions like tropical, sub tropical and temperate regions. Extremely high isolation rates of LPAI have been recorded in surveillance studies, with overall figures of about 11% for ducks and geese and around 2% for all other species (Alexander, 2007). Chicken get infection directly or indirectly from aquatic birds mostly in the system with out door rearing or back yard farming.

LPAI sub type H9N2 virus infection

H9N2 subtypes of the low pathogenic avian influenza (LPAI) virus has become globally prevalent in domestic poultry since 1990s and reached panzootic proportions (Alexander, 2002). The natural avian reservoir of H9 viruses were shorebirds and gulls. In poultry, H9N2 viruses have caused respiratory symptoms and egg drops. Mortality noticed when associated with opportunistic pathogens or immune suppression (Bano *et al.,* 2002). Out breaks of H9N2 LPAI occurred in domestic ducks, chickens and turkeys in Germany during 1995 to 1998, in chickens in Italy in 1994 and 1996, Pheasants in Ireland in 1997, ostriches in South Africa in 1995 and turkeys in the US in 1995 and 1996. Wide spread out breaks in chickens with H9N2 viruses in Korea were detected in 1996. Wide spread infections due to H9N2 in chicken were reported in china and Hong Kong during 1994. LPAI H9N2 infections have also been reported in the Middle East since 1998 and have also caused wide spread out breaks in commercial chickens in Iran and Pakistan often associated with serious disease problems. The impact of avian influenza caused by H9N2 viruses in Pakistan is now significantly more severe than in previous years. Iqbal *et al.* (2009) identified novel genotype of H9N2 influenza A viruses isolated from poultry in Pakistan containing NS genes similar to highly pathogenic H7N3 and H5N1 viruses. The disease is wide spread in India among commercial broilers, commercial layers and breeders causing heavy economic losses. Inspite of being low pathogenic virus its ability to cause high mortality is attributed to secondary complication with *E.coli,* mycoplasma, infectious bronchitis virus and New castle disease virus. Unfortunately no systemic studies were made on this disease.

Commercial layers: -

H9N2 out breaks in commercial layers are wide spread. Age group involved ranges from 28 weeks to 68 weeks. No outbreaks were recorded in growing flocks. Generally all the layer flocks in the farm get affected within period of 15 days after first outbreak. The average mortality was 5.03 per cent, which between the flocks varied from 1.2 to 8.7 per cent. In general mortality continued for two weeks. There was drop in egg production in all the flocks which ranged from 15.37 percent to 28.32 percent. The average production drop was 21.32 percent. Drop in feed consumption varied from 7.00 g/bird to 26.49 g/bird with average of 14.49 g/bird. In general after onset of outbreak production declined up to 3 weeks which later on started recovering but fails to reach original production before 5 weeks. There was no change in the eggs shell quality and the internal quality of eggs except few lathery eggs in the initial period of production drops.

The haematological data like Hb, PCV, RBCs and WBCs counts were found significantly low compared to that of normal healthy birds. There was relative heterophilia and lymphocytopenia which was the result of lymphocidal effect of virus.

Clinical signs included sudden onset of depression, reduced feed intake, egg drops, dullness and facial edema. Postmortem of birds revealed gross lesions mainly in respiratory, genital and digestive system. Affected birds showed mild to severe congestion even leading to hemorrhages in trachea. Excessive mucus in trachea and fibrinous flacks like material in the lumen were also observed. Lung showed congestion and edema in most cases. Few cases showed consolidation at the insertion of bronchi. Lesions of severe mucous degeneration with fibrinous clot in the nasal sinuses were also seen. Thoracic and abdominal air sacs were edematous, frothy and contained fibrinous exudates. Peritonitis was observed with low amount of fibrinous exudates and relatively large quantity of thick, white-yellow colored fluid in the abdominal cavity. Lesions in oviduct comprised severe transmural edema with clear excessive egg albumin in lumen. Proventriculus showed petechial hemorrhages. Pancreas was enlarged and hardened in few cases. Other organ like intestine, heart, liver, kidney and spleen did not show significant gross lesions.

Microscopically, trachea revealed variable severity of congestion, hemorrhages, mucous degeneration, mucosal edema, mononuclear cell infiltration and fibrinous tracheitis with fibrin exudates

in lumen. There was deciliation and desquamation of tracheal epithelium. Lung revealed edema, congestion, hemorrhages and thickening of interstitial septa with macrophage infiltration. Bronchi revealed mild to moderate congestion and mononuclear cell infiltration. Edema of the wall of the oviduct was most severe in the muscular layer with mild diffuse infiltration of heterophils and macrophages and an associated infiltration of lymphoplasmacytic cells around the veins. Pancreatitis with congestion, hemorrhages, infiltration of mononuclear cells and occasional focal necrosis were observed in pancreas. Liver and spleen showed congestion, hemorrhages and mononuclear cell infiltration. Additionally in spleen, lymphoid depletion with RE cell hyperplasia was also seen. Caecal tonsils showed hemorrhages in few cases. Kidney showed congestion, hemorrhages, glomerulonephritis and interstitial nephritis.

Commercial broilers:

Maximum prevalence of LPAI H9N2 was recorded in the month of March, April, May and June. The average mortality due to LPAI out breaks was 22.45 per cent. The age group affected with LPAI ranged from 17th day to 32nd day. The average body weight of affected farms at the end of 3rd, 4^{th,} 5th, and 6th week of age were significantly lower than non affected farms at the respective age. The hematological values like Hb, PCV, RBCs and WBCs counts were decreased in all LPAI affected flock as compared to normal healthy flocks. There was relative heterophilia and lymphocytopenia which indicates lymphocidal effect of virus.

Gross lesions were mainly observed in the organs of respiratory system. Affected birds showed severe congestion, haemorrhage and presence of excessive watery mucus in trachea. The most severe cases had fibrinonecrotic casts at the tracheal bifurcation. Lung showed congestion, edema and haemorrhage in LPAI affected birds. Thoracic and abdominal air sacs showed edema and deposition of fibrin with variable severity. Other organs like heart and liver showed deposition of fibrin on the surface in most of the cases.

Microscopically, trachea revealed Congestion, mucus degeneration, infiltration of mononuclear cells in the mucosa and sub mucosa and necrosis of epithelial lining. Lung revealed congestion, hemorrhages and mononuclear cell infiltration and deposition of fibrin in Para bronchi. Mild congestion, hemorrhages and focal acinar necrosis were observed in pancreas in few cases. Spleen showed congestion, hemorrhages and RE cell hyperplasia. Liver revealed fibrinous perihepatitis with congestion and haemorrhages of hepatic parenchyma and mononuclear cell infiltration. In most cases heart revealed thickening of the pericardium with deposition of fibrinous exudates and infiltration of mononuclear cells and few heterophils.

LPAI H9N2 and HPAI H5N1 have been widespread in poultry across large areas of the world resulting in a modified eco-epidemiology and a zoonotic potential. In recent years the H9N2 viruses have undergone extensive genetic reassortment which has led to the generation of H9N2 viruses of novel genotypes in the Indian sub continent. The novel genotypes of H9N2 viruses may play a role in the increased problems observed by H9N2 to poultry and reinforce the continued need to monitor H9N2 infection for their zoonotic potential. An extraordinary effort is required to manage these epidemics from both the human and animal health perspectives.

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DUCK PROCESSING, FOOD SAFETY AND QUALITY

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Abstract

During many years meat production, for red as well as for white meats, is characterized by an ongoing demand for increased production efficiency. Especially for poultry (more for broilers than for turkeys, ducks and geese), due to genetic selection this has resulted in higher growth speeds of the birds and an increased percentage of breast meat percentages of the carcasses. However, along with the drive for cost reduction and thus lower feed and protein conversion ratios this may lead to impaired meat quality as well as animal welfare and health problems, because of this growing at the edge of what is metabolically possible. Meat quality therefore is one of the four quality attributes. Others are animal welfare, product safety, product yield.

Poultry production and processing involve a series of interrelated steps designed to convert birds into ready-to-cook whole carcasses, cut-up carcass parts, or various forms of deboned meat products. Poultry meat quality is directly related to post-mortem chemical, physical and structural changes that occur during conversion of muscle to meat. Events which occur before and after the slaughtering of poultry influence carcass and meat quality. Major poultry meat quality attributes are appearance, texture, juiciness, flavor and functionality. For consumers appearance and texture are the most important. With the increasing trends in further processing, meat functionality and all sensory quality attributes have increased in relative importance.

Understanding of pre-slaughter and processing factors that influence poultry meat quality attributes, especially color and texture, is necessary to produce consistently high quality poultry products. Also complex products such as sausages, marinated fillets, breaded products, etcetera, require understanding of the contribution of poultry meat to these products as well as their influence on sensory properties of the final food product. In these cases functional properties such as water holding capacity are critical for successful product formulation.

Duck farming has a long history, but the modern duck industry is a relative small one in most parts of the world. However the duck industry is very dynamic and over the last couple of decades has been through a period of rapid expansion. In some parts of the world duck production has started to challenge the consumption of other types of poultry. More than 2/3 of the ducks are produced in China and so it is inevitable that what happens or does not happen in China will have a profound impact on the world of duck production.

Food safety begins with the suppliers of agricultural inputs to farmers and those involved in food production since materials such as pesticides and veterinary drugs pose different risks and therefore require specific attention. Animal feeding stuffs containing pathogens, including bacteria or toxic chemicals, may also pose specific risk.

This paper concentrates on aspects of duck processing and their effects on food safety and meat quality aspects.

Table 1. World duck slaughterings (millions)

	1997	2002	2007
World	1599	2173	2715
Africa	24	25	25
Americas	45	46	50
Asia	1384	1923	2474
Europe	143	175	162
Oceania	4	5	6

Data: Watt Executive guide 2009-2010

Table 2. Duck meat production (000s)

	1997	2002	2007
World	2365	3187	3955
Africa	54	57	58

Americas	92	97	129
Asia	1862	2560	3327
Europe	350	464	430
Oceania	7	10	11

Data: Watt Executive guide 2009-2010

Table 3. Examples of duck consumption, selected countries (kg per capita)

	2001
Hong Kong	2.5
Singapore	2.5
Taiwan	2.0
France	1.3
China	1.0
Malaysia	0.9

HOUSING AND MANAGEMENT OF DUCKS

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Like chicken, ducks are reared for eggs and meat. Duck eggs are relatively larger, weighing about 4.5% of duck's body weight, compared to chicken, whose egg weight is only about 3.3% of the hen's body weight. Moreover, ducks are more prolific than chicken and more adaptable to free-range system of rearing. They also grow faster than chicken. That is why; they are more popular in many European and Asian countries. They need simple housing, comparable to chicken.

Duck farming- Indian Scenario

As per livestock census 2002, the duck population of India is 23.48 million constituting 8.52 percent of the total poultry population. As per FAO statistics (2004), the duck meat production increased from 0.026 million tonnes to 0.15 m tonnes, recording 577 percent increase in growth rate, in two decades. The distribution and demographic dynamics of duck population revealed that they are concentrated in Eastern, North eastern and Southern states of the country. The leading states in duck population are West Bengal, Assam, Kerala, Andhra Pradesh, Tamil Nadu, Bihar and Orissa.

Duck farming in India is characterized by nomadic, extensive, seasonal, and is still held in the hands of small and marginal farmers and nomadic tribes. Traditionally West Bengal and Kerala are the major consumer states for duck egg and meat and one of the reason is that duck egg and meat highly suits and remains tastier for their fish based culinary preparations.

Advantages of Duck farming

1. Ducks are more prolific and produce about 20 eggs more than backyard chicken.
2. Size of the duck egg is 10-15 gram larger than chicken egg.
3. Ducks have long productive and profitable life *i.e.,* they lay eggs profitably during second and third year also.
4. Ducks supplement their feed by foraging; hence it will reduce the feed cost.
5. Marshy, swampy river side, wet lands, barren lands not suitable for chicken can be used for duck rearing.
6. Ducks lay their eggs during early in the morning (3am to 8am) and saves time and enables easy egg collection.
7. Duck farming is having symbiotic relationship with paddy cultivation, so ducks and paddy cultivation can be integrated in the entire paddy farming areas.
8. Ducks are quite intelligent birds and they can be easily trained for their daily routine (going to ponds, feeding etc) and it reduces the labour for management.
9. Ducks are quite hardy birds and can be easily brooded and are resistant to common avian diseases.
10. Broiler /green ducks are very fast growing than chicken, with better growth rate and feed efficiency.

Breeding Management

The desirable sex ratio for good fertility and hatchability for ducks is 1:6 for intensive rearing and 1:15-20 for extensive rearing system. In extensive system of rearing of rural ducks, farmers keep a wide sex ratio of 1:20-25, however they get a reasonable good fertility of 70-80 percent. Drakes usually mate during swimming. The high heritable traits like body weight, growth rate, rate of feathering, egg weight shall be improved by individual or mass selection. Medium heritable traits like age at sexual maturity, breast width and low heritable traits like egg number, hatchability and fertility shall be improved by family selection. Based on the above facts, individual selection may be followed for broiler breeding and family selection for layer breeding. In duck breeding, trap nesting is practically difficult to practice, so sire family selection may be practiced.

Brooding of ducklings

Ducklings may be brooded on wire floor, litter or batteries. The brooding period of layer ducklings is 3-4 weeks. For meat type ducklings, brooding for 2-3 weeks is sufficient. In general, in colder season, brooding period may extend up to 1-2 weeks longer than the regular period. Provide hover space of 90-100 sq.cm per duckling under the brooder. A 100 watt bulb can brood 30-40 ducklings. The temperature of 32^{o}C is maintained during the first week. It is reduced by about 3^{o}C per week till it reaches 24^{o}C during the fourth week. In wire floor, space of 0.5 sq.ft per bird and in litter 1 sq.ft per bird is sufficient up

to three weeks of age. Water in the drinkers should be 5.0-7.5 cm deep, just sufficient to drink and not to dip themselves. In deep litter brooding, the thickness of the litter will be 3 cm and above to absorb the excess moisture in the ducks' droppings.

In extensive system, no artificial warmth is provided, but the heat of brooding shed is conserved by making "Closed tents" (Tent brooding) to provide the required warmth. The ducks are allowed to swim in water after the brooding period is over. The duckling may be fed with 24% protein crumbled feed or wet mash, *ad libitum* from day one onwards. The feed must be free from aflatoxin and other toxins, since they are very sensitive for toxins.

Grower management

Ducks may be reared in intensive and semi intensive system. Under intensive system, floor space of 3 sq.ft per bird up to 16 weeks of age is sufficient. Under semi intensive system of rearing, a floor space of 2-2.5 sq.ft per bird for night shelter and 10-12 sq.ft per bird for outside run is necessary for free flow of birds up to 16 weeks. Water in the drinkers should be 10 -12 cm deep to allow the immersion of their heads. Partitions up to the height of 60-90 cm separating the pen and run are adequate for control of ducks.

In rural duck farming, straight run ducklings (male and female) will be reared up to 10 to 15 weeks of age, then female ducks will be kept for laying purpose and male ducks will be sold for meat purpose after selecting good males for breeding.

Layer management

Under intensive system, a floor space of 4 sq.ft per bird is essential. In semi intensive system a floor space of 3 sq.ft per bird for night shelter and 10-12 sq.ft per bird of outside run space is required. For wet mash feeding 10 cm of feeding space and for dry mash or pellet feeding 7.5 cm of feeding space per bird is required. For the collection of clean and hatching eggs, a nest box with 30x30x45 cm dimension shall be provided at the rate of one per three ducks. A light of 14-16 hours is necessary for optimum egg production.

The age at first egg and 50 percent egg production are 120, 140 days and the annual egg number is 320 eggs for Khaki Campbell ducks in intensive farming. The daily feed intake during laying period will be 120-140 gram, depending on the rate of egg production and body weight. The body and egg weights at 40 weeks of age is 1.8 kg and 68 grams, respectively.

Feeding Management of Ducks

Under intensive system of rearing ducks, they are meal eaters, taking 2 or 3 meals a day like humans; while chickens are nibblers; which nibbles with feed continuesly. It is commonly believed that the nutrient requirements of ducks are qualitatively similar to that of chicken, but ducks are having high growth rate during its early stage of growth. Ducks are attaining 70 percent (Chicken 40-50 percent) of the adult body weight at 12 weeks itself, which makes it more suitable for broiler production. Hence they need a high protein diet.

Ducks are good foragers. In extensive system of rearing, ducks are allowed to graze on pre and post harvested paddy fields, ponds, lakes, canals. In this system, fallen paddy grains, insects, snails, earthworms, small fishes, fingerlings, tadpoles, water plants like algae etc. are the main source of feeding for ducks. Here, it is worth mentioning that paddy cultivation and duck farming is having symbiotic relationship, paddy fields are the excellent foraging centers for grazing ducks and duck droppings are good sources of manure for paddy field and they also condition the soil by its shoveling like action in grazing and feeding. So active duck farming is seasonal, coincide with monsoon based paddy cultivation season. As a thumb rule 100 ducks require 0.5 acre paddy field per day for effective grazing.

During non laying periods, they are fed with low cost feed sources like paddy husk and low graded grains like broken rice, sorghum etc. Normally the rural duck farmers are practicing exclusively extensive system of rearing with grazing. Ducks will digest paddy and scaly fish and other sclera protein like fish scales, insects etc.

However, under the intensive and semi intensive system of rearing, ducks may be fed with wet mash or pellets. Ducks prefer wet mash due to difficulties in swallowing dry mash. For wet mash preparation, about 350 ml of water is added for each kg of feed. Prepare fresh wet mash each time, to prevent feed spoilage. Wash and sun dry feeders daily, to prevent caking. So pellet feeds are preferred, especially for broiler ducks.The most important point in feeding is Ducks should have a continues access to water, during feeding. . During the first eight weeks, ducks should always have an access to feed but later on they may be fed twice a day *ie* first in the morning and then later afternoon.

Watering of ducks

Though ducks are water fowls and fond of water, in contrast to the prevailing myth among farmers, water for swimming is not essential at any stage of rearing. However, water in drinkers or water channels provided in the house should be sufficiently deep enough to allow the immersion of their heads and not themselves. If they cannot do this, their eyes will get scaly and crusty and in some cases, blindness may follow. In addition, they also clean their bills periodically and wash them to keep it clean.

Common diseases of Ducks

In general, ducks are subjected to relatively few diseases when compared to chicken, but they are serious in nature. Light sandy soil is ideal for duck farming, because it tends to keep less disease germs and drain well. Since certain infections

of chickens may be transmitted to ducks such as salmonellosis, colibacillosis, it is desirable to keep duck farm away from commercial chicken farms.

Duck virus enteritis (Duck Plague)

It is an important contagious disease affecting adult birds, characterized by vascular damage with tissue haemorrhage and free blood in body cavities. The intestine and gizzard will be filled with blood. It usually occur in per acute form and the mortality varies from 5-100 percent. The major symptoms are droopiness, ruffled feathers, discharge from eyes and nostrils, swollen and sticky eyelids, greenish watery diarrhea. In males prolapse of penis and in females severe drop in egg production will be noticed.

The lesions are vascular damage, severe haemorrhages in gastro intestinal tract, petichae in liver, pancreas, lungs, kidney, ovary. In layers massive haemorrhages in ovary some times fill the abdominal cavity. Parent stock and commercial stock shall be immunized with live attenuated vaccines to transfer maternal antibody to the chicks. Commercial layers also immunized with vaccines at 8 weeks of age and repeated once in six months in endemic areas. Severe outbreaks of duck plague can be treated successfully, by administration of the homeopathic drug***," Mercurus corrosives-6 /12"*** at a dose of 5-10ml per 1000 ducks once or twice daily for 1 to 3 days.

Duck virus hepatitis

It is a highly infectious disease of ducks primarily affecting ducklings of 2-3 weeks of age, characterized by severe hepatitis. The major symptoms are closed eyes, falling on their sides, severe convulsions and death. The primary lesions are enlarged liver with haemorrhages. The reddish discolouration and mottling appearance of the liver with enlarged spleen and kidney is observed. Breeding stock can be immunized at 6-7 months of age to protect the ducklings.

Salmonellosis

The main causative organism is *Salmonella typhimurium*, usually occurs during first few days of life, clinical manifestation will be exhibited during the start of lay or peak production. The major symptoms are swollen and edematous eyelids. The primary lesions are enlargement and mottling of liver, pericarditis and arthritis makes the bird difficult in standing. The sulpha and furazolidone are the drug of choice for salmonellosis and control is by removal of carrier birds.

Pasteurellosis (Duck cholera)

It is an infectious disease caused by *Pasteurella multocida* around four weeks of age. The symptoms are raised body temperature, green colour diarrhea, complete paralysis of legs and sudden death. Prevention is by vaccination and treatment with suitable antibiotics. The prominent lesions are pericarditis and arthritis, petichae in myocardium. The distended pericardial sac will be filled with yellow flakes and caseous masses. Treatment with sulpha drugs will be beneficial and control with elimination of affected birds.

Aflatoxicosis

It is caused by aflatoxin produced by the fungus *Aspergillus flavus* and they are most potent carcinogen for ducks. Maize, Groundnut oil cake, soya bean oil cake, rice polish are the major feed ingredients for aflatoxin production on storage in wet conditions. Improper drying and humid weather favours the fungus growth. Ducks are very susceptible to aflatoxin content of the feed especially exotic ducks are more susceptible than indigenous ducks. The common aflatoxins are B_1, B_2, G_1, G_2 and B_1 is the most potent toxin. The minimum toxic dose is 0.03 ppm in the feed. The major symptoms are poor growth, lameness, purple discolouration of feet and legs. Ducklings will develop ataxia, convulsion and death. There is no specific treatment for aflatoxin and the preventive measures are, avoid the wet and mouldy feed and feed stuffs and use of completely dried feed and addition of fungistats and toxic binders.

Aspergillosis

It is caused by *Aspergillus fumigatus*. Inhalation and ingestion are main modes of infection. The symptoms are dyspnea, gasping and accelerated breathing and ocular discharge. The major lesions are yellowish grey material or whitish fluffy spots in lungs, trachea, and abdominal cavity. The prevention is by good management of litter and avoiding over crowding.

Parasitic diseases

Ducks are resistant to internal parasites, however, ducks grazing stagnant and over crowded ponds may get infestation of fluke, tape and round worms. Regular deworming with broad spectrum anthelmintics at 3 months interval during growing and laying stage will control the problem.

Duck Housing

In general, ducks need not require elaborate houses. The house should be well ventilated, dry, and rat proof. In semi intensive system of rearing, the house should have easy access to outside run as the ducks prefer to come out during the day

time, winter and rainy time. The run should have slope away from the house to provide drainage. In the house of semi intensive system, a continuous water channel of size 50 cm wide and 15-20 cms depth should be constructed at the far end, parallel to the pen in the grower and layer house.

Ducks can be reared in a variety of housing, starting from a **topless fenced night shelter**, to a sophisticated intensive housing, similar to chicken housing. Since duck dropping are more watery, they are more suitable and comfortable on **wire floor rearing.,** with **pen –cum –run system**. The run must be sandy to absorb more moisture, with slope towards the other end of the run; where a 15" wide X 10" deep water channel is provided. The water channel must be cement concrete, with ramp towards shed, for easy access for the ducks to in out of the water channel.

In many oriental countries, bamboo slats are used in the pens and absorbent floor in the run. The slat holes must be small to prevent eggs falling below the slats and legs get trapped in between the slats. **Broiler ducks or green ducks,** must not have access to swimming, because it will not only toughen the meat; but also results in poor feed efficiency. For better results, green ducks must be reared under intensive system, preferably on slats, with no access to swimming and fed with high efficiency pellet feeds, free from mycotoxins.

CLIMATE CHANGE ADAPTATION IN POULTRY PRODUCTION AS A PART OF FOOD SECURITY IN KERALA, INDIA

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Models on global warming indicate that rise in temperature on an average is likely to be around 3 ^{o}C by the end of this century. If rise in sea level happens as projected, the coastal areas which are thickly populated will be in peril and for the existing population the safe drinking water will be a great problem in addition to the damage to animal agriculture like poultry due to global warming. Ozone depletion is also taking place at faster rate due to man made interventions in the form of CFCs. The CFCs are used in a variety of industrial, commercial, and household applications. These substances are non-toxic, non-flammable and non-reactive. They are used as coolants in commercial and home refrigeration units, aerosol propellants and electronic cleaning solvents. The diurnal variation of UV-B radiation recorded at KAU, Vellanikkara (Kerala, India) revealed that the UV filtered radiation (>1MED) reaches the ground surface between 1030 h and 1430 h, which may be detrimental to biological activities. The ozone loss leads to more UV radiation reaching earth. It has the potential to increase incidence of skin cancer, cataracts and damage to people's immune system. In addition, mosquito transmitted diseases are increasing year after year due to global warming. Little is known on impact of ozone depletion and increasing UV-B radiation on ontogeny of tropical plants and human and animal diseases since studies in this direction are very few. Because CFCs remain in the atmosphere for100 years, continued accumulation of these chemicals pose ongoing threats, even after their use is discontinued.

The State of Kerala also experiences decline in annual and monsoon rainfall and increase in temperature. The mean annual maximum temperature over Kerala has risen by 0.6^{o}C, the minimum temperature by 0.2^{o}C and the average by 0.4^{o}C between 1956 and 2004. Increase in maximum temperature and decrease in minimum temperature were also noticed at several locations and thus there is a threat to thermosensitive crops and animal agriculture like poultry. The maximum temperature shot even up to 40 ^{o}C in Palghat during February, 2004 due to absence of rains from November, 2003 onwards. The ever highest maximum temperature of 41^{o} C was recorded on April 26, 1950 at Palghat. The year 1987 was the warmest year over Kerala. The decade 1981-90 was the driest decade over Kerala due to failure of northeast monsoon and pre-monsoon showers during summer. Severe summer droughts were noticed in 1983 and 2004, led to abnormal increase in maximum temperature during summer during the above two years. In contrast, the monsoon behaviour in 2007 was totally different to that of previous years and heavy rains were noticed from June to September, led to floods in low lying areas. The paddy crop in Kuttanad belt was flooded and the final crop productivity as well as production was less. The average yield of paddy in farmers` fields of Kuttanad, which is one of the rice bowls of Kerala, was only 3.0 t/ha as against the expected harvest of 5.0 t/ha. Out of 9,118 ha of total cultivated land, 5623 ha of paddy was damaged in the Alappuzha belt of Kuttanad alone in Kharif 2007 due to floods. The prolonged rains also led to delay in "puncha sowing (second crop). The high acidic nature and salinity of the Kuttanad soil were intensified due to floods and bund breaches during the monsoon season. To add to this monsoon fury, the unusual summer rains from 13-23rd March, 2008 also devastated the paddy production to a considerable extent in Alleppey District and Kole lands of Thrissur District. More than one lakh tonnes of paddy were the loss during 2007-08 due to occurrence of floods and unusual summer rains.

The State of Kerala has always been a food deficit State as it produced only 45 per cent the rice it needed even in 1950s. The deficit gradually rose to 76 per cent in the end of last century and now it is 85 per cent. It was attributed to decline in paddy lands and other socio-economic factors in addition to the occurrence of floods. The area under paddy cultivation was 7.6 lakh hectares in 1950s and it is now only 2.5 lakh hectares. Decrease in wetlands might be also one of the reasons for frequent floods during rainy

season and summer droughts in recent years, resulting in food crisis and price rise when such weather phenomena occur and re-occur.

The national economy is also mostly agrarian based and depends on onset of monsoon and its further behaviour. The year 2002 was a classical example to show how Indian foodgrains production depends on rainfall of July and it was declared as the all-India drought, as the rainfall deficiency was 19% against the long period average of the country and 29% of area was affected due to drought. The All-India drought is defined as the drought year when the rainfall deficiency for the Country as a whole is more than 10% of normal and more than 20% of the Country's area is affected by drought conditions. The *kharif* foodgrains production was adversely affected by a whopping fall of 19.1% due to all-India drought during monsoon 2002. Similar was the case during all-India drought in 1979 and 1987. Rice production in India is likely to be adversely affected in 2009 also. It was due to erratic monsoon behaviour and ended with 23 % rainfall deficiency, which was second highest rainfall

deficit year after 1972 in which the rainfall deficiency was 24 %. As a whole, the Indian foodgrains production is likely to be less by 16 % due to deficit monsoon rainfall of 2009. All these monsoon rainfall events reveal that the occurrence of droughts during Southwest monsoon across the Country adversely affect the Indian foodgrains production to a greater extent.

The occurrence of droughts and floods may be having direct impact on animal agriculture like poultry as non availability of feed may lead to low egg production and mortality. Like floods and droughts, the occurrence of heat waves on poultry is detrimental as low intake of feed due to high maximum temperature lead to low egg production. The production was less by 20.9% in poultry egg due to increase in maximum temperature by 2-8 ^{o} C during March 2004 in Himachal Pradesh (Rajendra Prasad and Ranbir Rana, 2006). According to Natarajan (2006), mortality is high when birds are suddenly exposed to heat wave conditions (air temperature touching mercury mark of 38 ^{o} C and above) but it may not be the case when acclimatization to higher temperature is gradual or when protective measures are adapted anticipating the heat wave. Such high temperatures prevail in the central part of Kerala as noticed recently in summer 2004 when severe drought occurred. The requirement of egg production by 2020 in India is just above 30 million tonnes in addition to the requirement of other crop and animal food as per the ICMR dietary requirements for a balanced diet in tune to the expected human population increase. It is to be achieved against the projected global warming of around 1^{o} C by 2020 at the current level of increase in CO_2 , which may lead to frequent occurrence of heat and cold waves and floods and droughts. They adversely affect poultry health and production including egg and meat production. Therefore, there is urgent need to climate change adaptation strategies in animal agriculture like poultry production under projected climate change scenario. As a part of adaptation strategy, farmers are advised to look into housing design to cope up with weather extremes as a pro-active measure. Increase diet energy, stimulate feed intake, body energy reserve, wet mash feeding, protein level correction with minerals and vitamins supplement, electrolyte balance, provision of cool water with nipple type and advance planning in diet change are some of the adaptation strategies against high temperature according to Natarajan (2006). Under high humid and rainfall conditions, sufficient stocking of the grains, good drying facilities and quality measures (mycotoxin estimation) will not only safeguard the birds from a possible outbreak of mycotoxins but also minimize the loss through reduced egg production and poor feed conversion. Poultry breeders should produce genotypes which can tolerate higher levels of both biotic and abiotic stresses through appropriate bio-safety and bio-security measures, mining and blending of desired genes from wild and native poultry populations or from other animals including microbes, selection of poultry for disease resistance, efficient feed conversion and tolerance to humid and hot climatic conditions according to Yadav (2009). However, animal agriculture requires immediate and substantial changes in regulation of production practices and consumption patterns as emissions of GHGs are likely to increase and thus leading to global warming.

It reveals that the occurrence of floods and droughts and heat and cold waves are common across the world. The adverse impact of weather calamities on world economy is tremendous in the form of food insecurity and increase in food prices. It is more so in India as our economy is more dependent on Agriculture. Interestingly, weather extremes of opposite in nature like cold and heat waves and floods and droughts are noticed within the same year over the same region or in different regions across the Country. Reports indicate that they are likely to increase in ensuing decades and food insecurity is likely world-over. Therefore, there should be a determined effort from developed and developing countries to make industrialisation environment-friendly by reducing greenhouse gases pumping into the atmosphere. Awareness programmes on climate change and its effects on various sectors viz., food security, health, infrastructure, water, forestry, land and ocean biodiversity and sea level and the role played by human interventions in climate change need to be taken up on priority. In the process, lifestyles of people should also be changed so as not to harm earth-atmosphere continuum by pumping greenhouse gases and CFCs into the atmosphere. Finally, we have to foresee the weather extreme events and prepare ahead to combat them so that the losses can be minimised. Therefore, strategies on mitigation and adaptation against weather extremes are to be chalked out on war-footing. Similarly attempts are to be made to forewarn local weather systems and weather extremes so as to minimise the human and crop losses. In addition, weather insurance package to the farmers against weather related disasters should be made compulsory and operational in an event of their occurrence. It will help them to maintain their livelihood in an event of weather extremes that depend solely on the income of Agriculture. It is the phenomenon even world over and thus there should be a mechanism to sustain food security against weather calamities.

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GENETIC RESOURCES & BREEDING

GROWTH PERFORMANCE OF PURE AND CROSSBRED DUCKLINGS IN ANDAMAN AND NICOBAR ISLANDS

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Abstract

Day old ducklings of Andaman local- Chara-Chembelli (CC) (mixed population), Khaki Campbell (KC), Pekin (P) and its various crosses viz PxP, PxCC, PxKC, KCxKC, KCxCC, CCxCC, CCxP, and CC x KC were evaluated for growth performance. A total of 128 healthy day old ducklings 16 in each group were reared in deep litter floor pen system of open sided poultry house. All the ducklings were provided with similar feeding and management conditions. Ducklings were kept in well cleaned and disinfected separate pens up to 21 days of age and thereafter transferred to 8 separate growing houses.. Duck starter ration was provided up to 14 days of age and thereafter grower ration was provided up to the age of 56 days. All mash dry feed and *ad libitum* water was provided through out the experimental period. Feed intake was recorded at the end of each week up to 8 weeks of age. The total feed consumption by each duckling was calculated. The ducklings were weighed at the beginning and then once in a week thereafter through out the experimental period. Feed efficiency and survivability of ducklings were recorded. Performance Index percent and production number were calculated.

The day old body weight, final body weight and live weight gain at 56 days of age, feed conversion ratio, performance index percent, and production number were observed highest in PXP and lowest in local CC where as the ducklings of PxCC cross showed second highest next to PxP ducklings in respect of final body weight (1817.4±99.44 g), live weight gain (1783.54±99.44 g), feed conversion ratio (3.12), performance index (58.25%), and production number (95.93). The differences among the treatment groups were statistically significant ($P<0.01$). The lowest feed intake was observed in CCx KC group (4448.02g) and highest in PxP group (6675.44g). The P x CC group consumed 5564.64 g of feed next to the PxP group. The survivability was highest in local CC x CC group (94.34%) followed by PxCC (92.22%), CCXP (90.12%), KCXCC (88.89%) and PxP group (88.82%).The Lowest survivability was observed in KCXKC (77.82%) The highest production number was found in PxP (121.70) and lowest in CCxKC (51.29).. It also indicates that the use of sire from PxP genotype having higher growth rate with dam of other genotypes of relatively lower growth rate than PxP, results in improved production number.

Considering the growth performance, the PxCC crossbred showed better than all other crosses and may be used as meat purpose duck.

Key words: Body weight, ducklings, cross bred, Chara-Chembelli, Pekin, Khaki Campbell, feed conversion rato, production number, survivability, performance index.[1]

Introduction

Ducks in India, with 23.5 million populations (Livestock census 1987) occupy an important position next to chicken farming in India. They form about 8- 10% of poultry population and contribute more than7% of the total poultry produced and 10% of total egg production in India. Ducks form 3% of the total poultry population of the islands and 2% of the eggs produced from ducks. The small, marginal and landless farmers raise about 90% of the ducks in these Islands (Ahlawat et. Al. 1987, Ahlawat, 1986)). As per 2003 census the total duck population in A&N islands was 63866 (desi) and 2531 improved variety. This form about 7.24 % of total poultry population in these islands. Ducks are mostly concentrated in eastern and southern states of India mainly coastal region and Andaman and Nicobar Islands with non- descript indigenous stocks, which however are poor layers. A study revealed that the ducks in these islands are reared on very small scale by poor and marginal farmers as a free range condition. Mostly desi ducks are reared and very little supplemented feeds are given in the form of broken rice bran or in the form of slurry and most of the nutrient requirements are met by the free grazing near the homestead, ponds, nallahs and paddy fields where ducks feed on insects, worms, greens, snails and earthworms (Senani et. al.2001,2002). Their study on deshi ducklings collected from farmers' field and rearing under farm condition revealed average hatch weight of 33.3±2.91g. The average body weight of the male and female ducks at 16th and 25th week of age were 545±41.03, 655±81.49 and 1284±38.28 and 1280±30.0 g respectively. Age at sexual maturity was 183 days and corresponding body weight was 1257.14±35.16g. Average egg weight was 42.72±2.16g and hen housed egg production was 33.8% over a period of 100 days. Senani et al (2002) reported average hatch weight of 42.,41 and 35g in ducklings of desi x Khaki Campbell and Khaki Campbell x desi cross, and in desi ducklings respectively and the respective body weight after 4 weeks were 130, 290 and 340g , and the corresponding growth rates were 2.9,8.3 and 10.2 g /day. Baruah et. al. (1993) reported highest mortality in Khaki Campbell followed by Pati and lowest in the crossbred during the period from day old to 20 week of age. Narahari et al (1986) reported aflatoxicosis to be the major cause of mortality as 6.7%, 0.4% and 3.5% in indigenous ducks from the period

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0-8, 9-20 and over 20 weeks of age respectively against the corresponding mortality of 12.9%, 9.2% and 6.4% in Khaki Campbell ducks.

Deshi ducks are poor producer of meat and eggs compared to those of exotic breeds; survivability of indigenous ducks is higher than exotic ducks (Hamid et al 1988). In A&N islands the available duck breeds are non-descript deshi, Chara-Chembelli (indigenous), Pekin, and Khaki Campbell. Pekin is an excellent meat producing ducks but has poor scavenging ability and high mortality under extensive condition (Ahmed, 1986). Indigenous ducks are well adapted to management and rural condition of Andaman and yield good quality meat. Exotic breeds of ducks are heavier and good layer than desi ducks, which are less acceptable to Andaman farmers due to its lower survivability. Local type ducks have special characteristics of tropical adaptability, better resistance to diseases and meat quality. Exploitation of these qualities using advance breeding methods would lead to economically viable backyard keeping of ducks which can be used on larger scale in rural as well as sub-urban areas.

There is scanty of information in relation to growth performance of different pure and cross bred ducklings in Andaman climatic condition. Keeping in view, the present study was designed to evaluate the growth performance of native breeds and their crosses with the exotic breeds for finding out the differences in growth performance among different genetic groups under tropical conditions.

Materials and methods

One hundred twenty eight day old ducklings of 8 genotypes viz. Pekin x Pekin (PXP), Pekin x Chara-Chembelli (P x CC), Pekin x Khaki Campbell (PxKC), Khaki Campbell x Khaki Campbell (KCXKC), Khaki Campbell X Chara – Chembelli(KC X CC), Chara -Chembelli x Chara- Chembelli (CCXCC), Chara- Chembelli x Pekin (CC x P) and Chara-Chembelli x Khaki (CCx KC) were randomly selected and distributed equally in eight treatment groups (16 ducklings in each) on the basis of genetic group. All the experimental birds were reared providing standard management condition and IAEC approved standards. Commercial BIS grade duck starter and grower feed was provided from 0-14 days of age and 15-56 days of age respectively. All mash dry feed and water ad libitum were provided through out the experimental period. Ducklings were brooded up to 21 days of age under well cleared and disinfected separate pens fitted with hover for each genotype in deep litter and transferred thereafter to growing houses providing one square feet floor space per duckling up to 21 days of age and 3 square feet per bird from 21 days onwards respectively. The ducklings were provided 23 hours light and half hour dark period daily up to the age of 56 days of age. Feed intake was recorded at the end of each week up to 8 weeks of age. The body weights were recorded at day old of age and thereafter every week through out

the experimental period. Feed efficiency and survivability of the ducklings were calculated. The performance index ((P.I) % was calculated as per Rashid et al (2002) and the formulas adopted for calculation of different traits are follows:

$$\text{Performance Index (P.I \%)} = \frac{\text{Live weight in kg}}{\text{Feed conversion ratio}} \times 100$$

$$\text{Production Number (P.N.)} = \frac{\text{Average Live weight in grams} \times \text{\% livability}}{\text{Duration of fattening in days} \times \text{Feed conversion ratio}} \div 10$$

$$\text{Survivability \%} = \frac{\text{No. of initial live birds - No. of dead birds during the experiment}}{\text{No. of initial live birds}} \times 100$$

$$\text{Feed conversion ratio} = \frac{\text{Feed intake in kg}}{\text{Weight gain in kg}}$$

The data were analyzed as per standard statistical software adopting completely randomized design.

Results

The growth performance of ducklings of various crosses and pure breeds from 0 to 56 days of age **viz**. Pekin x Pekin (PxP), Pekin x Chara-Chembelli (PxCC), Pekin x Khaki Campbell (PxKC), Khaki Campbell x Khaki Campbell (KC x KC), Khaki Campbell X Chara –Chembelli (KC X CC), Chara- Chembelli x Chara- Chembelli (CC x CC), Chara- Chembelli x Pekin (CC x P) and Chara- Chembelli x Khaki Campbell (CC X KC) is presented in Table1 and Fig1-4.

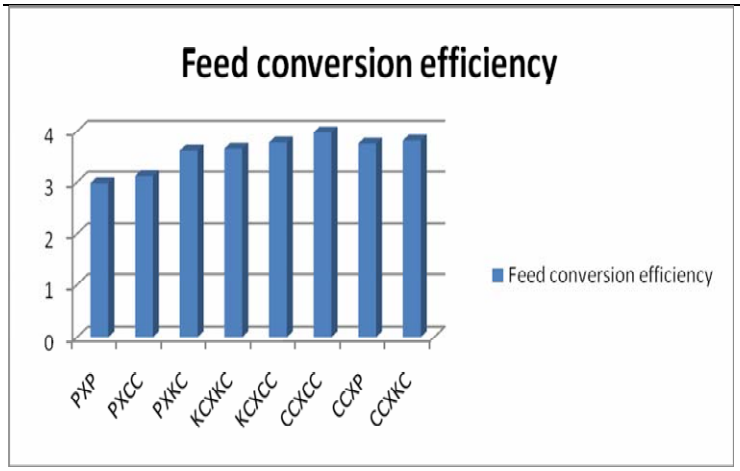

Fig1. Feed conversion efficiency of different genotypes of ducklings

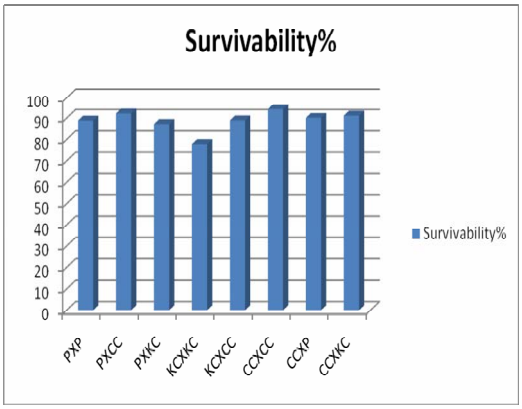

Fig2. Survivability percent of different genotypes of ducklings

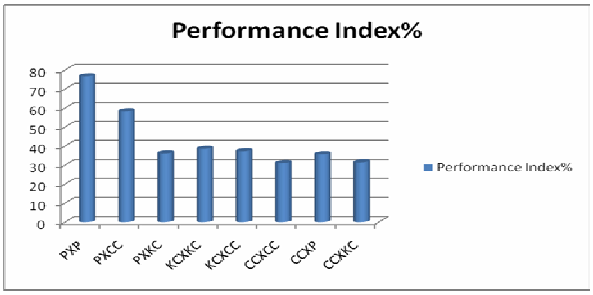

Fig3. Performance index% of different genotypes of ducklings

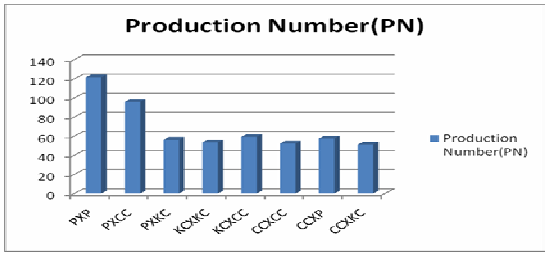

Fig4Production number of different genotypes of ducklings

Table1: The growth performance of pure and crossbred ducklings during the experimental period of 0- 8 weeks

Parameters	PXP	PXCC	PXKC	KCXKC	KCXCC	CCXCC	CCXP	CCXKC	Level of significance
Initial body weight (g/duckling)	46.50 ±1.64^{a}	33.88 ±1.83^{bcd}	37.88 ±2.15^{b}	36.81 ±2.24^{bc}	35.38 ±2.01^{bcd}	30.81 ±1.75^{d}	33.13 ±1.63^{bcd}	32.13 ±1.83^{cd}	**,P<0.01 **CD(0.01) = 6.909 CD(0.05) = 5.255**
Final body wt(g/duckling)	2286.6 ±107.35^{a}	1817.4 ±99.44^{b}	1305.8 ±86.50^{cd}	1406.3 ±65.39^{c}	1405.0 ±73.95^{c}	1105.5 ±67.57^{d}	1338.9 ±54.42^{c}	1199.6 ±54.33^{cd}	** **CD(0.01) = 279.361 CD(0.05) = 212.556**
live wt. gain(g/56 days)	2240.08 ±107.35^{a}	1783.54 ±99.44^{b}	1267.92 ±86.50^{cd}	1369.52 ±65.39^{c}	1369.66 ±73.95^{c}	1074.7 ±37.51^{d}	1305.79 ±54.42^{c}	1167.46 ±54.33^{cd}	** **CD(0.01) = 276.112 CD(0.05) = 210.089**
Feed Intake(g/duckling)	6675.44	5564.64	4577.19	4998.75	5163.62	4799.88	4896.71	4448.02	
Feed conversion efficiency	2.98	3.12	3.61	3.65	3.77	3.98	3.75	3.81	
Survivability%	88.82	92.22	87.12	77.82	88.89	94.34	90.12	91.23	
Performance Index%	76.73	58.25	36.17	38.53	37.27	31.08	35.70	31.48	
Production Number(PN)	121.70	95.93	56.27	53.54	59.16	52.35	57.46	51.29	
P=Pekin,CC=Chara-Chembelli,kC=Khaki Campbell,									
**=Significant(P<0.01)									

Initial Body Weight

The initial body weight (g/duckling) among the genetic groups were significantly (P<0.01) different. But the mean initial body weight was significantly the highest (46.50±1.64) in pure PXP and lowest in CC X CC (30.81±1.75)) among all the crosses as well as pure breeds studied. The differences were statistically significant (P<0.01).The Initial body weight of P X KC was 37.88±2.15 followed by KC X KC (36.81±2.24),KC X CC (35.38±2.01), PXCC(33.88±1.83), CCXP (33.13±1.63 and) CCX KC (32.13±1.83) .

Final Body Weight

The final body weight (g/duckling) at 8th week were comparable and significantly different (P<0.01) among the genetic groups. The pure PXP recorded highest body weight (2286.6±107.35) and the cross CCXCC which was local showed the lowest body weight (1105.5±67.57). The final body weight of the cross PXCC recorded highest body weight (1817.4.54±99.44) among the crosses and other pure breeds except pure PXP. The final body weight of KC X KC, KC X CC, CCXP, PXKC and CCXKC were 1406.3±65.39, 1405.0±73.95, 1338.9±54.42, 1305.8±86.50 and 1199.6±54.33 respectively.

Body Weight Gain (g/56days)

The gain in body weight at 8th week of age also differed significantly (P<0.01) among the genetic groups. The PXP showed highest gain in body weight (2240.08±107.35) and the local CCXCC recorded the lowest (1074.7±37.51). Among the crossbreds, the PX CC showed highest gain in body weight (1783.54 ±99.44) followed by KCX CC (1369.66±73.95), CC X P (1305.79±54.42), P X KC (1267.92±86.50) and CC X KC (1167.46±54.33).

Feed intake (g/duckling for 8 weeks)

The average feed consumption during the experimental period was 6675.44, 5564.64, 5163.62, 4998.75, 4896.71 4799.88, 4577.19 and 4448.02 gm in PXP, PXCC, KCXCC, .KCXKC, CCXP, CCXCC, PXKC, and CCXKC respectively.

The PXP consumed highest amount of feed which was followed by the ducklings of PXCC. The lowest feed was consumed by CCXKC. However, no significant differences in total feed intake were observed among the genetic groups.

Feed Conversion Ratio

Poor feed conversion ratio was observed in ducklings of CCXCC (3.98) where as the best feed conversion ratio was recorded in ducklings of PXP (2.98) compared to PXCC (3.12), PXKC (3.61), KCXKC (3.65), KCXCC (3.77), CCXCC (3.98), CCXP (3.75), and CC X KC (3.81) as shown in Table1 and Fig1.

Survivability Percent

Survivability in ducklings of different genotypes is shown in percentage in Table 1 and Fig 2. The percentage of survivability was highest in CCXCC (94.34) followed by PXCC (92.22). One interesting finding was that where ever the CC was used as one of the parents in the crosses viz. KCXCC (88.89), CCXP (90.12), CCXKC (91.23), and PXCC (92.22) the survivability was observed more than pure PXP (88.82), P X KC (87.12), or KCXKC (77.82).

Performance Index (PI) Percent

The performance index of ducklings of various genotypes is shown in percentage in Table1 and Fig 3. PXP showed highest Performance index (76.73) followed by its cross with CC local i.e. PXCC (58.25). The CCXCC recorded lowest P.I. (31.08). The P.I. of the ducklings of crosses such as CCXKC, CCXP, PXKC, KCXKC, KCXCC were 31.48, 35.70, 36.17, 38.53 and 37.27 respectively.

Production Number (PN)

The PXP recorded the highest production number (121.70) followed by PXCC (95.93),KCXCC (59.16), CC X P (57.46), P X KC (56.27), KC X KC (53.54), CC X CC (52.35) and the lowest in CC X KC (51.29) as shown in Table1 and Fig 4.

Discussion

The initial body weight (g/ duckling), final body weight in gram, , live weight gain (g/56 days , feed intake(g/ duckling), Feed Conversion Ratio, Survivability%, Performance Index% and Production Number (P.N.) of different pure and cross bred genotypes are presented in Table 1 and Fig1-4. From the Table, it is evident that the average data on initial and final body weight and body weight gain were recorded highest in PXP followed by

PXCC except for its initial body weight (33.88±1.83). These differences appear to be inherited and depend upon the genetic constitution of the breeding stock. The higher final body weight and body weight gain in PXCC might be due to heterotic effect. This result corresponds to the findings of Hamid et al (1988), Stankevicience (1980), and George et al (1980). The total body weight gain of P X CC cross bred ducklings were significantly lower than pure P X P but significantly higher than all other genotypes. It might be due to heterotic effect of gene of high yielding meat producing exotic ducks (Pekin) and mixed population of Andaman local-Chara–Chembelli breeds which have most adaptable capability than other crosses. Viz PxKC, KCxKC, KCxCC, CCxCC, CCxP, and CCxKC. This finding is in consistence with the report of Rashid et al, (2002). The live weight gain of KCxCC was though significantly lower than PxP, and PxCC but significantly higher than CCxCC. This might be due to heterocity of gene of KC X CC. All the pure crosses showed significant differences in body weight gain. This might be due to the breed characteristics. In comparison to KC X KC, CCXCC ducklings were superior in terms of survivability and KC ducks were superior to CCXCC in initial body weight, final body weight and gain in body weight. This result corresponds to the findings of Nageswara et al (2001).

Crossing Pekin as sire with Andaman local-Chara-Chembelli as dam line was more suitable for improvement in growth rate than crossing Pekin sire with other exotic dams. Positive heterotic effect of cross breeding in growth performance was in agreement with Rashid et al (2002); Baruah et al (1991,1992). Feed intake was highest in PXP followed by PXCC. The feed intake was lowest in CC X KC. The differences among the genetic groups were significant ($P<0.05$) with highest feed conversion ratio in PXP. These observations are in consistence with the previous reports (Baruah et al. 1994, Rashid et. al. 2002). The superiority of PXP high yielding breed in feed conversion than in crossbred genotypes was in accordance with the report of Rashid et. al. (2002). The survivability in PXP was less than crossbreds PXCC, CCXKC, CCXP, KCXCC and local CCXCC. This might be due to the fact that the local Chara-Chembelli was having disease resistance trait which has been inherited to the progeny. Thus cross breeding with local Chara-Chembelli had a distinct beneficial effect on survivability, which agreed well with the findings of Baruah et.al. (1993), Rashid et al (2002) and Narahari et al. (1986). From the above statement it can be said that ducklings produced from the crosses of local Chara-Chembelli were more adaptable to the adverse condition than pure Pekin or Khaki Campbell. Performance index was highest in pure breed (PXP) followed by its cross with Chara-Chembelli and other crossbred as well as purebreds .This result also corresponds to the findings of Rashid et. al. (2002)

Conclusion

Considering the growth performance, the PxCC crossbred showed better than all other crosses and may be used as meat purpose duck. The local Chara-Chembelli may be used as either of parents to produce crossbred ducklings for better adaptability under adverse condition.

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    Nageswara ref:1. The performance of indigenous ducks (ID), Khaki Campbell (KC) and their reciprocal crossbred layers was studied from 19 to 58 weeks of age. For each genotype, 4 x 18 ducks (3 males + 15 females) were reared under a semi-intensive system (SIS) and an intensive system (IS) with standard management, and 4 x 50 ducks (8 males + 42 females) were reared in an extensive system (ES) with traditional management. 2. In comparison to KC, ID were superior in terms of age at first egg, age at 50% egg production, egg weight, hatchability, eggshell thickness with higher egg shape index. KC ducks were superior to ID in body weight, egg production and feed/kg eggs. Egg quality was similar among the genotypes. Crosses were superior to their parent breeds in age at first egg,

egg production and feed/kg eggs. They were also superior to KC in egg weight and egg-shell thickness with a higher egg shape index. 3. The performance of genotypes in the SIS and the IS was similar and superior to the ES except for fertility and yolk colour. 4. Significant heterotic effects were recorded for age at first egg, age at 50% egg production, egg production per duck-day, and feed efficiency and egg weight in crosses. Performance was similar in the reciprocal crosses, but superior to their parent breeds.

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AN ASSESSMENT OF SEXUAL DIMORPHISM IN AFRICAN MUSCOVY DUCKS (CAIRINA MOSCHATA) USING MORPHOLOGICAL MEASUREMENTS AND DISCRIMINANT ANALYSIS

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Abstract

Sexual dimorphism was examined in 221 randomly selected adult African Muscovy ducks extensively reared in north central Nigeria using univariate and multivariate measures of body size and skeletal proportions. The body parameters investigated included body weight, eight primary linear body measurements (breast circumference, thigh circumference, body length, bill length, neck length, shank length, total leg length and wing length) and four morphological indices (massiveness, stockiness, long-leggedness and condition index). The univariate analysis showed male dominance ($P<0.05$) in all the morphometric measurements, with the exception of stockiness and long-leggedness where significantly higher mean values were recorded for females. Low, moderate and high positive and negative correlations among the body size and shape characters of the ducks were recorded. The canonical discriminant analysis on body weight and primary linear body measurements revealed that wing length was the most discriminating variable between the sexes, followed by body weight, neck circumference, total leg length, body length and shank length respectively. Three other variables not qualified to enter the model were expunged. The single discriminant function obtained correctly classified 91.4% of individuals from the sample of known-sex ducks.

Keywords: Muscovy duck, Nigeria, sex, body parameters, discriminant analysis

Introduction

Poultry production in the tropics is characterized by high dynamics of development. This outstanding trend is based on increasing demands and preferences for poultry products on one hand and on improvements in management, disease prophylaxis and breeding on the other hand (Horst, 1999). In the tropics such as Nigeria, the poultry industry is not as diversified as in the temperate. Here, emphasis is laid on egg production and on only one species of poultry, the domestic fowl; whereas economic and nutritional benefits can be derived from keeping other species, such as ducks, some strains of which are fast-growing, resistant to many diseases of the domestic fowls and can produce as many as 300 eggs per year (Oluyemi and Roberts, 2000; Teguai *et al*., 2008). Adesope and Nodu (2002) reported that the meat of Muscovy ducks, which make up about 74% of the total duck population in Nigeria, contains less fat and it's healthier.

Morphological variation within a species is of great biological interest, both as a phenomenon and as a descriptive and an analytical tool. Sexual differences in external morphology are of interest in studies of reproductive biology and descriptively, to analyse population composition (Piersma, 1988). This can be used to detect the amount and distribution of genetic variation within and between populations of the local Muscovy ducks thereby increasing the understanding of the historical processes underlying the genetic diversity. It can also provide important basic information for selection and breeding programmes. Knowledge on the objective description of body size and skeletal proportions of

native stock is imperative in Nigeria because of the introduction of exotic ducks such as Pekins and Khaki Campbell into the country which, as a result of interbreeding, could lead to the erosion of the genetic resource of the indigenous Muscovy ducks.

Visually assessing with certainty the sex of African Muscovy ducks in the field is a difficult task. In Nigeria, some attempts have been made to characterize the Muscovy ducks using univariate analysis of body weight and linear body measurements. However, there is dearth of information on their phenotypic differentiation using morphological indices and multivariate analysis; which are currently receiving increased attention in birds (Lorentsen and Rov., 1994; Strelec *et al*., 2005; Zenatello and Kiss, 2005; Robertson *et al*., 2008). The present investigation therefore, aimed at providing baseline information on sexual dimorphism in African Muscovy ducks using morphological indices and discriminant analysis in addition to primary morphometric characters. The information so obtained will ensure better characterization which could aid in the ecological studies, conservation, selection and genetic improvement of the native stock.

Materials & Method

Location of study and experimental animals

Data were obtained from two hundred and twenty one (221) randomly selected adult African Muscovy ducks of both sexes (95 males and 126 females respectively). The birds were selected in their breeding tracts in certain smallholder farms in Nasarawa State, north central Nigeria from December, 2008 to May, 2009. The State falls within the guinea savanna agro-ecological zone, and is found between latitudes $7^0 52'$N and $8^0 56'$N and longitudes $7^0 25'$E and $9^0 37'$E respectively). The birds were managed through the traditional scavenging system.

Traits measured

Body weight (BWT), eight primary biometric traits and four morphological indices were measured on each adult African Muscovy duck. Measurements were restricted to apparently healthy birds that conformed to the species' classification descriptors. The body parts measured were, body length (BDL), breast circumference (BTC), thigh circumference (THC), bill length (BLL), neck length (NKL), foot length (FTL), total leg length (TLL), wing length (WNL), massiveness (MAS) (the ratio of live body weight to body length × 100); stockiness (STK) (the ratio of breast circumference to body length × 100); long-leggedness (LLN) (the ratio of total leg length to body length × 100) and condition index (CND) (the ratio of live body weight to wing length × 100). The anatomical reference points were as earlier described (Fox *et al*., 1992; Oblakova, 2007; Teguai *et al*., 2008). A 5-kg measuring scale was used for the weight measurement. The length and circumference measurements were effected using a measuring tape calibrated in centimetres (cm). All measurements were taken by the same individual early in the morning before the ducks were released for scavenging.

Statistical analysis

Body weight, primary linear body measurements and morphological indices were subjected to analysis of variance to determine sex effect using the General Linear Model of SPSS Version 13 (2001). Means were separated using the two-tailed, two-sample t-test of the same statistical package. Pearson's coefficients of correlation among the various body parameters were computed. The multivariate technique involved the use of canonical discriminant analysis on body weight and the original eight primary linear body measurements of the ducks. The standardized discriminant function was used to screen for

the most discriminating variables between the sexes. For sex identification, the unstandardized discriminant function procedure was employed. The ability of this function to identify males and females is indicated as the percentage of individuals correctly classified from the sample that generated the function. The robustness (reliability testing) of the function was validated using split-sample validation (cross-validation) of the SPSS package.

Results and Discussion

The means, standard deviations and coefficients of variation of the body parameters of African Muscovy ducks are presented in Table 1. Sex-associated differences were found in all the body traits and
indices investigated. Males (drakes) had significantly ($P<0.05$) higher body weight, body length, breast circumference, thigh circumference, bill length, neck length, foot length, total leg length, wing length, massiveness and condition index. However, female (ducks) dominance ($P<0.05$) was observed in stockiness and long-leggedness. The longer total leg length of the males confers greater body height. The present findings on body weight and linear body measurements of both sexes are consistent with the reports of earlier workers (Tai and Rouvier, 1998; Goswami *et al*., 2000; Teguia *et al*., 2008). This sexual dimorphism is attributable to the usual between-sex differential hormonal action (Baeza *et al*., 2001) which invariably leads to differential growth rates. The greater difference in bill length between the sexes suggests that the trait may play an important role, probably in sexual display and territorial defence by males (Chochi *et al*., 2002).

Body conformation type and meatiness of the ducks could better be assessed using massiveness, stockiness, long-leggedness and condition index. These principal selection indices state the ratio of measurements that characterizes the proportionality of bird's body (Fox *et al*., 1992; Oblakova, 2007). In the present study, meatiness trait was better described in males using massiveness (5.65 versus 3.93%; $P<0.05$ for males and females respectively) while in females, it was better explained via stockiness (82.27 versus 79.16%; $P<0.05$ for females and males respectively). Body weight was corrected for body size using weight/ wing ratio × 100. This, according to Owen and Cook (1977), gives a better indication of a bird's ability to meet its present and future energy requirements than using body weight alone. This condition index was found to be higher in males (10.57%) than females (9.15%). This is of physiological importance because standard measures of metabolic activities are frequently expressed as a function of body size, and it is often useful to examine the relationship of structures or organs relative to overall body size (Blem, 1984). However, long-leggedness was higher in females (44.21%) compared to their male counterparts (42.12%). The higher leg-body ratio of the females is an indication that they have relatively longer legs while their male counterparts have relatively longer body. This index could play a role in the assessment of type and function. While the females display a narrower body, which is suitable for egg production; the males exhibit a blockier appearance, which is more a characteristic of meatiness.

Phenotypic correlations among body weight, zoometrical traits and indices are presented in Table 2. Low, moderate and high positive and negative correlation coefficients were recorded among the various body parameters. In males, the coefficients of correlation ranged from -0.12 to 0.92. In female birds, the estimates of correlation ranged from -0.01 to 0.89. High positive relationships among traits suggest that they are under the same gene action and can also be predicted from one another singly or in combinations (Ngapongora *et al*., 2004; Ogah *et al*., 2009). The varying phenotypic correlation coefficients in the two sexes suggest sexual differences in the genetic architecture of the birds.

Although the univariate analysis revealed differences in the body weight and linear type traits of the sexes of Muscovy ducks, the multivariate analysis provided better resolution (Table 3), thereby limiting the number of variables contributing to sexual dimorphism in ducks. Only a single standardized canonical discriminant function was extracted in the present study.

The significance of the discriminant function tested with the minimization of Wilks' Lambda (Lambda= 0.293) and Bartlett's Test (chi-square= 264.999; P<0.01) provided validity for the canonical discriminant analysis. The discriminating power of wing length was highest, followed by body weight, neck circumference, total leg length, body length and foot length. The present findings are consistent with the report of Zenatello and Kiss (2005) where wing length was observed as the most discriminating variable of the sexes of Rose-coloured Starlings *Sturnus roseus.* Similarly, Martinez-Gomez and Curry (1998) reported that wing chord and tarsus length were the two most important traits for sex-separation in birds. However, Lo Valvo (2001) reported that bill depth was the best parameter in sexing birds.

The unstandardized canonical discriminant function was used to classify individual birds. Wing length, body weight, neck length, total leg length, body length and foot length were the variables included in the discriminant (D) equation below:

D = -3.116 + 0.280WNL+ 0.921BWT + 0.191NKL - 0.196TLL - 0.063BDL - 0.283FTL

The classification function could be directly used to identify the two sexes, since positive D scores indicate males and negative D scores indicate females. This function was able to classify correctly 91.4% of individuals from the sample of known-sex ducks. Cross-validation with the split-sample method equally indicated a 91.4% overall success rate (96% of the females and 85.3% of the males were correctly assigned). The six variables therefore, were sufficiently robust to be used in the field to determine the gender of live birds. This is an indication that morphological measurements could be taken into consideration to increase the consistency of individual sexing especially by farmers, livestock extension officers and researchers who are not familiar with African Muscovy ducks. Sexual dimorphism is important because it allows the assessment of sex effect on survival and dispersal; evaluation of population dynamics, since female members are frequent model parameters and identification of species threats such as sex ratio disequilibria or sexual differences in predation risk (Bourgeois *et al*., 2007).

Table1. Descriptive statistics of the body weight (kg), linear body measurements (cm) and morphological indices (%) of adult African Muscovy ducks according to sex.

	Male animals (n=95)			**Female animals (n=126)**		
Traits	Mean	SD	CV	Mean	SD	CV
BWT	2.73[a]	0.58	21.25	1.52[b]	0.42	27.63
BDL	47.86[a]	5.94	12.41	38.35[b]	6.01	15.67
BTC	38.83[a]	4.29	11.08	31.28[b]	3.91	12.50
THC	9.32[a]	1.89	20.28	6.07[b]	0.96	15.82
BLL	4.98[a]	0.77	15.46	3.75[b]	0.52	13.87
NKL	18.10[a]	2.38	13.15	14.33[b]	1.22	8.51
FTL	4.74[a]	0.79	16.67	4.01[b]	0.46	11.47
TLL	20.09[a]	2.37	11.80	16.76[b]	1.84	10.98
WNL	25.68[a]	3.99	15.54	16.43[b]	3.03	18.44
MAS	5.65[a]	0.60	10.62	3.93[b]	0.76	19.34
STK	79.16[b]	7.99	10.09	82.27[a]	8.31	10.10
LLN	42.12[b]	2.74	6.51	44.21[a]	4.32	9.77
CND	10.57[a]	0.97	9.18	9.15[b]	1.14	12.46

SD: Standard deviation; CV: Coefficient of variation.

Table 2. Correlation matrices of body weight and morphometric traits of adult African Muscovy ducks

TRAITS	BWT	BDL	BTC	THC	BLL	NKL	FTL	TLL	WNL	MAS	STK	LLN	CND
BWT		0.92	0.76	0.89	0.80	0.74	0.79	0.89	0.92	0.91	-0.28	-0.21	0.72
BDL	0.75		0.79	0.76	0.77	0.73	0.76	0.85	0.85	0.68	-0.34	-0.44	0.67
BTC	0.75	0.77		0.74	0.59	0.75	0.47	0.60	0.68	0.64	**0.08**	-0.46	0.63
THC	0.84	0.64	0.63		0.75	0.77	0.64	0.75	0.79	0.87	**-0.16**	**-0.17**	0.68
BLL	0.77	0.67	0.75	0.53		0.68	0.71	0.69	0.71	0.70	-0.28	-0.29	0.62
NKL	0.67	0.60	0.62	0.51	0.70		0.47	0.59	0.65	0.66	**-0.15**	-0.32	0.62
FTL	0.75	0.50	0.59	0.62	0.53	0.58		0.86	0.70	0.65	-0.34	**0.02**	0.58
TLL	0.89	0.81	0.82	0.72	0.78	0.73	0.69		0.80	0.77	-0.37	**0.10**	0.66
WNL	0.89	0.68	0.65	0.76	0.68	0.59	0.67	0.79		0.83	-0.28	-0.24	0.39
MAS	0.82	0.25	0.43	0.67	0.56	0.46	0.67	0.60	0.71		**-0.14**	**0.02**	0.67
STK	-0.24	-0.61	**0.02**	-0.23	**-0.12**	**-0.15**	**-0.05**	-0.24	-0.26	**0.15**		**0.03**	**-0.15**
LLN	-0.22	-0.72	-0.34	-0.24	-0.20	**-0.15**	**-0.01**	-0.20	-0.22	0.28	-0.19		**-0.12**
CND	0.79	0.62	0.65	0.62	0.55	0.51	0.52	0.71	0.54	0.64	0.75	-0.23	

Significant at P<0.05 for all correlation coefficients except the **bolded** (P>0.05).
Upper matrix = male ducks. Lower matrix = female ducks.

Table 3. Standardized canonical discriminant function coefficients of the body parameters of adult African Muscovy ducks

Traits	Function 1
Wing length	0.977
Body weight	0.500
Neck circumference	0.344
Total leg length	-0.418
Body length	-0.376
Foot length	-0.224

Eigenvalue =2.410; variance explained (%) =100%; Wilks' Lambda =0.293; Bartlett's Test (chi-square= 264.999; P<0.01).

Conclusion

The study revealed that there were marked sexual differences in the morphological measurements of African Muscovy ducks with higher values in most cases recorded for males. Low, moderate and high positive and negative phenotypic correlations were observed among the body size and skeletal proportions. Wing length was the most discriminating variable between the sexes, followed by body weight, neck length, total leg length, body length and foot length. Chest circumference, thigh circumference and bill length were not included in the canonical discriminant model. The discriminant function correctly classified 91.4% of individuals in the sample from which it was derived. This means that the six variables were sufficiently robust to be used in the field to determine the gender of live birds. The use of biometrics and discriminant analysis therefore, may considerably increase the reliability of separating the sexes of African Muscovy ducks. The present results might aid in better understanding of the ecology, conservation and improvement of the indigenous birds.

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PROLACTIN PROMOTER VARIABILITY AMONG DIFFERENT DOMESTIC AVIAN SPECIES WITH REFERENCE TO DUCK

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Abstract

A study was conducted to explore and compare the promoter sequence of duck prolactin gene from that of other domestic avian species including chicken, turkey, emu and ostrich. Prolactin in birds plays a wide variety of functions including growth and development, metabolism, reproduction, osmoregulation, immunoregulation and broodiness behavior. A 277 bp fragment consisting of 1 to 215 bp promoter, 216 to 267 bp 5'UTR and 268 to 277 bp coding region of the prolactin gene was studied as this region of promoter is very much important for binding with Pit-1 factor responsible for transcription of the prolactin gene. This fragment of duck, chicken, turkey, emu and ostrich was amplified and sequenced. The promoter sequences of duck, chicken, emu, ostrich and turkey were submitted to the NCBI Gene Bank and the accession numbers were obtained as FJ882033, FJ434667, FJ882035, FJ882032 and FJ882034, respectively. The sequence variability between duck and chicken, duck and turkey and duck and ostrich were T229A, T232A, C234G, A236G, G237A, G238T, A239G and G241C while with emu the nucleotide differences were A236G, G238T, G241A, T242G, A247T, A248C, A250T and G252A. The divergence percentage between duck with chicken, turkey, emu and ostrich was 3.3, 3.3, 2.9 and 3.3%, respectively. The nucleotide sequence diversity was used for construction of phylogenetic tree, which revealed formation of a cluster consisting of duck and emu being distantly related from another cluster composed of chicken, turkey and ostrich.

Key words: **avian, divergence, duck, prolactin promoter, sequence**

Introduction

In vertebrates, prolactin plays a broad spectrum of functions including growth and development, metabolism, reproduction, osmoregulation, immunoregulation and behavior. In addition, this hormone had a role in regression of the ovarian follicles (Sharp *et al.,* 1984), which directly control egg production in poultry (Shimada *et al.,* 1991; Talbot and Sharp, 1994). The incubation behavior, broodiness is mainly controlled by prolactin hormone (Ishida *et al.,* 1991). For expression of this hormone, promoter of the gene plays vital role for which the nucleotide organization of the promoter is very much important. Thus, the present study was designed to explore the prolactin promoter sequence in duck and other avian species.

Materials and Methods

Samples

Feather samples of chicken, duck, emu, ostrich and turkey were collected from the farm and genomic DNA was isolated from feather follicles following standard protocol.

Polymerase chain reaction

A pair of primers, PRLP1F: 5'-CAT ACT CAG CAT CCC ACA GC-3' and PRLP1R: 5'-TGT TGC TCA TGG TAG GGA TTC-3' was designed from the sequence of prolactin gene (GenBank accession no. AB011434) by DNASTAR software (Lasergene Inc., USA) to amplify 277 bp fragment spanning 62 bp of exon 1 and 215 bp of promoter of the prolactin gene. A total of 10 µl PCR volume included 50 µg of DNA template,10 ng of each primer, 1.5 mM of $MgCl_2$, 100 µM of each dNTP, 1X assay buffer and 0.25 U of *Taq* DNA polymerase (MBI Fermentas). The PCR programme was 94 ^oC for 5 min followed by 30 cycles of 94 ^oC for 45 sec, 65 ^oC for 30 sec and 72 ^oC for 30 sec, and a final extension at 72 ^oC for 10 min.

Sequencing and analysis

The PCR products of prolactin promoter of all the species studied here were sequenced from both ends by the automated dye-terminator cycle sequencing method with Ampli *Taq* DNA polymerase in ABI PRISM377 DNA sequencer (Perkin-Elmer). The sequence analysis and phylogenetic tree was prepared by Meg Align programme of DNASTAR software.

Results and Discussion

Nucleotide variability

The 277 bp fragment in duck and other avian species comprised of 1-215 bp promoter from 5' end, 216-267 bp 5'UTR and 268-277 bp coding region of the prolactin gene. The promoter sequences of chicken, duck, emu, ostrich and turkey were submitted to the NCBI Gene Bank and the accession numbers were obtained as FJ434667 for chicken, FJ882033 for duck, FJ882035 for emu, FJ882032 for ostrich and FJ882034 for turkey.

The sequence variability between duck and chicken, duck and turkey and duck and ostrich were T229A, T232A, C234G, A236G, G237A, G238T, A239G and G241C while with emu the nucleotide differences were A236G, G238T, G241A, T242G, A247T, A248C, A250T and G252A. Between chicken and duck about 56% mutation was of transvertional type while between duck and emu, duck and ostrich, and duck and turkey, transvertional mutation stated lion's share of the total mutational changes. The comparison of chicken and emu determined the differences as A229T, A230C, C232T, G234C, A237G, G239A, C241A, T242G, A247T, A248C, A250T and G252A. Approximately, 67% changes revealed transvertional mutation between these two species. But, the sequence of chicken, ostrich and turkey did not show any difference in this fragment. The emu sequences were differed from both ostrich and turkey sequences at the positions of T229A, C230A, T232C, C234G, G237A, A239G, A214C, G242T, T247A, C248A, T250A and A252G of which 67% changes showed transvertional type mutation. The promoter sequences in ostrich did not show any differences from Turkey sequences. The overall nucleotide changes at the promoter site suggest that the expression patterns of prolactin gene might vary from species to species, since certain organizational changes have been detected in the promoter site. Nevertheless the fact was that the mutations have been identified only in 5' UTR region but not in the actual promoter site. The 5'UTR of prolactin gene has been reported to be a hotspot region for initiating the gene transcription as this region binds with an important transcription factor, Pit- 1 (Nelson *et al.,* 1988; Bradford *et al.,* 2000). Hence, mutation at 5'UTR is of prime importance for gene expression, which could lead the species-specific gene expression pattern. The binding tendency of transcription factors principally depend on the organization
of nucleotides of the promoter. Any deviation from the basal structure in the promoter may cause drastic change in the process of transcription and thus, may affect gene expression.

Sequence divergence and phylogenetic tree

The similarity of sequences between any two species varied from 95.7 to 100% of which between turkey and chicken, turkey and ostrich, and chicken and ostrich attributed 100% similarity. The divergence percentage between duck with chicken, turkey, emu and ostrich was 3.3, 3.3, 2.9 and 3.3%, respectively. The nucleotide sequence diversity was used for construction of phylogenetic tree (Figure 1), which revealed formation of a cluster consisting of duck and emu being distantly related from another cluster composed of chicken, turkey and ostrich. In conclusion, it may be stated that certain differences at nucleotide level of prolactin promoter existed between duck and other avian species.

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PCR BASED SEXING OF DUCKS (*Anas platyrhynchos*)

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Abstract

Sex determination being one of the key points in duck breeding. Conventional determination of sexing on the basis of external morphology is difficult or even impossible due to absence of sexual dimorphism. DNA was extracted from whole blood samples of 20 adults (10 males and 10 females of Khaki Campbell ducks) using CPCI and MPCI methods. The total procedure of DNA isolation required 15 hrs in case of the CPCI and only 7 hrs under MPCI. The CHD gene based primer pair viz., 2550F and 2718R was used for PCR based sexing. In the case males, there was a single bright band of 600 bp as compared to 500 bp in females. The intensity and clarity of bands were identical when viewed either with 2% or 2.5% agarose gel. . In conclusion this PCR based sexing method targeting CHD gene in case of ducks is user friendly, rapid and produces reliable results as compared to other techniques.

(Key words: Ducks, DNA sexing, PCR, CHD genes)

Introduction

In the present scenario, duck rearing is gaining importance especially in the coastal areas of India. The preference and demand for the duck eggs resulted in popularising duck rearing among rural farmers in India**.** Sex determination being one of the key points in duck breeding, it would be desirable to supply sexed ducklings for commercial purposes to the farmers and also with respect to maintenance of parental lines. Conventional determination of sexing on the basis of external morphology is difficult or even impossible due to absence of sexual dimorphism. The most popular vent sexing requires well trained technician and also ause human errors. Further, this technique appears stressful to the chicks, results in mortality and predispose for microbial contamination. Coming to autosexing, it is not possible to auto sex every duckling since it demands maintenance of different parental lines carrying sex linked genes either for colour or feathering. Laparoscopy requires anaesthesia and may lead to accidental injury to the vital organs and can also be lethal. With respect to Steroid sexing, it needs more validation especially concerning accuracy and specificity of hormone measurement. Although, Ultrasonography was tried, due to laborious process proved not suitable for mass sexing. Karyotyping demands an expert cytogenetisist and is time consuming apart from difficulties experienced in obtaining viable cells from cell culture. In view of the various limitations of the methods described and the economic advantage of rearing sexed females, it is desirable to evolve a rapid suitable method of sexing ducklings at an early age with minimum stress and maximum accuracy.

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. A number of reports on DNA based sexing in different avian species through the knowledge of sex identification genes are available in the literature. However, reports are scanty in the case ducks and (Chiba *et al.,* 2002; Volodin *et al.,*2009; Haunshi *et al*., 2008b). In the studies on the members of anatidae, primer set P2/P8 (Griffiths *et al.*, 1998), 2550F/2718R (Ong and Vellayan, 2008) and 1237L/1272H (Kahn *et al*., 1998) targeting CHD gene, were commonly employed for molecular determination of sex. However, the primer set 2550 F / 2718 R has not been evaluated for it's performance in ducks. Keeping this in view, 2550f /2718 R primer set and two methods of DNA extraction for polymerase chain reaction (PCR) based sex determination in Khaki Campbell ducks were evaluated.

Materials and Methods:

In all, 20 blood samples, 10 each from adult males and females of Khaki Campbell ducks being maintained at CPDO, Hessarghatta, Bangalore were collected and processed by conventional phenol: chloroform: iso-amyl alcohol (CPCI) (Sambrook *et al.*, 2000) and modified phenol: chloroform: iso-amyl alcohol (MPCI) method (Haunshi *et al.*, 2008a) for extraction of DNA. Quality and quantity of DNA were assessed estimating the ratio OD260 / OD280 for DNA extracted using CPCI and MPCI methods. Further, it was confirmed by electrophoresis it on 1% agarose gel. The amplification reaction was carried out in 0.2 ml micro centrifuge PCR tubes using a programmable thermal cycler (BIO-RAD).

The PCR reaction was carried out in a final volume of 25-µl reaction mixture. Each PCR tube contained 100 ng of genomic DNA, 25 pmol of each forward and reverse primer, 1.0 unit *Taq* polymerase (3U/ µl; Bangalore Genei), 1X assay buffer (2mM $MgCl_2$, 10mM Tris-HCl pH 9.0, 50mM KCl and 0.01% gelatin) and 250 µM dNTPs (Bangalore Genei). The amplification conditions included the 1st cycle with initial denaturation at 94^0 for 3 min, annealing at 51^oC for 60 sec. and extension at 72^oC for 60 sec. This was followed by 32 cycles, each of which comprised of denaturation at 94^0 for 45 sec, annealing at 51^oC for 60 sec and extension at 72^oC for 60 sec and a final extension step for 5 min at 72^oC.

The base sequence of specific primers used for the molecular sexing of chickens and members of Anatidae by Fridolfsson and Ellegren (1999) and the same primers were employed in the current study for ducks are given below:

Primers	Nucleotide Sequence
2550F	5′-GTTACTGATTCGTCTACGAGA-3’
2718R	5′-ATTGAAATGATCCAGTGCTTG-3′

After completion of PCR, amplified products along with 100 bp DNA ladder molecular size marker were subjected to electrophoresis using 2% and 2.5% agarose gels. Finally, the images were captured and the data analyzed Alfa-Imager software programmed.

RESULTS AND DISCUSSION

Isolation and quantification of DNA:

DNA was extracted from whole blood samples of Khaki Campbell using CPCI and MPCI methods. The DNA was extracted from 20 adult ducks (10 males and 10females). The details pertaining to number of samples analysed, range of OD values obtained, average OD values computed and the clarity of the band obtained is furnished in Table1. The total procedure of DNA isolation required 15 hrs in case of the CPCI and only 7 hrs under MPCI. This is in conformity with Haunshi *et al.* (2008a) who also reported that MPCI was rapid than CPCI for DNA extraction from blood samples. Spectrophotometry was utilized to predict the quality as well as quantity of the DNA extracted by CPCI and MPCI methods. Agarose gel electrophoresis was utilized to ascertain only the quality of DNA. The average of OD values obtained for DNA extracted using CPCI and MPC1 methods were 1.84 and 1.85 for males, 1.87 and 1.89 for females, respectively. Thus indicating extraction of good quality DNA either by CPCI or MPCI techniques. Further, electrophoreses using 1% agarose gel itself revealed intact DNA. Therefore, any of the extraction methods could be successfully employed. However, MPCI is to be preferred over CPCI for speedy extraction of pure DNA and thereby sexing.

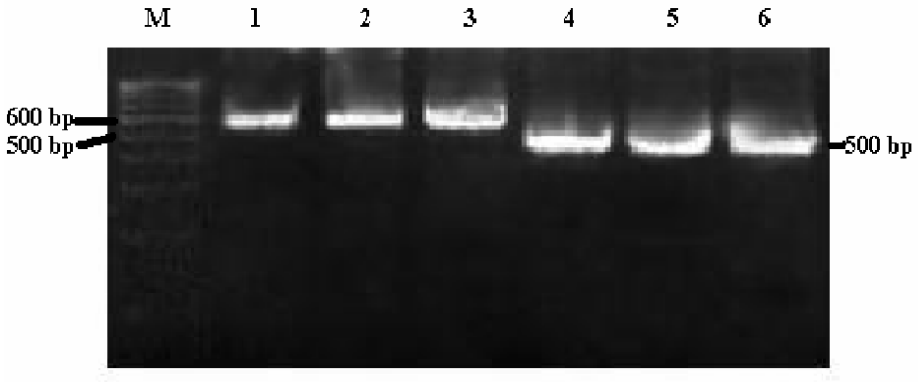
Table 4.1 Details of sample source and method of extraction.

	CPCI		**MPCI**	
	Males	**Females**	**Males**	**Females**
Sample size	10	10	10	10
Range of OD values	1.62-1.96	1.67-1.94	1.66-1.93	1.76-2.03
Mean OD values	1.84	1.87	1.85	1.89
DNA band	INTACT	INTACT	INTACT	INTACT

Sexing through Polymerase Chain Reaction (PCR):

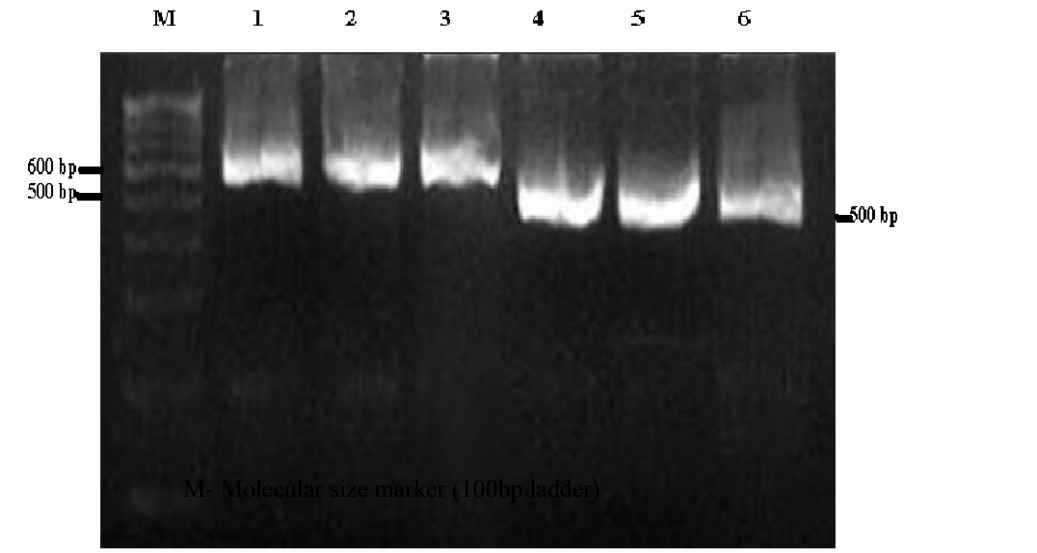
The conditions for successful amplification of DNA extracted from blood samples using CPCI and MPCI methods were satisfactory in yielding desired results. The CHD gene based primers viz., 2550F and 2718R were used for PCR based sexing in ducks. Only 2µl (100 ηg) of template DNA was sufficient to obtain the desirable results in 32 cycles. The sizes of DNA amplicons were estimated based on migration profile of 100 bp DNA ladder. The images of PCR profiles of DNA extracted using CPCI and MPCI are depicted in Plate 1 and Plate 2, respectively. In the case males, there was a single bright band of 600 bp as compared to 500 bp in females. The intensity and clarity of bands were identical when viewed either with 2% or 2.5% agarose gel. Hence, it is preferrable to use 2% agarose gel from the economic point.

Plate 1 PCR PROFILES OF DNA EXTRACTED USING CPCI METHOD IN 2% AGAROSE GEL



M- Molecular size marker (100bp ladder), Lane 1, 2, 3 - PCR amplified 600 bp amplicon of CHD-Z gene in male ducks. Lane 4, 5, 6 - PCR amplified 500 bp amplicons of CHD-W genes in female ducks.

Plate 2 PCR PROFILES OF DNA EXTRACTED USING MPCI METHOD IN 2% AGAROSE GEL



Lane 1, 2, 3 - PCR amplified 600 bp amplicon of CHD-Z gene in male ducks.
Lane 4, 5, 6 - PCR amplified 500 bp amplicons of CHD-W genes in female ducks.

Ong and Vellayan (2008) reported use of 2550 F and 2718 R primer set to determine the sex of majority of the members of anatidae family. However, no mention has been made with respect to ducks. In the current study, the use of the same primer set yielded desirable amplicon products in ducks for reliable sexing. This provided a higher confidence level of establishing the sex of ducklings. Thus the study indicated the possibility of sexing of ducklings even without the use of polyacrylamide gels as the case with some bird species when P8/P2 (Griffiths *et al.*, 1998) and 1237L/1272H (Kahn *et al.*, 1998) primer sets were used.

As for the ducks or bird species in the anatidae family, the single copy produced from the preferential amplification of the smaller sized CHD1W intron by the primer set 2550F/2718R (Fridolfsson and Ellegren, 1999) can be mistaken as a case of allelic dropouts or a male bird instead. The P2/P8 primer produces typical 1 band in case of males and two bands in case of females but requires 5% agarose gel or use of polyacrylamide gels. Therefore, while using 2550F/2718R pair of primers care has to be taken to match amplified region at a particular size to distinguish between males and females.

Sexing method in this study was based on avian CHD genes (CHDW and CHDZ). Introns, which are the region that do not code the genetic cipher, are less conserved compared to exon and their length varies among genes. Intron regions of

CHD genes are located in the middle of 2 conserved regions that primers bind. The lengths of them differ between CHD-W and CHD-Z genes, making sex identification possible. Conserved exonic and length varied intronic regions were amplified by PCR primers (2550F and 2718R) following the primer annealing. The PCR products are screened by agarose gel, male and female ducks showed single band corresponding to CHD-Z and CHD-W band. The difference between them was of 100 bp.

DNA typing is a promising method for sex identification in avian species. RAPD, Microsatellite, Minisatellite, AFLP, RFLP and CHD genes are the commonly used DNA based sexing techniques. The reliability of RAPD markers is questionable, as they are low reproducible, sensitivity to reaction conditions and / or competition between different DNA fragments cause more weakly amplified bands which disappear in presence of bright polymorphic bands. Microsatellite genotyping can encounter various errors from highly fragmented DNA and template DNA in low concentration. Griffiths and Tiwari (1993) found Minisatellite and RAPD as a species specific, laborious and time consuming. AFLP demands high safety requirement, costlier and requires more preparation time. So CHD based sexing is the most preferable for DNA based sexing.

CONCLUSION:

PCR based sexing method targeting CHD gene in case of ducks is user friendly, rapid and produces reliable results as compared to other techniques. It is also cost effective when compared to the other DNA based techniques.

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ESTIMATES OF INBREEDING RATES IN POPULATIONS OF BELGIAN WATERFOWL BREEDS

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Abstract

Ancient domestic waterfowl breeds, in addition to experimental and commercial lines, are valuable resources that contribute to the precious reservoir of poultry genetic variation. Lower heterozygote frequencies in some poultry species compared with those in other farm animals suggest that genetic variation within duck or goose populations would be lower and that more attention should be paid on preservation of this species gene pool. Moreover, many of them have undergone a major decrease in their population size and most of ancient waterfowl breeds in Belgium are under a critical status.

Proposed strategies for conserving these resources include their genetic management, requiring awareness on practices that may increase inbreeding. Obvious consequences of high inbreeding rates in a population are associated with breeding depression and deleterious effects on offspring fitness. These include reproductive traits such as fertility, hatchability, egg production or embryonic viability. A reduction in these traits will reduce the number of ducklings or goslings hatched per hen, thus decreasing reproductive efficiency and increasing production costs at breeding and hatching levels.

This study aims to evaluate inbreeding rates in Belgian waterfowl breeds, in the country of origin. Data was collected with the Walloon and the Flemish poultry fanciers associations where individuals listed in the poultry fanciers membership directory indicated the number of breeding males (N_m) and females (N_f) for each native breed conserved. Male: female ratio (N_m/N_f), total breeding population (N), effective population sizes (N_e), N_e/N ratio of breeders contributing efficiently genes to the population and hypothetical rates of inbreeding per generation (ΔF) of ancient Belgian duck and goose breeds existing in Belgium in 2005, were calculated.

The N_e/N ratio was over 75% and 95% in ducks and geese, respectively. The N_m/N_f ratio varied from 33-63% in ducks and was over 63% in geese. Higher N_e/N ratio was due to the higher number of males kept by fanciers, also reflected in the higher N_m/N_f ratio. Estimates for inbreeding rates per generation in populations varied between 0.01 and 0.125 (except Vire et du Ton goose with 0.25). Forest and Semois duck breeds had the lowest inbreeding rates (with less than 0.03). Highest rates were obtained with Huttegem (0.083) and Termonde (0.125) duck breeds, and Vire et du Ton goose breed. These estimates were within the range of those recently found in chicken populations. A rapid strategy to minimize inbreeding would be to maximize the effective population size of these flocks and increase the N_m/N_f ratio in some breeds.

Key words: Belgian waterfowl breeds, biodiversity, ducks, geese, inbreeding rates

Introduction

Belgian duck and goose breeds have different geographical origins (Brandt and Willem, 1985). Termonde duck breed was spread in the North part of Belgium during the nineteenth century. Merchtem duck breed originated from the Merchtem region nearby Brussels and had the Termonde and British Aylesbury breeds as presumed ancestors. Huttegem was originally a laying breed from the Scheldt River in Oudenaarde region and had the Termonde duck breed as an ancestor. Forest duck breed was first mentioned in 1890 and originated from Forest area in Brussels. Semois duck breed was first mentioned in the twentieth century and was from the valley of the Semois River. Both Oie Flamande and Oie du Vire et du Ton goose breeds were selected for meat and feathers production and also got their names from different locations in Belgium. Moreover, many of them have undergone a major decrease in their population size and most of ancient waterfowl breeds in Belgium are under a critical status (Larivière and Leroy, 2005, 2007). Strategies for conserving these resources include their genetic management, requiring awareness on practices that may increase inbreeding, associated with breeding depression and deleterious effects on offspring fitness (Ibe et al., 1983; Hagger et al., 1986; Nordskog and Cheng, 1988; Flock et al., 1991; Sewalem and Wilhelmson, 1999; Sewalem et al., 1999). This study aims to evaluate inbreeding rates in Belgian waterfowl breeds, in the country of origin.

Materials and Methods

Data on populations from traditional breeds

Data was collected from a previous realized survey (Larivière et Leroy, 2005; 2007) and conducted by the University of Liège, with the Walloon and the Flemish poultry fanciers associations. Individuals listed in the poultry fanciers membership directory (2005) indicated the number of breeding males (N_m) and females (N_f) for each native breed conserved. Farm-parks, universities, research center and the industry were also contacted (via e-mail/telephone) to report on the status of their stocks. Duck breeds included Canard de Forest, Canard de la Semois, Canard de Merchtem, Canard Huttegem and Canard de Termonde. Geese breeds included Oie Flamande and Oie de la Vire et du Ton

Effective population size

The effective population size (N_e) is the number of individuals from a population randomly selected and randomly mated that would expect to have the same rate of inbreeding as the population itself. Populations do not take into account the transboundary breeds (found outside the country of origin). It may be unrealistic to assume that these populations, mainly from fanciers, are under random mating with no selection but the effective population size of waterfowl populations estimated here aims to give an approximate idea of the upper limit. Calculations are based on the formula given by Wright (1931):

$$N_e = \frac{4N_f N_m}{N_f + N_m}$$

where: N_f is the number of breeding hens, N_m is the number of breeding drakes/ganders.

Inbreeding rates

We calculate inbreeding rates for 7 existing waterfowl breed populations. The variation in inbreeding rate (ΔF) is inversely proportional to the number of individuals contributing equally to the gene reservoir:

$$\Delta F = \frac{1}{2N_e}$$

Results

Effective population size, male: female ratio and N_e/N ratio

Estimated effective population sizes are given in Table 1. The effective population size was highest with Canard de Forest duck breed (90.1) and Oie Flamande goose breed (41.7). N_m/N_f ratio varied from 33 to 63 % in duck breeds and 63 to 100 % in goose breeds. The Ne/N ratios varied widely from 75 to 95 % in duck breeds and 95 to 100 % in goose breeds.

Table 1 Number of breeding drake/gander (N_m) and hen (N_f), drake/gander: hen ratio (N_m/N_f), total breeding population (N), effective population sizes (N_e), Ne/N ratio of breeders contributing efficiently genes to the population and hypothetical rates of inbreeding per generation (ΔF) of ancient Belgian ducks and geese breeds existing in Belgium in 2005 (from Larivière et Leroy, 2007).

Breed	N_m	N_f	N_m/N_f	N	N_e	N_e/N	ΔF
Ducks							
Canard de Forest	33	71	0.46	104	90.1	0.87	0.011
Canard de la Semois	15	24	0.63	39	36.9	0.95	0.027
Canard de Merchtem	7	15	0.47	22	19.1	0.87	0.052
Canard Huttegem	4	12	0.33	16	12.0	0.75	0.083
Canard de Termonde	3	6	0.50	9	8.0	0.89	0.125
Geese							
Oie Flamande	17	27	0.63	44	41.7	0.95	0.024
Oie de la Vire et du Ton	2	2	1.00	4	4.0	1.00	0.25

Hypothetical inbreeding rates within populations

Estimates of inbreeding rates are also presented in Table 1. Rates per generation in populations of the waterfowl breeds varied between 0.01 and 0.125 (except Oie du Vire et du Ton with 0.25). Canard de Forest and Canard de la Semois duck breeds had the lowest hypothetical inbreeding rates (less than 0.03 per generation). Highest rates were obtained with Canard Huttegem (0.083) and Canard de Termonde (0.125) duck breeds, and Oie du Vire et du Ton goose breeds. As an example, an inbreeding coefficient of 0.01 % means that 0.01 percent of heterozygosity is lost in one generation. Assuming 1.5 hatches per generation every year, this will represent a total loss of 75 % after 50 years.

Discussion

Effective population size, male: female ratio and N_e/N ratio

Effective population sizes of some Belgian waterfowl breeds may be higher as their number of males is close to those of the females. This corresponds to a strategy to minimize family bond between parents, a priority in a conservation programme being to maximize the effective population size (Zanon and Sabbioni, 2001 as cited by Spanola et al., 2007). To compare with other poultry species, the effective population size over census population sizes and the male: female ratio in some European chicken populations varied from 33 to 82 % and from 8 to 25 %, respectively (Spanola *et al.*, 2007). In our Belgian waterfowl breeds, these ratios were higher with 75-100 % and 33-100 %, respectively. This higher ratio of effective

population size over census population size is due to the highest number of males kept by Belgian fanciers, also reflected in the higher drake/gander: hen ratio.

Inbreeding rates (per generation or over long term)

Inbreeding rates in our waterfowl breed populations were within range of those in 37 local chicken breeds conserved in institutions of five European countries (Spanola et al., 2007), with relatively low hypothetical inbreeding rates (ΔF=0.02-0.71 %). According to Simon et Buchenauer (1993), populations with inbreeding rates of less than 5 % run less risks of being extinct, between 5 and 15 % are potentially at risks, those between 25 and 40 % are endangered, and more than 40 % are under a critical status.

Management practices to limit inbreeding

As an helpful guideline to implement, maximizing the number of individuals contributing to the genetic pool is required to limit effects of genetic drift (Wright, 1931) and of inbreeding in limited effective populations. Matings between congenic individuals lead to the loss of alleles, specially for robustness characters such as breeding traits. These small effective flocks, with no pedigree, would need to be supported through genetic management assistance to limit inbreeding levels. In Lower-Saxonny in Germany per example, pedigree recording is encouraged. Nevertheless, this only represents 5 % of total poultry fanciers in Germany (Federal Ministry of Food, Agriculture and Consumer Protection Germany, 2009). The use of a herd book and the systematic recording of the origin and performance are practices that are not so frequent in Europe because trapnesting is laborious and time consuming. In practice, mating of a male from a unique farm to a large number of females is to be avoided. A constant number of hens with as high as possible number of drakes/ganders, achieving a rotation of drakes/ganders between families and assuring a slow change of drakes/ganders to increase the generation interval is strongly suggested (Scherf, 2000). However, the suggestions in circulating drakes/ganders between breeders may sound unrealistic for fanciers who have precise selection criterias and who will not choose a drake or a gander from a neighboor.

Conclusion

Hypothetical inbreeding rates of 0.01 to 0.25 % per generation were estimated in Belgian waterfowl breed populations and were within the range of other studies on small chicken flocks in Europe. Effective population sizes in studied breeds varied between 63 % and 100 % of census population sizes with a drake/gander: hen ratio between 33-100 %. A rapid strategy to minimize inbreeding would be to maximize the effective population size of these flocks and increase the drake/gander: hen ratio in some breeds. A long term strategy would be to initiate pedigree record through trapnesting.

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INDIGENOUS DUCK VARIETIES IN UTTHIRAMERUR BLOCK OF NORTH EASTERN AGRO CLIMATIC ZONE OF TAMIL NADU

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Abstract

The scientific characterization and evaluation of indigenous breeds / varieties of ducks of Tamil Nadu is scanty. However, based on a field survey in a block at North Eastern zone of Tamil Nadu, it was observed that from the farmers point of view, two prominent varieties of ducks are available with distinct plumage color and pattern and they are Sanyasi and Keeri varieties of ducks. Sanyasi variety named as Sanyasi because of its dull brown (Sanyasi in Tamil – saint-saffron color) plumage throughout the body as base colour.This is the highly preferred variety by the farmers for its good look, production potential, and easy identification. In majority of the flock, this is the predominant variety of ducks accounts for 50-60 percent.

Drake of this variety is partially upright in posture and gait. Plumage color thorough out the body is dull brown with or with out white patches. Neck is lustrous blackish green in color with or with out white bands. The shank and bill are dark orange. Duck is squat in posture and gait. Plumage color is dull brown with or with out white patches. Neck is completely dull brown with or with out white bands. Shank and bill are dark orange. Keeri variety is named after its plumage pattern, which are blackish brown stripes in the base of brown color. This is the second predominant variety after Sanyasi with 20-25 percent of the flock. Drake is partially upright is posture and gait. Neck is dull blackish green. Body plumage color is brown with blackish brown stripes all over the body. Back is predominantly blackish brown. The shank, bills are orange in color. Duck is squat in posture and gait. The general plumage color is brown with blackish brown stripes. Shank and bill are orange. The colour of the egg is white. But they prefer to maintain male for their breeding flock from Sanyasi or Keeri variety only, to get more number of ducklings of this two varieties.

Key words: Duck, Indigenous duck varieties Tamil Nadu

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Introduction:

Traditional, extensive and nomadic duck farming is still dominant in developing countries like India, although the intensive production system is predominant in the western countries. Though the ducks are reared all over the country, they are more concentrated in Eastern, North Eastern and Southern states of Tamil Nadu. Among the southern states, Tamil Nadu is one of the leading states in duck production and farming. As per the Livestock census of Tamil Nadu (2004) the duck population showed an increasing trend from 219,391 in 1951 to 5, 12, 422 in 2004 with a compound growth rate around 2 percent. In Tamil Nadu, North eastern agro climatic zone of Tamil Nadu is having the highest duck

population of around 70 per cent of the total population. In Tamil Nadu almost all the farmer s maintaining only the indigenous ducks varieties for the production system. Among the population, north
eastern and central districts farmers are procuring ducks from Aarani area of Tamil Nadu and they are popularly called as Aarani ducks. The breeding tract of Aarani ducks is Aarani taluk of Thiruvennamalai district. In farmers opinion the preponderance of Aarani ducks for the duck farming in northern districts of Tamil Nadu is quite understandable and clearly based on the following factors. In farmers opinion, indigenous ducks are superior in adaptability , moderate production potential, high disease resistance, suitability of this ducks to the production system are the favorable points for Aarani ducks.

However, absolutely there is no organized and scientific documentation on the indigenous ducks. In this context, a complete survey, evaluation and characterization of these indigenous ducks of Tamil Nadu is highly warranted. As a base work for that, a small level survey was designed in an intensive duck farming block Uthiramerur of Kanchepuram district of Tamil Nadu to identify varieties of ducks if any available with specific phenotypic characteristics.

Materials and Methods:

A small scale survey was designed with specific objectives, to identify any indigenous varieties of ducks available in the in intensive duck farming tract. A total of 20 traditional duck farmers were interviewed personally about their knowledge on indigenous duck varieties which is based on plumage color and pattern or distinct phenotype characteristics.Informatin provided by the farmers were verified with their flock of ducks to assess the practical conditions of their versions in their flock. Apart, standard biometrical measurements including body weights of male and female ducks were recorded on the specified ducks with distinct plumage color and pattern. The information on age at sexual maturity, age at 50 per cent duck day egg production and total egg number in a laying cycle was collected. The observations were recorded and analyzed systematically to draw some valid conclusions on the availability of distinct indigenous duck population.

Results and Discussion:

The results of the survey were presented and discussed below. Based on the farmer's observations and verification of the individual farmer's flock of ducks for phenotypic identification and similarity, two varieties of ducks were identified and they were Sanyasi and Keeri variety of ducks.

Sanyasi variety:

It is named as "Sanyasi" because of its dull brown (Sanyasi in Tamil – saint-saffron color) plumage throughout the body, with or with out white patches in the body and white bands in neck. This is the highly preferred variety by the farmers for its good look, production potential, and easy identification. In any population this is the predominant variety of ducks accounts for 50-60 percent.

Male is partially upright posture and gait. General plumage color thorough out the body is dull brown with or with out white patches. Neck is lustrous blackish green in colour with or with out white bands. The shank, bill, bean are dark orange.

Female is squat in posture and gait. General plumage color is dull brown with or with out white patches. Neck is completely dull brown with or with out white bands. Shank and bill are dark orange. The identification of male is by its curled feathers (drake feather) and lustrous blackish green color neck. The color of the egg is white.

Keeri variety:

This is named because of its plumage pattern, which are blackish brown stripes in the base of brown color. This is the second predominant variety after "Sanyasi" with 20-15 percent of the population. Male is partially upright is posture and gait. Neck is dull blackish green. General body

plumage color is brown with blackish brown stripes all over the body. Back is predominantly blackish brown. The shank, bills are orange in color. Female is squat in posture and gait. The general plumage color is brown with blackish brown stripes. Shank and bill are orange. The color of the egg is white.

The biometrical measurement of Sanyasi and Keeri Variety ducks were presented in table and 1. Based on the results, Sanyasi Variety of duck is slightly bigger in size than Keeri Variety.

Table. 1. Mean ± SE Biometrical Measurements of Sanyasi and Keeri variety of ducks

Biometry (in cms)	Indigenous variety			
	Sanyasi		Keeri	
	Male	Female	Male	Female
Bill length	6.81± 0.82	6.01± 0.90	6.71 ± 0.89	6.01 ± 0.74
Length of Neck and Head	32.47 ± 0.43	30.30 ± 0.82	33.13 ± 0.26	30.16 ± 0.22
Length of Neck	21.10 ± 0.12	18.70 ± 0.24	20.23 ± 0.14	17.15 ± 0.45
Length of Body	32.73 ± 0.14	31.26 ± 0.29	30.14 ± 0.24	29.25 ± 0.26
Shank length	6.02 ± 0.15	5.58 ± 0.28	7.02 ± 0.48	5.81 ± 0.23
Height of duck	20.28 ± 0.20	19.84 ± 0.32	19.84 ± 0.26	21.24 ± 0.83
Breast length	14.43± 0.24	13.22 ± 0.19	13.14 ±0.45	14.12 ±0.21

Other varieties:

Pigeon Variety: General plumage is ash in color (pigeon like) constitutes 5 percent of the population. Pure black or pure white color plumaged birds constitute 1 percent of the population. Irrespective of the flock size, all units having one black color duck for sentimental purpose The body weight of Sanyasi and Keeri Variety ducks were presented in Table.2.

Table.2.Mean ± SE body weight of Sanyasi and Keeri variety ducks in different ages

Age	Indigenous variety			
	Sanyasi		Keeri	
	Male	Female	Male	Female
Day Old (g)	46.84 ±0.84		46.24 ± 0.37	
20th Week (kg)	1582 ±18.84	1543±17.24	1559±20.28	1511±19.28
52nd Week (kg)	1292 ±12.24	1235±10.24	1237±18.22	1185±17.23

Breeding practice:

The farmers are not maintaining separate breeder flock for hatching egg collection. Commercial layer flock and breeder flock remains the same, but they prefer to maintain male for their breeder flock from "Sanyasi" variety or "Keeri" variety only, to get more number of ducklings of this two varieties. No scientific selection or breeding is practiced. The desirable sex ratio in field conditions is 1:15-20 and even with wide sex ratio, they are obtaining 70 per cent hatchability to total eggs set. The reported values on the age at sexual maturity and 50 duck day egg production are 140 3.14 and 196 2.15 days respectively in these of indigenous duck. The mean duck day egg production in the laying cycle of one year is 40-50 per cent. The preference of farmers for indigenous ducks is due its good egg size, (65-70 gm) high adaptability to their farming conditions (extensive, nomadic, foraging – limited availability of feed resources) and hardiness to diseases

Conclusion:

Based on the survey findings it is concluded that, in perception of farmers opinion, experience and observations, there is a possibility of availability of two distinct varieties of indigenous duck are in favour. The survey observations also confirming the presence of two distinct varieties of indigenous ducks available in rural Tamil Nadu. How ever it needs large scale Survey, Characterization, Evaluation and Karyotype of Indigenous ducks of Tamil Nadu to ascertain the fact and to explore the production potential of these ducks in field conditions.

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PERFORMANCE EVALUATION OF DESHI DUCKS OF ORISSA AND DESHI X KHAKI CAMPBELL CROSS IN EXTENSIVE SYSTEM OF REARING

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Abstract

Day old ducklings of Deshi ducks of Orissa and Deshi X Khaki Campbell (DK) crossbred were distributed to the farmers Different traits were measured at different ages. Juvenile body weights were recorded at 2, 4, 6 and 8 weeks of age in combined sex. Except two weeks body weight the DK ducklings recorded significantly ($p< 0.05$) higher body weight than the Desi ducks. The 8th week body weight in Deshi and DK were 975.22±17.90 and 1447.50±35.65 g. respectively. Age at first egg of the flock and age at 50% duck day egg production were obtained almost in similar ages in both the genetic groups. Weight at 40 weeks of age was significantly ($p< 0.05$) higher in DK duck than Deshi. Duck day egg productions per bird up to 60 week of age were 97.77 and 68.10 eggs, respectively. Egg weight at 40 weeks of age was 68g in both the genetic groups. The results indicate that the egg production is better in DK cross than the Deshi and the cross may be used for extensive duck farming for better profit.

Introduction

Ducks has been considered as an alternative poultry bird for both egg and meat especially in the costal states in India, where resources for duck farming is available. Reports on productive performance of indigenous ducks and their crossbreds are available in the literature (Baruah *et al*. (1991), Eswaran *et al*. (1985), Nageswar *et al.* (2005) and also the comparative performance of indigenous ducks of Orissa with Khaki Campbell and their crossbreds are available Padhi *et al.* (2009a) and Padhi *et al.* (2009b) in intensive system of rearing. However till now comparative performance of indigenous ducks of Orissa with Khaki Campbell and their crossbreds in extensive system has not been assessed. So the present study was under taken to evaluate the production performance of Deshi ducks of Orissa and Deshi X Khaki Campbell cross in extensive system of rearing.

Materials and Method

A total of 200 Desi and 140 of Deshi(male) X Khaki Campbell (female) (DK) ducklings produced in single hatch were distributed to the farmers 20 number each . All the ducklings were brooded in deep litter system at farmers field with normal brooding management and feeding the body weights of indigenous birds were recorded at 2nd, 4th, 6th, 8th weeks during growing period and at 40th weeks of age during laying period. Egg productions of genetic groups were recorded from the start of laying to end of one year cycle i.e up to 72 weeks of age. Egg weights recorded at 40th week of age. Age of the flock at first egg and at 50% duck day (DD) egg production were recorded. Duck day egg productions per duck of two genetic groups were calculated up to 40, 60 and 72 weeks of age as per the standard formula. The egg production data and age at different stages of production were measured in groups. The body weight and egg weight data were analyzed statistically as per Snedecor and Cochran (1989).

Results

Body weight of Desi at 2nd, 4th 6th and 8th week of age in combined sex were 245±4.71, 438±9.08, 657±14.85, 975± 17.90 g, respectively. Corresponding body weight in Desi X khaki Campbell (DK) ducks were 269±14.20, 658±19.15, 1105±30.15 and 1448±36.61 g, respectively. DK ducks recorded

significantly higher body weight than Desi except at 2nd week of age. Age at first egg of the flock were recorded at 126 days of age in both the genetic groups. Age at 50 % duck day egg production were
obtained at 158 days of age in both Desi and DK. DK recorded 1710±40.31 g body weight at 40th week of gae as compared to 1515±21.25 g in Desi ducks. Duck day egg production per bird up to 40th week of age was 50.31 eggs in Desi compared to 44.54 in DK. However, duck day egg production per bird up to 60th week of age were 88.78 in Desi and 97.77 in DK. Corresponding duck day egg production up to 72nd week of age were 125.32 in DK and 103.14 in Desi. Egg weight at 40th week of age in both the genetic groups was 68 g with out much difference.

Discussion

Body weight obtained in the present study revealed that crossbred perform better and grow faster than the Desi in extensive system of rearing. High growth rate in crossbred is reported by Nageswar *et al*. (2005), Padhi *et al.*, (2009a) and

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Padhi *et al.* (2009b). Further, it was observed that the body weight of DK at 8th week of age is higher than the reports Padhi *et al*. (2009a) but in Desi it is lower. This may be due to different levels of feed available in the different farmers field. The age at first egg of the flock and age at 50 % duck day egg production is better in the present study than the report of Eswaran *et al.* (1984), Das *et al*. (2000) and Nageswar *et al*. (2005), however, the value is higher than the report of Padhi *et al*. (2009b). This may be due to difference rearing system and stocks difference. Duck day egg production per bird up to 40th, 60th and 72nd week of age obtained in the present study was lower than the report of Eswaran *et al*. (1985), Nageswar *et al*. (2005) and Padhi *et al.* (2009b). However, the production is better compared to the reports of das et al, 2000 in field study. Further, all the above agreed that the crossbred perform better than the Desi except at 40th week of age where desi produced more eggs but as the age advanced the egg production in crossbred increases.

The egg weight obtained in the present study is in agreement with the reports of Padhi et *al.(*2009b) but higher than the report of Nageswar *et al.* (2005). This may be due to difference of stocks used by Nageswar *et al.* 2005. Body weigh of the layer ducks at 40th week of age revealed higher weight in DK than Desi indicating the carcass yield from spent ducks is more in crossbred.

Conclusion

The present study revealed that the performance of Desi X Khaki Campbell crossbred is better compared to Desi ducks in respect to growth, egg production and equal in performance in respect to egg weight and age at sexual maturity. This showed that Desi X Khaki Campbell may be used for extensive system of duck rearing for better egg production and as a source of subsidiary in come for rural poor and tribal people.

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CANONICAL CORRELATION ANALYSIS FOR ESTIMATION OF RELATIONSHIP BETWEEN SOME BODY MEASUREMENT AT BIRTH AND AT TEN WEEKS PERIOD IN MUSCOVY DUCK

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Abstract

A canonical correlation analysis was used to evaluate the relationship between some traits at birth and at ten weeks of age in muscovy duck, Three traits were measured, they include body weight (bwt) , body length (bdl) and chest circumference (ccf) were obtained from eighty male muscovy duck. For the canonical correlation analysis, the traits measured at birth period were one set of measurement (X -variable) and the same trait measured at ten weeks period were the second set of measurement (Y- variables) . Three canonical correlation were obtained (0.913, 0.561 and 0.021) .Among the estimated coefficient only the first canonical variable was significant ($p<0.01$). Highest contribution for the explanatory capacity of canonical variables for the traits at birth and ten weeks of age was maintained by the body weight and body length respectively. It can be assumed that body weight and body length of the muscovy drakes at birth period can be used as early selection criteria for determining the duck that have high live weight at ten weeks.

Key words: Canonical correlation, muscovy duck and factor loading

Introduction

There are several measures of correlation to express the relationship between two or more variables (such as the standard Pearson product moment correlation coefficient , rank correlation, Kendal tau correlation , multiple regression , multiple correspondence analysis etc)(ZAR 1999) . Canonical correlation analysis is an additional procedure for assessing the relationship between variables. Specifically this analysis allows researchers to investigate the relationship between two sets of variables.

Canonical correlation analysis (CCA)was proposed by Hotelling 1935 in Thomson 1984 is a technique for describing the relationship between two variables sets by calculating linear combination that are maximally correlated, it also has the ability to deal with two variable set simultaneously and to produce both structural and spatial meaning .The application of CCA such as determination of the relationship between some traits measure pre and post slaughtering , milk and reproductive traits, body measurement at birth and six weeks of calves were discussed in other livestock (Alkandari and Joliffe 1997, Fouries et al 2002 ,Cankaya et al 2008). However the application of CCA in poultry particularly ducks in estimation of the relationship between some measurements at different period is not known.

The relationship between early performance or early morphological performance and subsequent morphological expression is a veritable area to exploit in both meat and egg producing poultry as the morphology of the bird is a function of its genetic constitution and determine the productivity of the bird. However little work has been done in this area. The aim of this study is first to estimate the relationship between some traits which were obtain from muscovy duck at birth period and at ten weeks period and secondly to determine which of the traits can be used as early selection criteria for determining the muscovy duck that have high body weight at ten weeks using CCA.

Materials and Methods

Eighty ducklings of indigenous muscovy duck hatched and reared at the poultry unit of the college of Agriculture lafia, Nasarawa state, Nigeria were used for this study. Lafia falls within the
guinea savannah zone of the north central Nigeria and is located within latitude 08 35N and longitude 08 33E.The traits examined include body weight (BWT) body length (BDL) and chest circumference (CCR) were measured at day old and at 10 weeks of age .while the bwt ,bdl and ccf measured at day old period were included in the first variable set (x- variable set) and the same traits measured at the 10 week period were included in the other variable set (Y-variable set).

Statistical method and Data analysis

Canonical correlation analysis (CCA) was used to investigate the relationship among the measurement at birth and at 10 weeks period. These analysis was performed with SAS PRO> CANCORR (SAS,1999) .From CCA a linear association between predictor variables (measurement at birth) and dependent variables (measurement at 10 weeks) were determine d .Canonical variables are linear combination of the original quantitative measurements that contain the highest possible multiple correlation with each group and that summarizes among class variation . The goal of CCA is to evaluate the relative contribution of each variable to the derived canonical function in order to explain nature of the relationship(s) consider the following two equations

$v_m = a_m x1 + a_m x2 + \ldots\ldots\ldots a_{mp} X_p$ 1

$w_1 = b_{m1} y_1 + b_{m2} y_2 + \ldots\ldots\ldots b_{mp} y_p$ 2

equation (1) and (2) gives the new variable v_m and w_1 which are a linear combination of the X (birth) and y (10weeks) variables respectively. Let cm be the correlation between v_m and w_m.the objective of the canonical correlation is to estimate am_1, am_2 …….am_p and bm_1 , bm_2 …..bm_p such that cm is maximum. Equation 1 and 2 are the canonical equation v_m and w_s are the canonical variates and cm is the canonical correlation(Sharma, 1996)

Canonical correlation coefficient does not identify the amount of variances accounted for in a variable set by other variables set. Therefore it is suggested to calculate the redundancy measure for each canonical correlation to determine how much of the variance in one set of variables is accounted for by the other set of variable (Sharma 1996).

Result

Table 1 showed means standard errors , minimum and maximum of the three variables in the two periods (at birth and at ten weeks).Bivariates correlations displaying the relationship between body weight and the body measurements at birth and at 10 weeks period is presented in Table 2. The relationship were all positive for all the traits across the two periods and were significant ($p<0.01$, $p<0.05$) .The highest correlation was between body weight and body length at birth (0.88) ($p<0.01$).Canonical correlation coefficient between the characters set were depicted on Table 3 . The first canonical correlation coefficient was significant (0.913)($p<0.01$) among all the estimated canonical coefficient . Based on this result the study interpreted the relationship between the first pair of canonical variable ($V_1$and w_1). Standardized canonical coefficient (canonical weight) and canonical loading were given for the first pair of canonical variable ($V_1$and w_1) in Table 4 and 5 respectively. Defining the canonical variate ($V_1$and w_1) as representing the optimal linear combination of dependent and in dependent variables by the standardized canonical coefficient given in Table 4 as

$W_1=0.53(bwt_1)+0.33(bdl_1)+0.30(ccf1)$

$V_1=0.88(bwt_2)+0.59(bdl_2)-0.52(ccf_2)$.

Table 5 and 6 presented positive correlations which are canonical loading of original variables with their canonical variables and cross loading with opposite canonical variable while Table 7 presented the result of the canonical redundancy analysis.

Table 1 : Descriptive Statistics

Parameter	mean se	minimum	maximum
bwt_1	40.86±0.36	37.40	42.60
bdl_1	13.19±0.08	12.60	13.60
ccf_1	12.36±0.19	10.60	13.2
bwt_2	1162.60±41.69	932	1401
bdl_2	28.56±6.45	25.00	31.80
ccf_2	28.12±0.36	26.00	30.20

Table 2 ; Correlation matrix between the traits

	Bwt_1	bdl_1	ccf_1	bwt_2	bdl_2	ccf_2
Bwt_1	1.00					
Bdl_1	0.883**	1.00				
Ccf_1	0.877**	0.818**	1.00			
Bwt_2	0.697*	0.787**	0.531	1.00		
Bdl_2	0.833*	0.706*	0.664*	0.587	1.00	
Ccf_2	0.728	0.700*	0.563	0.510	0.799**	1.00

**($p<0.01$) *($P<05$)

Table3; Summary result of canonical correlation analysis

Canonical correlation	prop	eigen values	likelihood ratio	probability
1 0.913	0.917	5.069	0.113	0.007
2 0.561	0.083	0.459	0.685	0.410
3 0.021	0.001	0.600	0.999	0.946

Table 4; Standardized canonical coefficient for canonical variables

X	variable set			Y	variable set		
	bwt_1	bdl_1	ccf_1		bwt_2	bdl_2	ccf_2
V_1	0.876	0.592	-0.522	W_1	0.531	0.329	0.296

Table 5; canonical loading of original variable with their canonical variables

	X variable set				Y variable set		
	bwt_1	bdl_1	ccf_1		bwt_2	bdl_2	ccf_2
V_1	0.942	0.939	0.731	W_1	0.875	0.878	0.830

Table 6; Cross loading of original variables with opposite canonical variables

	X variable set				Y variable set		
	bwt_1	bdl1	ccf_1		bwt_2	bdl_2	ccf_2
W_1	0.861	0.858	0.668	V_1	0.800	0.802	0.759

Table 7;Explained Total variation ratio by canonical variable for variable set

	X - Variable set			Y - variable set	
	Variance extracted	redundancy		variance extracted	redundancy
V_1	0.768	0.641	W_1	0.742	0.620

Discussion

Canonical correlation analysis demonstrate the main contradiction among the multitudinal correlation variable and it can reflect the corrective essence of the two character sets , that could not be settle by the simple correlation, sometimes due to the influence of other factors, simple correlation can only reflect the exterior non essential correlation(Yang et al 2006) A number of researchers have reported positive correlation between body weight and body measurement traits in ducks. Generally in poultry chest depth , width body length and breast bone are reported to have strong correlation with body weight (Wang et al 2004, Tang et al 1994,)This study found out that strong correlation between body weight and the body measurements (body length and chest circumference) was more on duck at day old (0.883 and 0.847) as against at 10 weeks old (0.587 and 0.510). This similar trend was reported in the work of Cankaya et al.(2008) on Holstein Friesian calves at birth than 6 month period. Fourie et al. 2002 , however noted that it is difficult to explain relationship between the live weight and each of the body measurements in practice , thus necessitate the use of canonical correlation coefficient in explaining the interrelationship between variable set .From the result s the traits measured at birth except for ccf have a positive effect on body weight at ten weeks of the muscovy duck .That is if the value of body weight and body length increases the body weight at ten weeks will also increase. Similarly for the canonical loading body weight and body length both at birth and at ten weeks of age are more influential than chest circumference at both periods. Also according to cross loading the body weight and body length contribute more to the canonical variate w_1 and v_1 , this can be concluded that selection for body weight and body length in ducks at birth period will affect identification of the duck that have high body weight at ten weeks of age . In this study it was also found that 76% of the total variation in the body weight and body length measurement at ten weeks old duck were explained by canonical variable v1 while the redundancy measures of 0.64 for the first canonical variable suggest that about 64.1% of the ratio was explained by the canonical variable w1 . In contrast 74.2% of the total variation in the same variable set at ten weeks period was explained by the canonical variate w1, 62.0% of the ratio was explained canonical variate v1 .

Conclusion

Canonical correlation coefficient helps in determining the interrelationship between characters thus help in prediction in muscovy duck. Body weight and body length were most influential factors in this respect. The findings of this study will provide a platform for the duck breeder who are interested in body weight improvement using birth data.

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NUCLEOTIDE POLYMORPHISM IN INTERFERON GAMMA GENE OF INDIAN RUNNER NATIVE DUCK USING PCR-RFLP

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Ducks are considered as the second most preferred poultry in India after chicken, primarily for egg and meat purposes, also known to possess unique disease resistance and adaptability characteristics. However, information on their genetic characterization is scanty. PCR-RFLP is a DNA level marker used for tis purpose. Nucleotide polymorphism in the gamma-interferon gene **(DuIFN-γ)** was studied using PCR-RFLP in Indian Runner native duck, being maintained at regional centre of the Institute. Exons of duck interferon gamma region were determined by comparing homologous sequence of chicken interferon-γ with duck interferon-γ. Exon 1 and 4 had and estimated size of 123 bp each. Unique primers were designed with using DNASTAR software and got synthesized commercially. Amplification of exon 1 yielded PCR product of approximately 123 bp, whereas amplification of exon 4 yielded PCR product of approximately 120 bp. PCR-RFLP of exon 1 with *Hinc* II revealed monomorphic pattern (81 and 42 bp fragments). PCR-RFLP analysis of exon 4 with *Taq* I also revealed monomorphic pattern (75 and 45 bp), however, PCR-RFLP of exon 4 with *Alu* I RE revealed polymorphic pattern (AA: 79 bp only and AB: both 79 and 39 bp fragments). The frequencies of AA and AB genotypes were 0.88 and 0.12, respectively. Present findings were in accordance with chicken INF-γ gene showing conserved exonic region in DuIFN-γ. However, *Alu* I polymorphism at exon-4 region needs further investigation towards identification of markers related to disease resistance.

Key words: Indian Runner Duck, Gamma interferon, Exon 1 and 4, DNA Polymorphism

Introduction

Modern poultry farming has taken the shape of industry with its two well defined facets viz. meat and egg. The rural people in the coastal areas mostly prefer ducks as second line poultry birds after chicken. Varieties of native ducks are found in India, however, limited research and scientific attention has been paid to characterize them, to improve their productivity and to exploit their unique characteristics. Poultry health is an important factor as it not only reduces the losses due to morbidity and mortality but also influences the overall performances of the flock. Disease inflicts a great economic loss (8-10%) to poultry industry (Bootwala, 2005). Improvement of disease resistance, which is under genetic control, by way of identification of molecular markers could be a method of choice for effective protection from disease resistance to disease is multigenic trait, governed mainly by immune system and its interaction with many physiological and environmental factors (Gross et al., 1988, Zakaris *et al*., 2002). Interferon gamma (IFN-γ), which has been cloned in several mammalian species and recently in birds, plays a critical role in modulating immune functions. Indian Runner Duck originated in Asia. The most popular varieties are Fawn, White, Brown and Chocolate. They are prolific layers, carriage is upright and straight. One of the important thrust areas in duck industry is improvement of disease resistance. Therefore, Indian Runner native duck were studied for nucleotide polymorphism in the gamma-interferon gene (DuIFN-γ) using PCR-RFLP.

Methods

Genomic DNA was isolated from 30 ducks, maintained at Bhubaneswar centre of the institute, from venous blood using Phenol extraction method (Kagami *et al*., 1990). DNA concentrations were

estimated by using optical density measured by spectrophotometer. The exons of duck interferon gamma region were determined by comparing homologous sequence of chicken interferon-γ with duck interferon-γ using DNASTAR software. Exons 1, 2, 3 and 4 were estimated as 123, 69, 180 and 123bp, respectively. Exon 1 and 4 were chosen for study. Primers were designed using DNASTAR and obtained commercially. Primers sequences were Exon 1: 5'-ATGACTTGCCAGACCTACTGC (Forward) and 5'-AAAATCAGCTTTCAGTTTGTCTATG (reverse) and Exon 4: 5'-ACTGGCTTGAAAATCCAACGC (Forward) and 5'-TTAACATCTGCATCTCTTTGGAG (reverse). PCR programme included heat inactivation at 95C for 5 min., 30 cycles of denaturation at 95C for 1 min., annealing at 58C (for Exon 1)/ 57C (for exon 4) for 1 min and extension at 72C for 1 min, lastly final extension at 72C for 10 min. Having checked the amplified products on 1.4% Agarose, they were digested with specific restriction enzymes, determined using DNASTAR. Exon 1 amplicons were digested with *Hinc II* and exon 4 with *Taq I* and *Alu I* REs. The RE digests were resolved on 10% of polyacrylamide gel electrophoresis. Molecular sizes of the digests were determined using Quantity one software (Bio Rad, USA). Different alleles and genotypes were recorded after determining the molecular sizes of the digests

Results

The PCR-RFLP analysis of Exon 1 & Exon 4 of duck gamma-interferon gene (DuIFN-γ) revealed interesting findings. The amplification of Exon 1 of duck gamma-interferon gene (DuIFN-γ) with the developed duck specific primer yielded PCR product of approximately 123 base pairs, whereas amplification of exon 4 of duck gamma-interferon gene (DuIFN-γ) yielded PCR product of approximately 120 base pairs. PCR-RFLP of exon 1 with *Hinc* II revealed monomorphic pattern (81 and 42 bp fragments). PCR-RFLP analysis of exon 4 with *Taq* I also revealed monomorphic pattern (75 and 45 bp), however, PCR-RFLP of exon 4 with *Alu* I RE revealed polymorphic pattern (AA: 79 bp only and AB: both 79 and 39 bp fragments). The frequencies of AA and AB genotypes were 0.88 and 0.12, respectively.

Discussion

The resent findings were suggestive of conserved exonic region of duck gamma-interferon gene (DuIFN-γ) which is in concordance with findings that there was no polymorphism in the exonic region of chicken interferon gamma gene either by PCR-RFLP or SSCP and opined that theses region were highly conserved (Kaiser *et al*., 1998). However in the present finding PCR-RFLP of exon 4 of duck gamma-interferon gene (DuIFN-γ) with *Alu* I RE revealed polymorphic pattern which needs further investigation for exploitation in identification of markers related to disease resistance.

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GROWTH AND PRODUCTION PERFORMANCE OF MOTI (MUSCOVY) DUCK FOUND IN ORISSA

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Abstract
Moti (Muscovy) ducks found in Orissa were collected, multiplied and maintained in the Regional center through random mating. For the present study ducklings hatched were wing banded at day old and brooded under deep litter. Standard starter and grower management was followed. Body weight were recorded at weekly interval up to 20th weeks of age and then at 30th and 40th week of age. At 12th week of age few males were kept and the rest were discarded for sale. Significant ($p<0.05$) difference between the sexes was recorded at 8th week of age and after ward but for body weights before 8th week no sexual dimorphism was evident. Body weight at 12th week of age in male and female were 1937±52 and 1416±27 g, respectively. Body weight of female at 20th and 40th week of age was 1724±14 and 2005±26 g, respectively. Age at first egg of the flock was recorded at 198 days. Duck day egg production performance per bird up to 40th week of age was 11.20 eggs and egg production up to 50th week of age was 24.30 eggs per bird. Egg weights at 40th and 50th week of age were 69.20±1.78 and 73.56±1.93 g, respectively. The hatchability percent on total egg set basis in the breed was found to be 38 percent.
Key words: body weight, egg production, hatchability, Moti duck, Muscovy

Introduction

There is an increasing demand for animal protein and duck production may be able to help meet this demand. Numerous water ways, hot and humid climate of this country give an ideal environment for duck farming. Most of the farmers reared indigenous duck in the backyard. Farmers of Malkangiri area of Orissa reared indigenous Muscovy duck locally known as 'Moti' duck. These ducks are preferred for their meat as well as they are quiet, good forager and naturally broody. They are good mothers and hatch and brood their ducklings efficiently. Regional centre of Central Avian Research Institute, Bhubaneswar , collected the ducks from their original rearing tracts in Orissa and kept in the farm for their adoptability and multiplication. Preliminary study on their growth and carcass characteristics are reported (Padhi *et al.,* 2008). Present study is undertaken to study the growth, production and reproduction traits of indigenous Muscovy ducks of Orissa locally known as 'Moti' ducks.

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Materials and methods

A total of 143 ducklings were hatched out of 376 eggs set on 36th day of setting. Ducklings were wing banded and kept for brooding under deep litter with standard management practices. Standard growing and laying management practices were followed for growing and laying period. Weekly body weight were recorded along with day old body weight up to 20th week of age. Ducks are sexed from their sound and size at 12th week of age. At 12th week of age about 50% of male were removed randomly and at 17th week of age male having higher body weight were kept as per the requirement according to the number of female. At 20th week of age the birds are divided in to three groups and egg production as well as laying period body weight were recorded in female. Egg production were recorded up to 50th week of age and egg weight recorded at 40th and 50th week of age. Data for body weights are analyses only in the ducks survived for the experimental period. Replicate group was considered as experimental unit for calculation of average of age at first egg of the flock (AFE), duck day egg production per duck up to 40th and 50th week of age. Whereas, for body weight variable data for individual birds were considered for analysis. Data were analysed as per Snedecor and Cochran, (1989).

Results

The average body weight of the duck during the starter, growing and laying period are presented in table 1. Body weight did not differ ($p<0.05$) statistically between male and female up to 7th week of age , however, on numerical value the male recorded higher value than the female irrespective the age of measurement. Form 8th week onward male recorded significantly ($p<0.05$) higher body weight than female and the sexual dimorphism is evident physically as the age of the ducks advances. At 12th week of age the body weight of female was 86.47 % of corresponding body weight in male. Similarly at 16th and 20th week female recorded 64.48 and 56.34 %, respectively of the male body weight. From 20th to 40th week the body weight of female only increased 275g. Further, it is evident from the results that the gain in body weight of male were more than 200 g per week from 8th week onwards up to 12th week of age there after weekly gain in body weight was reduced. More

body weight of male at 18th week than at 17th week is due to selection of higher body weight male for mating. In female more than 200g body weight gain were recorded from 9th to 10th week of age and then the gain in body weight was slower.

Table-1. Body weight of Moti (Muscovy) ducks at different weeks of age.

Age (week)	Male (64)	Female (71)
Starter period		
0,day (g)	47.18±1.04	44.80±1.68
1st week(g)	66.68±2.12	63.29±1.87
2nd week(g)	126.59±5.69	114.10±3.75
3rd week(g)	168.53±7.05	162.63±4.97
4th week(g)	265.28±8.72	255.81±8.61
5th week(g)	395.08±12.36	371.34±11.39
6th week(g)	533.98±14.49	503.58±13.70
7th week(g)	720.88±18.26	662.98±17.26
8th week(g)	944.33±23.22	832.39±21.11
9th week(g)	1223.72±24.43[a]	1029.44±22.93[b]
10th week(g)	1463.82±38.95[a]	1233.81±27.85[b]
11th week(g)	1714.34±38.95[a]	1342.20±26.44[b]
12th week(g)	1936.81±51.83[a]	1415.47±26.70[b]
Growing period	Male (35)	Female (60)
13th week(g)	2043.00±65.52[a]	1453.33±21.28[b]
14th week(g)	2195.05±54.14[a]	1504.12±22.42[b]
15th week(g)	2303.42±71.95[a]	1593.23±30.30[b]
16th week(g)	24.92.86±44.71[a]	1607.28±24.78[b]
17th week(g)	2525.64±66.36[a]	1608.74±23.85[b]
18th week(g)	2887.19±113.85[a] (14)	1718.91±26.45[b]
19th week(g)	3070.98±70.09[a] (14)	1723.56±14.43[b]
20th week(g)	3071.20±54.66[a] (14)	1723.75±14.44[b]
Laying period (only for female		
30th week(g)	-	1889.00±25.73 (60)
40th week(g)	-	2005.00±26.15 (60)

Means showing common superscript with in a row did not differ significantly at $p<0.05$.
Figures in parenthesis are number of observation. Where the figure in parenthesis are not given with mean the number of observation is same as given in the in the first row of that period.

Age at first egg of the flock was obtained at 198 days of age and number of egg produced (duck day) per bird up to 40th and 50th week of age were 11.20 and 24.30 eggs, respectively. The number of egg produced per bird was more during 40th to 50th week of age than up to 40th week of age. The egg weight at 40th week and 50th week of age were 69.20±1.78 and 73.56±1.93 g, respectively. Hatchability % on total egg set basis was found to be 38%. Mortality % from 0 day to 12th week of age was 5.59 % and from 12th to 20th week and 20 to 40th week of age no mortality was recorded.

Discussion

Faster growth of male than female in the present study is in agreement with the report of Vander Sluis (1993) and Padhi *et al.,* (2008). However, the body weight obtained in the present study was lower than the report of Leclercq and de Carville (1985) and Hu *et al.,* (1999). However, they reported in some selected Muscovy duck where as the present stocks are of indigenous in origin with only natural selection. Sexual dimorphism obtained in the present study was also similar to the report of Leclercq and de Carville (1985) and Padhi *et al.* (2008). Lower body weight of female about 59 % of male at 10th week of age was reported by Leclercq and de Carville (1985). Body weight obtained in the present study indicates that the extra male may be used for meat purpose at 12th week of age.

Age at first egg of the flock is higher compared to other breeds of duck which is in agreement with the report of Hu *et al*., (2004). The egg production obtained in the present study up to 40th week of age is compared to the report of Hu *et al.,* (2004) but lower up to 50th week of age. Lower egg production of this breed may be due to late sexual maturity. Egg production and egg weight obtained in the present study is also comparable to the report of Banga-Mboko *et al*., (2007). However, the hatchability % obtained on total egg set basis in the present study is lower than the report of Harun *et al*., (1998) and Banga-Mboko *et al*., (2007), which needs to be improved in the breed. Mortality % obtained in the present study is of acceptable limit. The results indicate that the ducks may be used for extensive system of rearing for meat purpose and further improvement is needed in the breed for all of the traits to get maximum benefit from rearing this breed of ducks.

Conclusion

Results of the present study raveled that significant difference ($p<0.05$) between the sexes was observed from 8th week of age and onwards and the female recorded 56.36 % of the body weight of male at 20th week of age. Weight gain in male and female are more up to 12th and 10th week of age, respectively. egg production and hatchability of the ducks were lower which needs to be improved further through selection methods along with improvement in body weight. The ducks are suitable for rearing in the free range for meat purpose as well as for the hatching of ducklings in remote areas where artificial incubation facility is not available.

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COMBINING ABILITY ANALYSIS FOR DIFFERENT EGG QUALITY TRAITS IN DUCKS

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Abstract

Twenty freshly laid eggs were collected from nine genetic groups produced by a 3X3 diallel experiment involving Desi ducks of Orissa, Khaki Campbell and White Pekin for egg quality study at 40th and 60th week of age. Different egg qualities viz,. egg weight, shape index, albumen index, yolk index, Haugh unit, shell thickness, albumen, yolk and shell percent were recoded and calculated as per the standard procedure. Significant (p<0.05) difference was observed between different genetic groups for all the traits measured irrespective of age of measurement. Egg quality traits measured at 40th week of age revealed significant (p<0.05) general combining ability (GCA), specific combining ability (SCA) and reciprocal effect (RE) except for Shape Index for which SCA was found non significant. Similarly egg quality traits measured at 60th week of age showed significant (p<0.05) GCA, SCA and RE for most of the traits except SCA was non significant for yolk index and RE was non significant for albumen percent. The significant GCA and SCA for different traits indicate importance of both additive and non-additive genetic effects for different traits. Different crossbreeding genetic parameters for all the traits were estimated along with heterosis percent for different crosses.

Key words: combining ability, crossbreeding parameters, ducks, egg quality, heterosis

Introduction

Duck production in India is mostly concentrated in coastal regions and other states having large water bodies. Ducks farming are popular among the farmer for their adoptability to different climatic condition and can be reared in the areas where chicken rearing on free range may be difficult. Different breeds of ducks are reared by the farmer and they are mostly indigenous type. Duck are mostly reared for their meat and egg production. Quality of eggs is important for their popularity and acceptability among consumers. Studies on different traits of Desi ducks of Orissa and their crosses have been reported (Padhi *et al.,* 2007, Padhi *et al.*, 2009b, Padhi *et al*.,2009c). Reports on quality of eggs are available in the literature (Eswaran *et al.,* 1985, Das *et al.,* 2000, Nageswar *et al.*, 2005,. Padhi *et al*., 2009a). However, combining ability study in respect to egg quality traits is very limited in ducks. Therefore, the present study was undertaken to measure the effects of different genetic groups on egg quality traits at different ages and to know the combining ability of different breeds of ducks for egg quality in a 3X3 complete diallel cross.

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Materials and methods

A complete 3X3 diallel cross was made using three breeds of duck viz: Desi ducks of Orissa (D), Khaki Campbell (K) and White Pekin (W) producing three purebreds, three crossbreds and three reciprocals. The ducklings produced were reared for brooding on deep litter with standard feeding and management practices. Ducks were screened at 8th week of age and are reared for growing and laying period with similar standard feeding and management practices for all the nine genetic groups. For egg quality study 20 freshly laid eggs were collected randomly at 40th and 60th week of age and different egg quality parameters were measured as per standard procedure. Data collected are analysed for difference between genetic groups and traits showing significant difference between genetic groups were used for combining ability analysis using Griffing (1956) model. Least square analysis of variance technique as suggested by Harvey (1975) was adopted for statistical analysis of data. Duncan's multiple range test (Duncan, 1955) was used to make pair wise comparison of means. Heterosis for different cross and the reciprocals were calculated using the formula {(average of the crossbred-average of pure breds)/average of purebreds} X 100.

Results

Egg quality traits in different genetic groups:

Average of different egg quality parameters at 40th and 60th week of age in different genetic groups are presented in table 1 and 2 respectively.

Egg quality at 40th week: The results revealed that amongst purebreds at 40th week of age White pekin and Desi recorded significantly higher egg weight than the Khaki Campbell. Amongst all the genetic groups Khaki Campbell recorded significantly lower egg weight. Except KD and DK crosses all other crossbred recorded significantly higher body weight than their parents. Shape index in different genetic groups differ significantly ($p<0.05$) and Desi recorded significant higher shape index than the Khaki Campbell and amongst the crossbred KD recorded significantly higher value than other genetic groups except DW. Albumen index was higher in Desi amongst all the genetic groups and KD recorded significantly higher albumen index amongst crossbreds followed by WD, DK, WK and DW. Yolk index was higher in White Pekin followed by Khaki Campbell and Desi amongst the purebred. White pekin as female parent reduced the yolk index value in the crossbred. Haugh unit score was higher and revealed very good score in all the genetic groups. Amongst purebred Khaki Campbell showed better Haugh unit score and amongst crossbreds Desi as female parent with other two breeds recorded better Haugh unit than as male parent. Shell thickness with membrane reveals that, as the egg weight increases the shell thickness is also increases. Higher shell thickness observed for Desi and White Pekin eggs amongst purebreds and the crossbreds showed higher shell thickness than their parents showing the presence of heterosis.

Albumen % was higher in White Pekin followed by Khaki Campbell and Desi. Further, it is observed that except KD in all other genetic groups, albumen % was lower than the better parent. Yolk % was higher in Desi than the other purebreds just reverse than the trends in albumen % indicating when there is increase of albumen % in the egg there is decrease in yolk %. Amongst the crossbred except KD other genetic groups showed higher yolk % than there respective better parent. Shell with membrane % was higher in White Pekin amongst purebreds and there was significant difference between different genetic groups. Crossbreds showed higher shell % than their parents.

Egg quality at 60th week: Compare to 40th week, egg weight increases significantly in Khaki Campbell and White Pekin but there is decrease in egg weight of Desi . However, amongst the crossbred WK and KW showed higher egg weight. Invariable the cross having White Pekin as one parent showed higher egg weight. KD and DK recorded higher egg weight at 60th week than at 40th week of age. Shape index was significantly higher in Desi than the other genetic groups but other genetic groups did not differ amongst them selves statistically indicating the similarity in shape. Albumen index was significantly poor in White Pekin than the other two purebreds. However, amongst the crosses White Pekin as female parent recorded significantly higher value than when used as male parent. KW recorded significantly higher albumen index amongst all the genetic groups. For yolk index Khaki Campbell purebred and KW cross recorded lower value than the other genetic groups. Haugh unit score was significantly higher in Desi and Khaki Campbell than White Pekin amongst the purebreds. KW recorded higher Haugh unit score amongst the crossbred. White Pekin as female parent showed higher Haugh unit score in the eggs of crossbred. Shell thickness with membrane showed lower value for Khaki Campbell than the other two purebreds. It is also observed that crossbred having Khaki Campbell as one parent recorded higher shell thickness in the crossbred

Albumen % did not differ statistically amongst the purebreds but all the crossbreds have significantly lower albumen % than the three purebreds except KW. It is also observed that albumen % decreases in some genetic groups at 60th week of age than at 40th week. Amongst purebreds yolk % was lower in White Pekin. However, it is observed that the yolk % increases in value as compared to 40th weeks of age. Crossbreds recorded higher yolk % than the purebreds. Shell with membrane % was lower in Khaki Campbell than the other purebreds similar to 40th week of age. Amongst the crossbred it was observed that the shell % was better than the purebred. However, overall in all the genetic groups the shell with membrane % decreases than the value observed at 40th week of age (table 1 and 2).

Combining ability and crossbreeding genetic parameters

Egg quality at 40th week: General combining ability (GCA), Specific combining ability (SCA) and Reciprocal effect (RE) were all significant for egg weight (table-3). GCA estimates was highest in White Pekin followed by Desi and Khaki Campbell (table-3). SCA estimates was positive and highest for KW . For egg weight White Pekin combine well with other two breeds. Reciprocal effects showed positive estimates for KW and DK. For shape index GCA and RE are significant. Positive estimates of GCA was observed for Desi and other recorded negative estimates. Similarly RE estimates showed positive estimates for DW cross. GCA, SCA and RE were significant for albumen index and positive estimates were recorded for GCA in Desi and Khaki Campbell. Negative estimates were observed for SCA and RE for DK, DW and KW. Significant GCA, SCA and RE were observed for yolk index. Positive GCA estimates were recorded in Khaki Campbell and White Pekin where SCA was positive for DK and DW. RE were negative for the three crossbred . Haugh unit score showed significant difference for GCA, SCA and RE. GCA was positive for Khaki Campbell and White Pekin. SCA estimates were positive for DK and DW and RE were negative for DK, DW and KW. Shell thickness with membrane showed significant difference for GCA, SCA and RE. GCA was positive for Desi and White Pekin and negative for Khaki Campbell. SCA was positive for DK and KW combination and RE was found negative for the three crosses.

Albumen % recorded significant GCA, SCA and RE. Significant positive GCA estimates were recorded for Khaki Campbell followed by White Pekin. SCA estimates was positive for DK and negative for other. RE estimates was positive for DW. GCA, SCA and

RE were significant for yolk % and positive GCA was found in Desi reverse to albumen %. SCA estimates were positive for the cross having DW and KW where as RE was positive for DK, DW and KW. Shell thickness with membrane revealed significant GCA, SCA and RE and positive GCA estimates were obtained in Desi and White Pekin. SCA was found positive for DK and KW combination. RE was positive for DW and KW.

Egg quality at 60th week of age: Estimates of different crossbreeding genetic parameters are presented in table-4. Significant GCA, SCA and RE were found for egg weight at 60th week of age and negative estimates were observed for Desi and Khaki Campbell and positive for White Pekin. SCA was positive for combination of Desi X Khaki Campbell and Khkai Campbell X White Pekin. RE estimates showed White Pekin as male parent with other two breeds increase the egg weight in the crossbred. Shape index showed significant GCA and SCA. GCA estimates was positive for Desi and SCA was positive for KW combination. Albumen index was highly significant for GCA, SCA and RE. GCA estimates was positive for Desi and Khaki Campbell. SCA estimates were positive for DW and KW similar positive estimates for RE also observed in DW and KW. Yolk index was significant for GCA and RE only. Positive estimates were recorded in Desi and White Pekin breed. RE was positive for DW crossbred. Significant GCA SCA and RE was recorded for Haugh unit score and positive GCA estimates were recorded for Desi and Khaki Campbell where as, SCA was positive for the combination for DW and KW. Significant and positive RE were observed for DW and KW crossbred. Shell thickness with membrane showed highly significant GCA, SCA and RE and the GCA estimates were positive for Desi and White Pekin. SCA estimates was positive for DK and KW, whereas, RE was positive for KW crossbred. Similar trends also observed at 40th week of age.

Albumen % recorded significant GCA and SCA estimates for GCA was positive for White Pekin and Khaki Campbell. However, SCA was negative in all the combination. Yolk % recorded significant difference for GCA, SCA and RE and the direction of the estimates were reverse than that for albumen % for GCA and SCA estimates. RE was positive in direction for DK and DW crossbred. Shell % showed significant GCA, SCA and RE and GCA estimates in Desi and White Pekin were similar in trend to egg quality at 40th week. However, SCA estimates was positive in DW and KW, For RE estimates similar trend in estimates were observed that at 40th week of age.

HeterosisHeterosis for different crossbreds for different traits are presented in table-5. Most of the traits showed positive heterosis for different crossbred except yolk index at 40th week, shape index at 60th week and albumen % at both the age of measurement. It is further seen that though DK and KD cross showed negative heterosis for egg weight and albumen index at 40th week but showed positive heterosis at 60th week of age. Negative heterosis for shape index at 60th week of age in all the crossbreds indicates lower value for crossbred than the purebreds. Positive heterosis % for albumen index at 60th week than at 40th week indicates the quality of albumen in crossbred is better at 60th week of age. Yolk index showed positive heterosis percentage for most of the crossbred at both the age of measurement except KW at both age and WK at 40th week. Haugh unit score showed positive value at 60th week of age but at 40th week except KD and WD all showed negative heterosis. Shell thickness with membrane recorded positive heterosis % for all the crosses at 40th week except DW but at 60th week of age positive heterosis % were recorded for DK, KD and KW crosses. Except KD at 40th week all the crossbred showed negative heteroiss % for albumen % irrespective of the age of measurement. Heterosis % were positive for most of the crossbreds at both the age of measurements except KD at 40th week and KW at 60th week for yolk %. Shell with membrane % showed positive heterosis % for all the crossbred at both the age of measurement except WD at 40th week and WK at 60th week, indicating White Pekin as the male line give better shell % which is desirable.

Table-1. Least square estimates ±SE of egg quality traits at 40th week of age.

Genetic groups	Egg wt.(g)	Shape Index	Albumen index	Yolk index	Haugh unit score	Shell thickness (mm)	Albumen %	Yolk %	Shell %
Pure									
Desi	68.14^{c} ±1.11	74.82^{ab} ±0.52	0.1935^{a} ±0.0056	0.3490^{d} ±0.0070	90.96^{de} ±1.31	0.4350^{bc} ±0.0067	57.74^{de} ±0.38	32.26^{b} ±0.37	9.74^{bc} ±0.15
Khaki Campbell	61.43^{d} ±1.12	72.33^{c} ±0.46	0.1760^{abc} ±0.0047	0.4675^{bc} ±0.0050	96.92^{abc} ±1.10	0.3500^{d} ±0.0060	60.42^{bc} ±0.66	31.16^{c} ±0.34	8.97^{d} ±0.16
White Pekin	69.57^{c} ±1.63	72.94^{bc} ±1.20	0.1610^{cd} ±0.0079	0.4895^{a} ±0.0081	94.92^{abcd} ±1.48	0.4775^{b} ±0.0060	62.35^{a} ±0.77	27.27^{e} ±0.66	10.06^{ab} ±0.16
Cross									
DK	64.18^{d} ±0.97	72.94^{bc} ±0.54	0.1579^{c} ±0.0046	0.4684^{bc} ±0.0049	92.73^{cde} ±1.10	0.4179^{c} ±0.0047	57.44^{e} ±0.68	33.08^{b} ±0.32	10.00^{ab} ±0.09
DW	76.14^{b} ±1.73	74.89^{ab} ±0.79	0.1414^{e} ±0.0040	0.4600^{c} ±0.0045	88.74^{e} ±1.04	0.4410^{b} ±0.0049	54.95^{f} ±0.58	34.65^{a} ±0.50	10.40^{a} ±0.17
KD	60.81^{d} ±1.34	76.36^{a} ±0.48	0.1800^{ab} ±0.0064	0.4962^{a} ±0.0053	98.84^{a} ±1.64	0.4352^{bc} ±0.0073	61.43^{ab} ±0.71	28.85^{d} ±0.42	10.19^{b} ±0.21
KW	84.05^{a} ±1.28	71.97^{c} ±0.80	0.1465^{de} ±0.0082	0.4525^{c} ±0.0061	90.78^{de} ±2.31	0.4715^{a} ±0.0064	57.84^{de} ±0.41	32.06^{bc} ±0.37	10.10^{ab} ±0.13
WD	76.90^{b} ±1.01	72.96^{bc} ±0.65	0.1743^{bc} ±0.0064	0.4833^{ab} ±0.0087	97.28^{ab} ±1.36	0.4448^{b} ±0.0058	57.68^{de} ±0.58	32.40^{bc} ±0.42	9.54^{c} ±0.13
WK	75.77^{b} ±0.61	72.97^{bc} ±0.59	0.1575^{cd} ±0.0056	0.4705^{bc} ±0.0039	93.96^{bcd} ±1.65	0.4235^{bc} ±0.0039	59.34^{cd} ±0.40	31.09^{c} ±0.39	9.54^{c} ±0.16

Means showing one superscript in common in a column did not differ significantly at $p<0.05$

Table-2. Least square estimates±SE of egg quality traits at 60th week of age.

Genetic groups	Egg wt.(g)	Shape Index	Albumen index	Yolk index	Haugh unit score	Shell thickness (mm)	Albumen %	Yolk %	Shell %
Pure									
Desi	65.70^{f} ±1.25	76.57^{a} ±0.58	0.1495^{bcd} ±0.0041	0.4520^{ab} ±0.0058	91.79^{bc} ±1.21	0.4205^{bcd} ±0.0088	58.03^{a} ±0.79	33.04^{ab} ±0.73	9.47^{bc} ±0.32
Khaki Campbell	69.35^{e} ±0.76	73.37^{b} ±0.58	0.1470^{cd} ±0.0050	0.4330^{b} ±0.0050	92.31^{bc} ±1.19	0.3645^{f} ±0.0073	60.15^{a} ±0.36	31.63^{bc} ±0.33	8.36^{e} ±0.14
White Pekin	87.40^{a} ±1.47	72.00^{b} ±0.90	0.1190^{e} ±0.0056	0.4660^{a} ±0.0062	84.25^{d} ±2.41	0.4370^{ab} ±0.0099	59.54^{a} ±1.49	30.79^{c} ±1.44	9.17^{bgd} ±0.19
Cross									
DK	73.93^{d} ±1.66	72.38^{b} ±0.80	0.1495^{bcd} ±0.0051	0.4540^{ab} ±0.0060	92.57^{bc} ±1.33	0.3985^{e} ±0.0077	56.41^{b} ±0.74	34.35^{a} ±0.65	8.93^{cd} ±0.16
DW	73.26^{d} ±1.81	72.57^{b} ±0.62	0.1648^{ab} ±0.0058	0.4671^{bc} ±0.0079	95.85^{ab} ±1.89	0.4095^{cde} ±0.0044	56.44^{b} ±0.70	33.51^{ab} ±0.57	9.65^{ab} ±0.16
KD	73.21^{d} ±1.07	73.18^{b} ±0.54	0.1580^{bc} ±0.0062	0.4640^{a} ±0.0063	93.94^{abc} ±1.58	0.4005^{de} ±0.0100	56.76^{b} ±0.63	33.94^{a} ±0.49	8.96^{cd} ±0.24
KW	79.12^{c} ±1.52	71.87^{b} ±0.67	0.1757^{a} ±0.0066	0.4348^{b} ±0.0084	97.91^{a} ±1.86	0.4481^{a} ±0.0050	58.69^{a} ±0.49	30.86^{c} ±0.45	10.07^{a} ±0.19
WD	78.95^{c} ±1.23	71.31^{b} ±0.57	0.1380^{d} ±0.0047	0.4645^{a} ±0.0064	89.76^{c} ±1.68	0.4245^{bc} ±0.0054	56.97^{b} ±0.62	33.23^{ab} ±0.39	9.35^{bc} ±0.12
WK	83.60^{b} ±0.60	72.37^{b} ±0.58	0.1450^{cd} ±0.0057	0.4655^{a} ±0.0092	89.90^{c} ±1.50	0.3940^{e} ±0.0040	56.64^{b} ±0.57	34.12^{a} ±0.23	8.69^{de} ±0.11

Means showing one superscript in common in a column did not differ significantly at p<0.05

Table-3. Estimates of different crossbreeding parameters for egg quality traits at 40th week of age

Particular	Egg weight (g)	Shape index	Albumen index	Yolk index	Haugh unit	Shell thickness (mm)	Albumen %	Yolk %	Shell %
GCA	**	**	**	**	*	**	**	**	**
G_1	-1.73	0.89	0.008	-0.03	-0.65	0.02	-0.97	0.83	0.10
G_2	-2.83	-0.42	0.0003	0.01	1.12	-0.03	0.68	-0.19	-0.21
G_3	4.56	-0.47	-0.008	0.02	0.47	0.01	0.29	-0.63	0.11
SE	±0.40	±0.22	±0.002	±0.002	±0.46	±0.002	±0.19	±0.14	±0.05
SCA	**	NS	*	**	*	**	**	**	*
S_{12}	-3.76	0.61	-0.005	0.04	1.41	0.02	0.92	-1.09	0.37
S_{13}	2.92	-0.08	-0.007	0.02	0.23	-0.03	-1.81	1.91	-0.08
S_{23}	7.41	-0.22	-0.005	-0.02	-2.18	0.01	-1.18	0.98	0.78
SE	±0.63	±0.35	±0.003	±0.003	±0.72	±0.003	±0.30	±0.21	±0.08
RE		**	**	*	*	**	**	*	**
R_{12}	1.68	-1.71	-1.01	-0.01	-3.05	-0.009	-2.00	2.12	-0.10
R_{13}	-0.38	0.96	-0.02	-0.01	-4.27	-0.002	1.36	1.22	0.43
R_{23}	4.14	-0.50	-0.006	-0.009	-1.58	-0.02	-0.75	0.48	0.26
SE	±0.84	±0.47	±0.004	±0.004	±0.97	±0.004	±0.39	±0.29	±0.01

** significant at P<0.01; * significant at p<0.05, GCA=General combining ability, SCA=Specific combining ability, RE=Reciprocal effect, SE= standard error. In first column subscript 1 indicates Desi, 2 indicates Khaki Campbell and 3 indicates White Pekin

Table-4. Estimates of different crossbreeding parameters for egg quality traits at 60th week of age

Particular	Egg weight (g)	Shape index	Albumen index	Yolk index	Haugh unit	Shell thickness (mm)	Albumen %	Yolk %	Shell %
GCA	**	**	**	**	**	**	**	**	**
G_1	-4.27	-0.92	0.002	0.003	0.58	0.002	-0.63	0.69	0.13
G_2	-1.30	-1.09	0.004	-0.008	1.12	-0.02	0.39	-0.07	-0.29
G_3	5.56	-0.83	-0.006	0.005	-1.71	0.01	0.24	-0.62	0.17
SE	±0.42	±0.02	±0.002	±0.002	±0.53	±0.002	±0.24	±0.24	0.06
SCA	**	*	**	NS	**	**	**	**	**
S_{12}	3.08	-0.89	-0.002	0.008	-0.49	-0.003	-0.92	0.70	-0.08
S_{13}	-1.25	-0.99	0.006	0.002	1.90	-0.01	-0.64	0.46	0.26
S_{23}	-1.03	0.19	0.013	-0.002	2.46	0.01	-0.70	0.35	0.32
SE	±0.66	±0.33	±0.003	±0.004	±0.83	±0.004	±0.38	±0.34	±0.09
RE	**	NS	**	**	**	**	NS	**	**
R_{12}	0.37	-0.40	-0.004	-0.005	-0.69	-0.001	-0.175	0.21	-0.02
R_{13}	-2.85	0.63	0.01	0.001	3.05	-0.007	-0.267	0.14	0.15
R_{23}	-2.24	-0.25	0.12	-0.015	4.01	0.03	1.021	-1.63	0.69
SE	±0.89	±0.44	±0.004	±0.005	±1.12	±0.005	±0.52	±0.45	±0.13

** significant at P<0.01; * significant at p<0.05; GCA=General combining ability, SCA=Specific combining ability, RE=Reciprocal effect; SE= standard error

In first column subscript 1 indicates Desi, 2 indicates Khaki Campbell and 3 indicates White Pekin

Table-5. Heterosis % for different traits at 40th and 60th week of age.

Heterosis % at 40th week of age									
Cross	Egg wt.	Shape Index	Albumen index	Yolk index	Haugh unit score	Shell thickness	Albumen %	Yolk %	Shell %
DK	-0.91	0.87	-14.53	14.72	-1.29	6.47	-2.77	4.32	6.95
DW	10.59	1.37	-20.22	9.71	-4.52	-0.04	-8.48	16.43	5.05
KD	-6.12	3.79	-2.57	21.53	5.22	10.88	3.98	-9.02	8.98
KW	28.32	-0.92	-13.06	-5.43	-5.36	18.26	-5.77	9.76	6.20
WD	11.69	-1.25	-1.66	15.26	4.67	0.16	-3.93	8.87	-3.64
WK	15.68	0.45	-6.53	-1.67	-2.04	6.22	-3.32	6.44	0.32
Heterosis % at 60th week of age									
DK	9.49	-3.45	0.88	0.44	0.56	1.53	-4.53	6.24	0.22
DW	-4.30	-2.30	22.80	1.76	8.89	-4.48	-3.98	5.01	3.54
KD	8.43	-2.39	6.61	4.98	2.05	2.04	-3.94	4.98	0.56
KW	0.96	-1.11	32.10	-3.27	10.91	11.88	-1.92	-1.12	14.95
WD	3.14	-4.00	2.83	1.20	1.98	-0.98	-3.08	4.14	0.32
WK	6.67	-0.43	9.02	3.56	1.83	-1.62	-5.35	9.32	-0.80

Discussion

Egg weight in different genetic groups differ stastically at both the age of measurement. Further, the egg weight at 60th week of age increases in most of the crossbred and purebred except Desi purebred and KW and DW crossbred which may be due to higher egg production rate in the above genetic groups. Higher egg weight of crossbred than the purebred is in agreement with reports of Das *et al.* (2000), Nageswar *et al*. (2005), Padhi *et al.(*2009a). Eegg weight observed in the present study in Desi, Khaki Campbell and their crossbred is higher than the reports of Kalita *et al*.(1992) and Nageswar *et al.* (2005) indicating the effect of crossing to improve the egg weight. Over dominance is evident in the KD and DK crossbred egg weight at 60th week of age. Further, White Pekin as one parent with other purebreds increases the egg weight in the crossbreds. Higher shape index of Desi than the other three breeds and significant difference between genetic groups are in agreement with the reports of Eswaran *et al.* (1985), Das *et al.* (2000) and Nageswar *et al.* (2005). Shape index at 60th week of age was higher than at 40th week of age indicating that the length of the eggs was little higher compare to width at 40th week of age. At 60th week of age statistically similar value for shape index were observed in different genetic groups except in Desi. Albumen index decreases at 60th week of age in all the purebreds which may be due to age effect. However, the value recorded at both the age of measurement are higher than the reports of Eswaran *et al.* (1985) and Nageswar *et al.* (2005). It is also found that the crossbred albumen index decreases less at 60th week compare to at 40th week of age. However, in purebreds the value decrease at 60th week of age. White Pekin as female parent recorded better albumen index towards the later part of laying period. Decrease of yolk index at 60th week of age in most of the genetic groups than at 40th week of age may be due to age effect. However, the value obtained in the present study were higher than the reports of Das *et al.* (2000), Nageswar *et al.* (2005), Okruszek *et al*., (2006). The value of Haugh unit score decrease at 60th week of age than at 40th week of age which may be due to poor albumen height at 60th week of age however, the value obtained in the present study were higher than the reports of Das *et al.* (2000), Nageswar *et al*. (2005) and Okruszek *et al.* (2006). Higher Haugh unit score in crossbred than the purebreds indicates the presence of heterosis and is in agreement with the reports of Das *et al*.(2000) and Nageswar *et al.* (2005).

Decrease of shell thickness at 60th week of age than at 40th week indicates the effect of age on shell thickness. Lower shell thickness of Khaki Campbell may be due to lower egg weight of this breeds compare to other genetic groups. Shell thickness observed in the present study are lower than the reports of Eswaran *et al.* (1985) and Okruszek *et al*., (2006) which may be due to different of genetic stock. Decrease of shell thickness and shell % towards later stage of laying in White Leghorn chicken reported by Ledur *et al.* (2002) which agree with the present findings. Albumen % decreases as the age of measurement increases and the crossbred recorded lower albumen % than the purebreds indicating the effect of crossbreeding for both albumen and yolk %. It is also seen that as the age of measurement increase the yolk % increases. However, yolk % is lower than the reports of Okruszek *et al*., (2006). Age effect on shell % is evident in all the genetic groups and as the age of measurement increases the shell % degreases. Crossbred recorded better shell % which may be exploited to get better shell quality in crossbred. Non significant difference between % of yolk, white and shell has been reported by Mazanowski *et al.* (2005) in two purebred ducks which agree for some traits in the present study.

Significant GCA, SCA and RE for egg weight indicates the importance of additive genetic effects in addition to non additive genetic effects and maternal and or sex linked effects. For shape index additive genetic effect and reciprocal effect important for 40th week

and all the effects are significant at 60th week of age. This is in agreement with the report of Fairfull *et al*. (1983) in chicken. Eisen *et al.* (1967) also observed important of GCA for the above two traits. Significant effect of GCA, SCA and RE for albumen index at both eth age of measurement showed the importance of both additive and non additive genetic effects. Similar observations were observed for yolk index at both age except SCA was non significant at 60th week of age indicating the non additive genetic effects is non significant at 60th week of age. All the crossbreeding genetic parameters are significant for Haugh unit score at both the age of measurement indicating the importance of different effects. Significant GCA and RE for egg quality traits reported by Fairfull *et al*. (1983) including significant SCA for majority of traits. In contrast non significant GCA and SCA was reported by Eisen *et al.* (1967) in chicken for different egg quality traits. White Pekin as female line perform better than the male line. Similar trend were also observed in respect to shell thickness with membrane. Significant GCA, SCA and RE were observed for albumen yolk and shell % except RE non significant at 60th week of age. This indicates the importance of different crossbreeding genetic effects and the traits can be improved by pure line selection followed by crossbreeding and with development of specialized sire and dam line. As the breeds are not selected before there is lot of variation in the breed and the crossbred may be of useful for improving the egg quality traits. Significant RE for different egg components also reported by Ledur *et al.* (2002) in White Leghorn.

GCA estimates of White Pekin for egg weight indicates this breeds combine well with other two breeds. However, SCA estimates revealed DW cross have better nicking ability. DK crossbred also showed the egg weight may improve in later part of the laying cycle than the purebreds. Positive estimates of Desi at both age of measurement showed the importance of Desi as male parents for better shape index. Negative estimates of GCA for White Pekin indicates White Pekin as one parent decrease the albumen index in the crossbred. However, from SCA and RE estimates White Pekin as male parent improve the albumen index in crossbred. SCA was positive for yolk index for DK and KW irrespective of age of measurement showing this two crossbred have better combining ability, Significant RE indicates importance of maternal and sex linked effects for the yolk index. At 60th week of age the Haugh unit score decreases compare to 40th week and DW and KW showed positive SCA indicating the importance of White Pekin as female line for the better Haugh unit score. This is also evident from the RE estimates. GCA is important for shell thickness at both the age of measurement and from the estimates DK and KW nicking well for higher shell thickness. Albumen and yolk % estimates revealed that as the age increases the yolk % increases except DW at 60th week where positive RE estimates for albumen % was recorded. Crossbred showed higher yolk % than the purebreds as evident from the estimates. Positive GCA estimates for Desi and White Pekin for Shell % irrespective age of measurement implies the two breeds for improvement for further increases in shell thickness through pure line selection. White Pekin as female parent in the cross showed better shell % in the crossbred irrespective of age.

Heterosis % were positive for most of the traits in the crossbreds indicating the presence of dominance and over dominance in most of the traits. However, for albumen % all the crossbred showed positive estimates indicating the higher yolk % in crossbred eggs than the purebred egg. From the egg quality parameters KW showed better heterosis % compared to other crossbred in overall performance. However, for better egg weight in crossbred DK and KD prefer for 60th week and at 40th week the cross having one parent as White Pekin giving better egg weight. Significant heterosis for egg weight, shell thickness and Haugh unit are reported by Prasetyo *et al.* (2000) which is in agreement with the present study. Importance of heterosis for most of the egg quality traits except Haugh unit in chicken reported by Fairfull *et al.* (1983).

Conclusion

Egg quality traits studied in nine genetic groups produced by a 3X3 diallel cross experiment indicates that for all the traits there is significant difference between different genetic groups irrespective age of measurement. Most of the traits the crossbred perform better than the purebreds. Combining ability showed the importance of GCA, SCA and RE for majority of the traits. White Pekin performs better as female line than as male line. Heterosis % revealed that except albumen and shape index the crossbreed has better value than the mid parent value. Overall results indicate that KW performs better at 60th week of age but at 40th week of age no general trend was observed for all the traits. The results indicate that the pure line selection followed by crossbreeding may be of value for improving the egg quality and specialized sire and dam line may be developed for further improvement in egg quality.

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MOLECULAR CHARACTERIZATION OF INDIAN DUCK (*ANAS PLATYRHYNCHOS*) POPULATIONS USING MICRSATELLITE MARKERS

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Abbreviated title: Mol. Charac. of Ind. Duck Pop.

ABSTRACT

The mallard ducks of India contribute significantly to the economy of lower strata of farming community in the coastal and North Eastern regions of the country. It also contributes as a source of animal protein to these farmers. The ducks of India have not been studied at molecular level. This present study involved genotyping of 24 Microsatellite loci for construction of Genetic relationship among the different populations of India and revealing of population structure. All of the selected Microsatellite loci exhibited high polymorphic information content and gene diversity. The F statistics points towards presence of population structure in the four indigenous duck populations. On the basis of Microasatellite genotyping study, there was not much differentiation among the duck populations along the coast line, while Jharkhand ducks (mainland birds) were distinct from the ducks of coast line.

Keywords: *Anas Platyrhynchos*, Microsatellite genotyping, Polymorphism, Heterozygosity.

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Introduction

Avian species play a vital role in livelihood of human beings throughout the world, especially, in developing countries. Backyard poultry provides livelihood to large and small farmers while the poultry industry has a lead role in raising the economic resources of country, especially, the agricultural sector. Poultry includes the class of domesticated fowl reared for meat and eggs. The domestic fowl are typically the members of the order *Galliformes* (such as chicken and turkeys) and *Anseriformes* (waterfowls such as ducks and geese). Recent publication of World Watch list of domestic animal biodiversity (WWL-DAD, www.fao.org) reveals 14 avian species (87.5%) and 1049 avian breeds (16.4%) distributed all over the globe. The total population of ducks in India is 10 million and it ranks 2nd in the world after Indonesia. The domestic duck is distributed throughout the world. It has its greatest economic importance in Southeast Asia, the principal countries being Bangladesh, China, Indonesia, Myanmar, Philippines, Thailand and Vietnam.

Taxonomically ducks belongs to the Order *Anseriformes*, and family *Anatidae* that diverged from the chicken (*Galliformes*) 110 million years ago. The main radiation of the modern duck took place during the Miocene, (5-23 million years ago). In India, the ducks are mainly concentrated in Eastern and Southern States of India. Coastal areas of Orissa, Kerala, WestBengal and certain parts of Assam and Jharkhand constitute the main breeding tracts for ducks.

In India the total egg production is 404031 million, out of which 94.7% comes from fowl and 5.3% comes from ducks. Indigenous ducks contributes 91% of the total egg produced by ducks and 9% are produced by improved varieties. Indigenous duck have production potential of about 130-140 eggs per annum. Nearly 30% of the total 245 million tons of meat is of poultry origin. Duck meat is a good dietary source of high quality protein, energy and several vitamins (Vitamin A, C, E, K, B6, B12) and minerals (Calcium, Iron, Magnesium, Sodium, Potassium, Zinc, Copper, Manganese). The common Indian breeds of ducks are Indian Runner, White Bearded, Nageshwari, Sythetmete and Chara but no information on scientific lines is available either at phenotypic or at genetic level.

There are no reports on indigenous germplasm and through the present investigation an attempt has been made to genetically characterize the duck populations of the country based on Molecular markers distributed throughout the genome, i.e Microsatellite markers. It is envisaged that the genomic studies presented here shall help in conserving endangered

populations and can also be used in production of improved varieties by selective breeding and through biotechnology applications in future.

The scientific literature on molecular genetic studies is confined to ducks of Chinese origin (Maak *et al.,* 2000; Stai and Hughes 2003; Genet *et al.,* 2003; Xiao *et al*., 2004; Huang *et al.,* 2005; Tang *et al.,* 2007; Li *et al.,* 2007, and Su *et al.,* 2007), and the confirmation on Indian duck populations is meager, therefore, it was proposed to utilize a set of molecular marker available in public domain for detecting the variability, structuring of the population, migration patterns in indigenous duck populations.

In the present study the random samples were collected from four duck populations of WestBengal, Orissa, TamilNadu and Jharkhand. KhakhiCampbell (commercial duck) was taken as an outgroup in the present study.

Materials and Methods

Fourty eight blood samples from each population were collected from randomly selected unrelated birds from their breeding tracts (Figure 1)**.** A 0.5 ml of blood sample was collected from wing vein of randomly selected birds in 5ml Heparinized vacutainers and the blood was well mixed with heparin to prevent clotting. The blood samples were transported and stored at 4^{o}C prior to isolation of DNA.

DNA isolation was carried out by using standard phenol chloroform extraction protocol (Sambrook *et al.,* 1989). A set of 24 Microsatellite loci were selected from published data mostly related to Chinese ducks (Table 1). The selection was based on number of alleles in Chinese ducks. The PCR conditions were optimized for all of the 24 Microsatellite primers for the amplification in five ducks populations. The amplification was carried out in Thermal cycler (ABI Perkin Elmer System/Bio-Rad Research Laboratories, USA) at suitable annealing temperatures of respective primers. The PCR products were checked for amplification by loading on 2% agarose gel and electrophoresing at constant voltage of 10 V/cm. A 100bp ladder was loaded alongside as molecular size marker, and checked for amplification on UV-Transilluminator. The amplified products without non-specific amplification were further used for genotyping and sequencing of D-loop region.

The genotyping was carried out on ABI-3100 AVANT automated DNA sequencer with Liz-500 (Applied Biosystems) as internal lane standard (size standard). The post PCR multiplexing was used to simultaneously genotype 3 or 4 loci depending upon the size and dye label of the PCR product. The sizing and allele calling was performed using Genotyper ver. 3.0 software (Applied Biosystems). The allele data thus generated was used for further statistical analysis.

Statistical Analysis

The data generated for five duck populations using the Microsatellite loci was subjected to Ewens-Watersson test of Neutrality to check for the loci being selectively neutral and exported for further statistical analysis. The statistical analysis was carried out using POPGENE software (Yeh *et al*., 1999). The heterozygosity measures were calculated using the following formulae given by Nei (1978).

The software FSTAT 2.9.1 (Goudet, 1995) was used to compute values of standard genetic diversity indices, their variances and pairwise estimates of F_{ST}.

The F statistics values F_{IS}, F_{IT} and F_{ST} were estimated using Jack-knifing over loci and the confidence interval were generated using 10,000 permutations with the GDA software (Lewis and Zaykin, 2002). The number of migrants (Nm) was estimated using

$$Nm= 0.25 (1-F_{ST})/F_{ST.}$$

Genotype assignment for all pairs of five duck populations was performed by computing the log likelihood of the genotype of each individual in every sample. The assignment of individuals to the correct population and to other populations was also estimated. Nei's Standard Genetic distances were estimated using the software POPGENE. The analysis of molecular variance (AMOVA) was carried out using the software ARLEQUIN version 3.0 (Excoffier *et al.,* 2005). The populations were tested for being in Mutation Drift equilibrium using Software BOTTLENECK. The correspondence analysis was carried out using GENETIX ver. 4.05 software (www.genetix.univ-montp2.fr/genetix/genetixhtml). The Bayesian analysis for clustering and inferring populations of Indian ducks was carried out using software STRUCTURE (Pritchard *et al*., 2000).

Results

The mean allelic patterns across populations are given in Table 2. The mean number of alleles was maximum in WestBengal (Hansa) ducks (7.292), followed by Jharkhand and Orissa ducks, while the mean number of alleles was lowest in KhakhiCampbell (4.917). It is evident as KhakhiCampbell is a pure breed. The effective number of alleles was maximum in Orissa ducks (3.464) and minimum in KhakhiCampbell (2.382). The number of private alleles was highest in Hansa (1.625) and least in KhakhiCampbell (0.292). The mean expected heterozygosity was maximum in Hansa, which pointed towards existence of population structure.

The summary of genic variation and heterozygosity statistics of all the five population for 24 loci is presented in Table 3. Number of alleles observed in the selected populations along with the effective number of alleles is also described. The mean number of alleles (Na) over 24 loci was found to be 11.2917 while the mean effective number of alleles (Ne) was 4.2594 in all the five duck populations. The mean observed heterozygosity in all the five duck population for all the 24 loci

was found to be 0.4043 while the mean expected heterozygosity was 0.6805. The observed heterozygosity is less than the expected which points towards presence of population structure in these populations. The observed

heterozygosity was less than expected heterozygosity in all the coast line birds, whereas, it was more than expected in mainland birds.

The F statistics of 24 loci over all the five populations was estimated. Mean F_{ST} value over all the 24 loci has been found to be 0.1718 and the values are more than the estimated.

The Number of migrants was calculated using F_{ST} values and is presented in Table 4. As it is evident, the maximum value for Nm is 6.13 which is between Orissa and TamilNadu ducks.

The population assignment was done for the five duck populations. The WestBengal and Jharkhand ducks came out to be intact populations with no admixture from other populations. Being an outgroup the KhakhiCampbell ducks also form a separate group (Figure 2). There was admixture in Orissa and TamilNadu ducks, suggesting the continuity in these two duck populations. The five duck populations formed three clusters clearly. WestBengal ducks came out as a separate population. KhakhiCampbell, being an outgroup formed a separate cluster, while, the Jhakhand birds came near KhakhiCampbell, due to geographical closeness. Being a mainland bird the Jharkhand ducks came out to be entirely different from the coastline birds. Orissa and TamilNadu birds showed overlapping in the populations. There was high genefow among the birds from two states.

The Analysis of Molecular Variance was carried out to find out the differences among population and within the populations. The AMOVA revealed a total of 27% variation was attributed to among population variance while rest 73% variance was within the populations. It means to specify that the individuals within the breed/ populations contribute more to the variability than the individuals between the populations.

Three tests viz., sign test, standardised differences test and Wilcoxon test were employed in order to find out whether these five duck populations have undergone recent bottleneck. All the three models of Microsatellite evolution IAM, SMM and TPM were utilised for the purpose. The values of nl (sample size in haploid genomes), H_e the heterozygosity observed, k_0 (No. of alleles observed) for the data have been given in the Table 5 for the five duck populations. The fourth test utilised to test the bottleneck is Mode-shift. This is a qualitative method for estimation of bottleneck. The non-bottleneck populations that are near mutation-drift equilibrium are expected to have a large proportion of alleles at low frequency. The graphical method (Luikart *et al.,*, 1998) utilises allelic classes and proportion of alleles. The graphs thus plotted for the five duck populations are shown in Figure 3 (a-e). None of the five populations exhibit a mode shift rather a normal L shaped distribution is observed, suggesting no bottleneck in indigenous ducks and outgroup. Thus the Indian duck populations of have a large effective population size and have shown no evidence of severe reduction in effective population size in immediate past.

The Nei's standard genetic distance is given in Table 6 (above diagonal). The maximum distance value was between WestBengal and KhakhiCambell ducks (0.78) while the minimum genetic distance was found between TamilNadu and Orissa ducks (0.07). The Reynold's genetic distance which provides a measure of population divergence by drift only and provides coancestry coefficient (Reynold *et al.,* 1983) have been shown in Table 6 (Below diagonal). The least values were found to be between Orissa and TamilNadu ducks (0.05) while the maximum were between WestBengal and KhakhiCampbell ducks (0.30).

The Nei's standard genetic distance (Nei's,1972) was utilized for construction of phylogenetic tree for finding out the relationship among five duck populations as shown in Figure 4.

The correspondence analysis was carried out using GENETIX ver. 4.05. The three axis of the correspondence analysis contributed 41.93, 27.37 and 6.75 percent of the variance

and cumulatively explained 76.05 percent of the variance. Each of the individual 5 populations is depicted with a different color. The three dimensional view along the three axis is shown in Figure 5.

The Bayesian analysis for clustering and inferring populations of Indian ducks was carried out using STRUCTURE. Model based structure analysis utilizing the genetic data obtained on coast line as well as inland birds was carried out. The results presented are based on a Burnin value of 50000 followed by recording of 50000 MCMC (Monte Carlo Marcov Chain) simulations. To choose an appropriate value of K for this model the inference for the number of populations is estimated using the formula Probability Pr (K/X). From the estimates of Pr (K/X), shown in the last column of Table 7, it is clear that the models with K = 2, 3 and 4 are completely insufficient to model the data and the model with K = 5 is substantially better then models with smaller value of K (2, 3, 4).The results were displayed using the DISTRUCT software as shown in Figure 6.

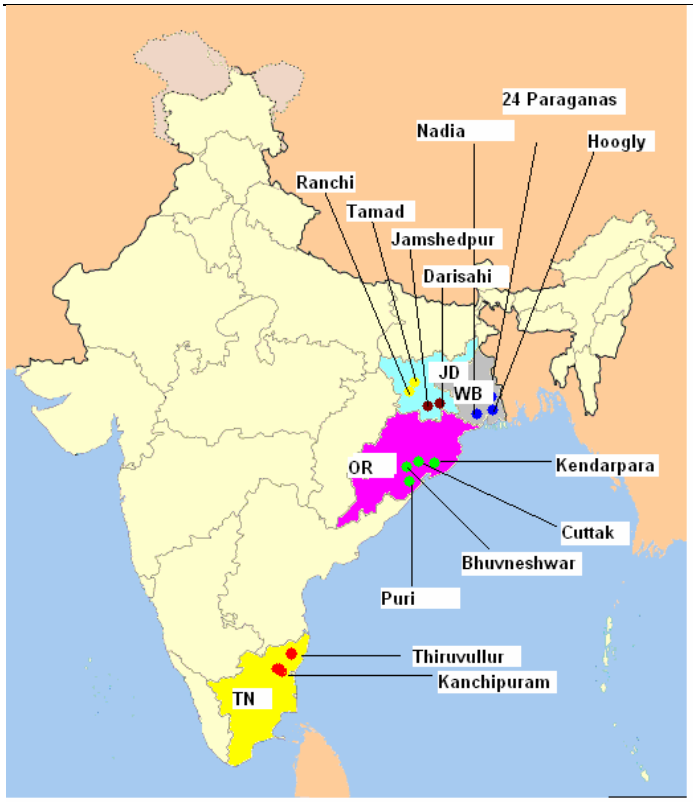

Figure 1: Geographical Distribution of Five Selected Duck Populations Used in the Present Study in the States of WestBengal, Orissa, TamilNadu and Jharkhand. (WB- WestBengal, OR- Orissa, TN- TamilNadu, JD- Jharkhand)

TABLES 1-8

Table 1 List of Microsatellite Primers Selected for the Genetic Diversity Analysis in Duck Populations

Sr. No	Primer name	Primer sequence in 5' – 3' orientation	Dye	Repeat	Tm values (°C)	Expected PCR product size	Linkage group	Gene bank accession
1.	CAUD010	F-GGATGTGTTTTTCATTATTGAT R-AGAGGCATAAATACTCAGTG	PET	CA	50.3	116-135	CAU-2	AY493255
2.	CAUD011	F-TGCTATCCACCCAATAAGTG R-CAAAGTTAGCTGGTATCTGC	FAM	CA	50.3	126-141	CAU-2	AY493256
3.	CAUD013	F-ACAATAGATTCCAGATGCTGAA R-ATGTCTGAGTCCTCGGAGC	PET	AC	58.1	90-114	Unidentified	AY493258
4.	CAUD016	F-TTTAGGTAAAACTGTGAATCAA R-ATCAAAGCAGGGAGCTAAG	NED	T	51.4	202-218	Unidentified	AY493261
5.	CAUD017	F-AGAAATACACTTACAGCACT R-TGTCATAAAATGGTTAATTGC	NED	TC	58.1	200-246	CAU-8	AY493262
6.	CAUD019	F-CTTAGCCCAGTGAAGCATG R-GCAGACTTTTACTTATGACTC	VIC	TC	58.1	186-210	CAU-7	AY493264
7.	CAUD022	F-CATGCTGAGTGTCCTATCCT R-CCAGGTCAGGCGTGTGCT	FAM	GCA	55.5	125-137	Unidentified	AY493267
8.	CAUD023	F-CACATTAACTACATTTCGGTCT R-CAGCCAAAGAGTTCAACAGG	FAM	AC	51.4	163-183	Unidentified	AY493268
9.	CAUD024	F-TCGCATTAAGCTCTGATCT R-ATCAACAGAATCCAAAATATG	VIC	T	55.5	265-345	CAU-1	AY493269
10.	CAUD025	F-AGTTCATCCCGATTTGTAGC R-AAATGCAGTGAGGTAAACCC	VIC	CA	63.5	280-320	CAU-1	AY493270
11.	CAUD026	F-ACGTCACATCACCCCACAG R-CTTTGCCTCTGGTGAGGTTC	FAM	AC	60.8	138-152	Unidentified	AY493271
12.	CAUD027	F-AGAAGGCAGGCAAATCAGAG R-TCCACTCATAAAAACACCCACA	PET	CA	66	108-123	CAU-1	AY493272
13.	CAUD031	F-AGCATCTGGACTTTTTCTGGA R-CACCCCAGGCTCTGAGATAA	PET	TC	51.4	110-140	CAU-1	AY493276
14.	CAUD032	F-GAAACCAACTGAAAACGGGC R-CCTCCTGCGTCCCAATAAG	PET	CA	58.1	110-125	Unidentified	AY493277
15.	CAUD033	F-ACCCAGAAGAGTCAAGAATAG R-GAGTATTCCTGGTCTGTGCT	NED	AC, Tn	58.1	200-207	Unidentified	AY493278
16.	CAUD035	F-GTGCCTAACCCTGATGGATG R-CTTATCAGATGGGGCTCGGA	NED	CA	63.5	220-238	CAU-6	AY493280
17.	APH01	F-TACCTTGCTCTTCACTTTCTTT R-GTATGACAGCAGACACGGTAA	FAM	GT	53.8	191-200	CAU-5	AJ272577
18.	APH03	F-ACCCAAGACAGAATAATCCTA R-GAACACAACTGCTTTGCTA	NED	GT	51.6	209-220	Unidentified	AJ272578
19.	APH07	F-ACATCTTTGGCATTTTGAA R-CATCCACTAGAACACAGACATT	VIC	TC	52.7	229-238	CAU-5	AJ272579
20.	APH09	F-GGATGTTGCCCCACATATTT R-TTGCCTTGTTTATGAGCCATTA	PET	AT, GT	58.1	102-125	CAU-18	AJ272580
21.	APH10	F-ATTAGAGCAGGAGTTAGGAGAC R-GCAAGAAGTGGCTTTTTTC	FAM	AC	52.3	111-137	Unidentified	AJ272581
22.	CAUD001	F-ACAGCTTCAGCAGACTTAGA R-GCAGAAAGTATTAAGGAAG	VIC	An	55.5	277-329	CAU-11	AY493246
23.	CAUD004	F-TCCACTTGGTAGACCTTGAG R-TGGGATTCAGTGAGAAGCCT	NED	AC	60.8	186-222	CAU-16	AY493249
24.	MCW328	F-ATGGAAACAGATGGAGCTGGC R-CTCCAATCCCAGGCTCCAAC	FAM	TG	51.6	204-220	Unidentified	G32083

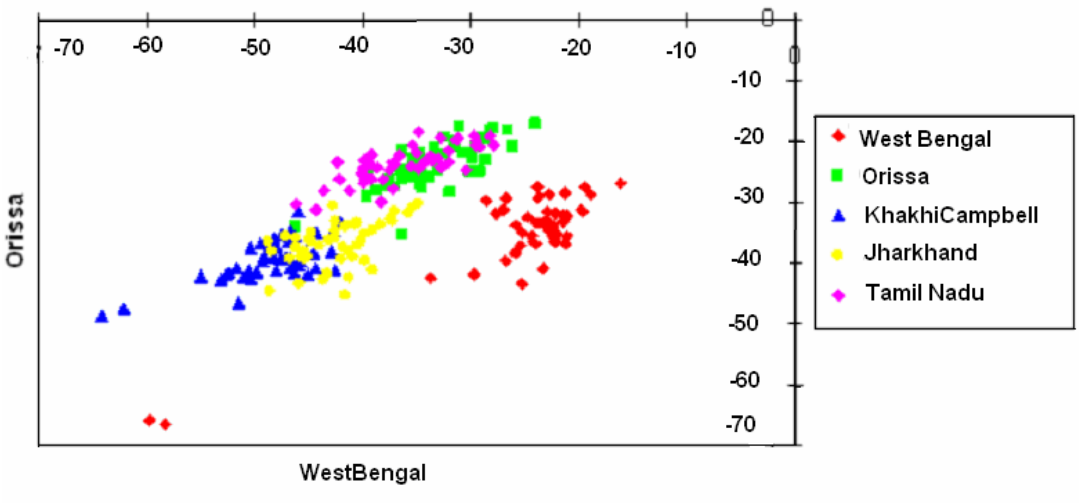

Figure 2: Graphical Representation of Population Assignment in the Five Duck Populations

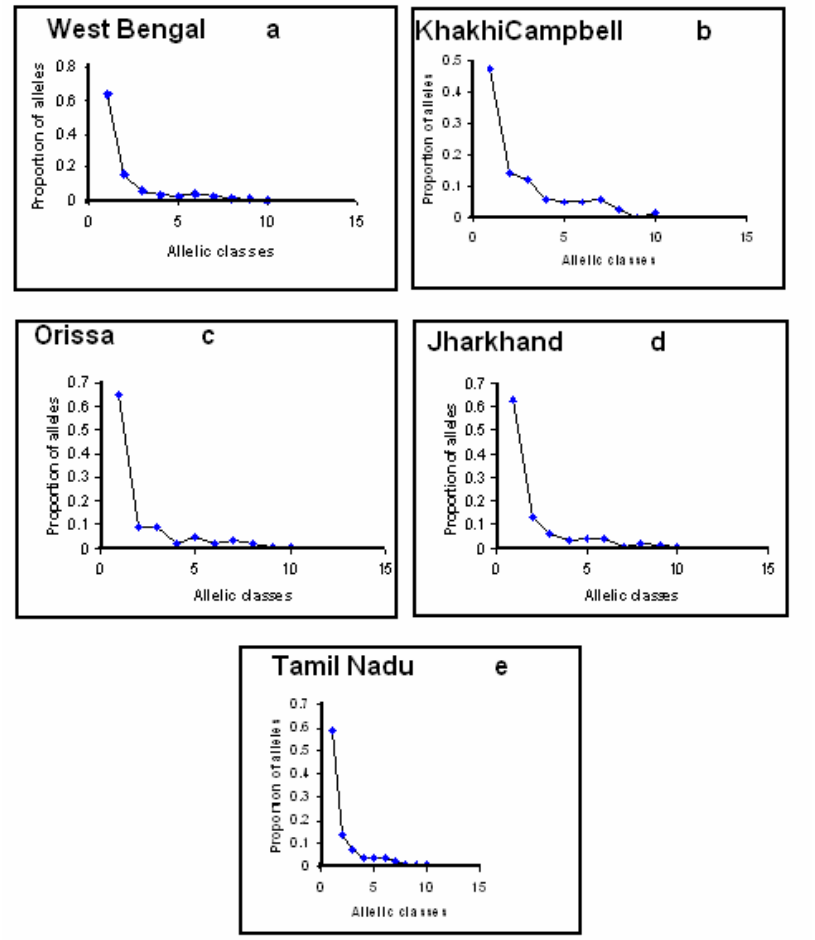

Figure 3: The Mode-shift Test using Graphic Representation in Five Duck Populations

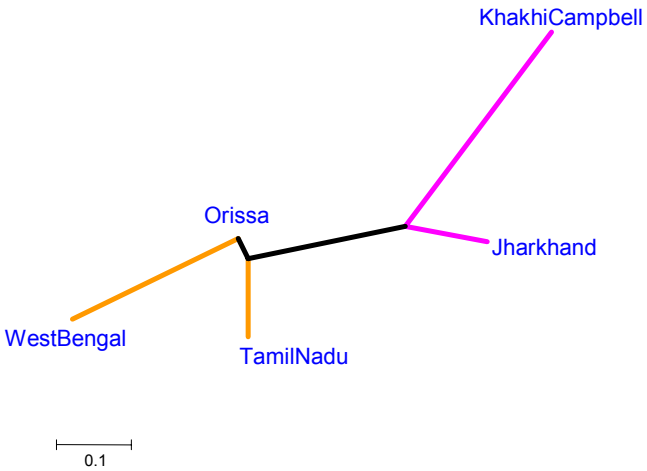

Figure 4: Relationship among Duck populations based on Nei's 1972 genetic distance

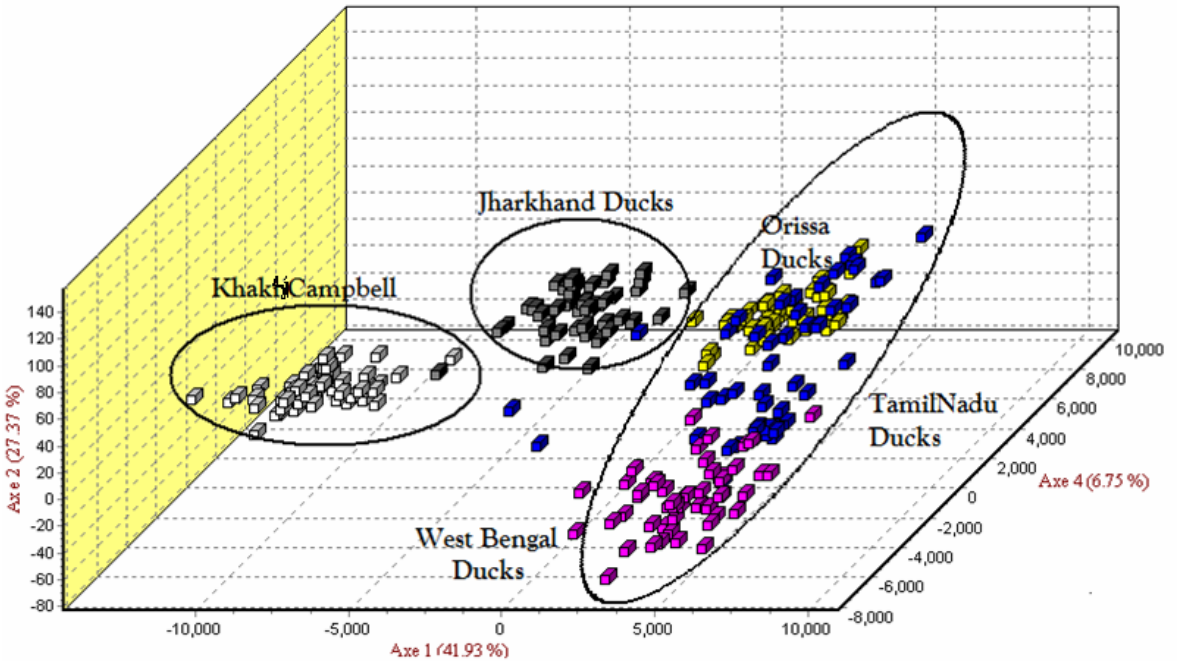

Figure 5: The Correspondence Analysis of Five Duck Populations with Independent Colour Code;
Pink denotes- WestBengal, Yellow denotes- Orissa, Blue denotes- TamilNadu Brown denotes- Jharkhand, White denotes- KhakhiCampbell

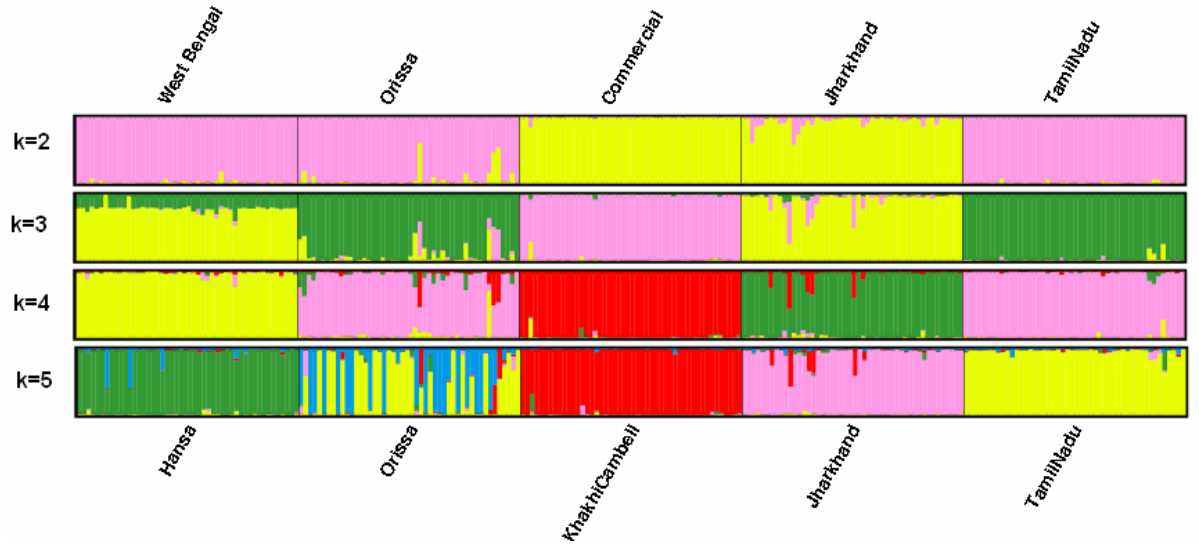

Figure 6: Bayesian Analysis for Individuals using DISTRUCT Software for Display, at the Value of K= 2, 3, 4 & 5

Table 2 Mean Allelic Patterns Across Populations

Population	WestBengal	Orissa	KhakhiCampbell	Jharkhand	TamilNadu
Na	7.292	6.583	4.917	6.583	5.667
Na Freq. >= 5%	4.042	3.708	3.083	3.542	3.500
Ne	3.420	3.464	2.382	3.197	3.047
I	1.292	1.192	0.987	1.172	1.084
No. Private Alleles	1.625	0.625	0.292	0.542	0.333
Number of Less Common Alleles (<=25%)	0.000	0.000	0.000	0.000	0.000
Number of Less common Alleles (<=50%)	0.750	0.917	0.583	0.917	0.583
He	0.605	0.576	0.526	0.566	0.539
U He	0.611	0.582	0.532	0.572	0.545

Discussions

The results of Microsatellite markers in the present investigation are in agreement to studies carried out in Chinese ducks by Huang *et al.,* (2005), Su *et al.,* (2007), Yan *et al.,* (2008) and Xiao *et al.,* (2009). A quick comparison of the locus wise results of the Indian and Chinese duck populations has been summarized in Table 8. This revealed that the Microsatellite markers were highly polymorphic for Indian duck populations and the different values are quite comparable among the two set of populations. The observed heterozygosity values and the Polymorphic Information Content were higher in Indian ducks, owing to the high genetic diversity in Indian ducks in comparison to Chinese duck populations.

Genetic distance studies based on 24 Microsatellite loci reveal that ample of diversity exists among the duck populations employed in the present investigation. Clear cut differentiation between the land and coastal area ducks reflect the need to consider the two as distinctive populations and breeding plans need to be devised accordingly. The free gene flow among the coastal birds reveals homogeneity among the populations. The free gene flow also reflects lack of genetic structure among the coastal ducks and this can be attributed to negligible selection or breeding for specific purposes.

Table 3 Summary of Genic Variation and Heterozygosity Statistics of Five Populations for All Loci

Locus	Na	Ne	Ho	He
APH01	5	1.878	0.2667	0.4685
Caud01	19	3.4483	0.6125	0.7115
Caud10	5	1.537	0.2875	0.3501
Caud17	15	4.8518	0.1875	0.7955
Caud13	11	3.7054	0.5583	0.7316
Caud23	8	4.2184	0.5333	0.7645
Caud25	8	2.4108	0.2667	0.5864
Caud33	4	2.1014	0.4292	0.5252
APH10	8	2.2031	0.3333	0.5472
Caud16	10	3.0801	0.3542	0.6767
Caud19	29	13.6744	0.7331	0.9288
Caud31	15	3.0167	0.5458	0.6699
APH09	9	5.7288	0.5208	0.8272
Caud26	7	3.1599	0.2292	0.685
Caud24	38	17.0692	0.6167	0.9434
Caud35	11	4.147	0.3729	0.7605
APH03	6	2.2674	0.1833	0.5601
APH07	12	3.0239	0.25	0.6707
Caud22	9	2.7012	0.325	0.6311
Caud27	9	3.2501	0.5297	0.6938
Caud04	13	5.1218	0.675	0.8064
Caud11	7	3.5013	0.4292	0.7159
Caud32	7	4.0022	0.4083	0.7517
MCW328	6	2.1284	0.0542	0.5313
Mean	**11.2917**	**4.2594**	**0.4043**	**0.6805**
St. Dev	7.8324	3.6153	0.1745	0.1397

Where
Na - Number of Alleles, Ne - Effective number of Alleles,
Ho - Observed Heterozygosity, He - Expected Heterozygosity

Table 4 Population wise F_{ST} values and Number of Migrants

	WestBengal	Orissa	KhakhiCampbell	Jharkhand	TamilNadu
WestBengal	0.00	2.02	0.62	0.93	1.18
Orissa	0.11	0.00	0.81	1.17	6.13
KhakhiCampbell	0.29	0.24	0.00	0.99	0.73
Jharkhand	0.21	0.18	0.20	0.00	0.92
TamilNadu	0.17	0.39	0.26	0.21	0.00

Number of migrants (Above diagonal); F_{ST} values (Below diagonal)

Table 5 The values of n (sample size in haploid genomes), H_e (heterozygosity observed), k_0 (No. of alleles observed) for Five Duck Populations

Locus	WestBengal			Orissa			KhakhiCampbell			Jharkhand			TamilNadu		
	n	ko	He	n	ko	He	n	ko	He	n	ko	He	n	ko	He
APH01	96	4	0.371	96	3	0.157	96	3	0.491	96	4	0.335	96	2	0.081
Caud01	96	13	0.811	96	9	0.709	96	5	0.554	96	9	0.717	96	5	0.665
Caud10	96	5	0.584	96	3	0.381	96	2	0.100	96	3	0.207	96	3	0.383
Caud17	96	12	0.868	96	10	0.744	96	4	0.397	96	9	0.852	96	5	0.595
Caud13	96	6	0.692	96	5	0.671	96	5	0.527	96	3	0.369	96	8	0.763
Caud23	96	6	0.623	96	6	0.724	96	5	0.648	96	7	0.701	96	6	0.668
Caud25	96	8	0.774	96	4	0.423	96	3	0.524	96	6	0.623	96	2	0.449
Caud33	96	4	0.525	96	4	0.520	96	4	0.359	96	4	0.527	96	2	0.504
APH10	96	5	0.469	96	4	0.553	96	3	0.446	96	3	0.456	96	3	0.194
Caud16	96	7	0.614	96	5	0.500	96	3	0.534	96	4	0.627	96	4	0.566
Caud19	96	10	0.848	96	20	0.938	96	8	0.603	96	17	0.899	96	17	0.877
Caud31	96	8	0.682	96	8	0.716	96	7	0.522	96	5	0.420	96	8	0.794
APH09	96	6	0.773	96	6	0.795	96	3	0.590	96	7	0.740	96	8	0.691
Caud26	96	6	0.628	96	4	0.593	96	4	0.568	96	5	0.620	96	6	0.674
Caud24	96	26	0.940	96	21	0.941	96	14	0.772	96	22	0.928	96	22	0.934
Caud35	96	7	0.501	96	9	0.548	96	6	0.687	96	8	0.686	96	5	0.551
APH03	96	3	0.381	96	3	0.554	96	4	0.642	96	6	0.604	96	2	0.379
APH07	96	5	0.541	96	6	0.568	96	10	0.774	96	7	0.626	96	4	0.523
Caud22	96	5	0.390	96	3	0.194	96	4	0.499	96	3	0.408	96	2	0.021
Caud27	96	6	0.587	96	4	0.579	96	5	0.626	96	6	0.616	96	4	0.618
Caud04	96	7	0.703	96	9	0.741	96	6	0.764	96	7	0.672	96	8	0.759
Caud11	96	4	0.608	96	5	0.498	96	4	0.624	96	4	0.590	96	3	0.294
Caud32	96	7	0.521	96	5	0.497	96	4	0.466	96	6	0.469	96	3	0.523
MCW328	96	5	0.230	96	2	0.418	96	2	0.041	96	3	0.041	96	4	0.569

Table 6 Genetic Distances Between Duck Populations Based on Allele Frequencies

Population	WestBengal	Jharkhand	KhakhiCampbell	Orissa	TamilNadu
WestBengal	0.00	0.51	0.78	0.22	0.36
Jharkhand	0.22	0.00	0.39	0.37	0.44
KhakhiCampbell	0.30	0.21	0.00	0.51	0.53
Orissa	0.12	0.19	0.25	0.00	0.07
TamilNadu	0.19	0.22	0.26	0.05	0.00

Nei's D_S above diagonal and Reynolds Below diagonal

Table 7 Inferring the value of K, the Number of Populations, for the Indian Duck Populations Data

K	Log P(X/K)	P(K/X)
2	-15694.8	0.049
3	-14726.8	0.042
4	-13898.2	0.035
5	-13629.8	0.033

Conclusion

Genetic distance studies based on 24 Microsatellite loci shows existence of large diversity among Indian duck populations. On the basis of F_{ST} values and effective number of migrants exchanged between populations, the minimum population differentiation was found between Orissa and TamilNadu ducks, with large value of effective number of migrants 6.13. These results demonstrated that there was quite high gene flow among the duck populations. The increased gene flow is because of the continuity of populations and introduction of germplasm for improvement in egg production. The AMOVA revealed that the individuals within the populations contribute more to the variability than between the populations. The correspondence analysis revealed three distinct clusters. The out-group KhakhiCampbell was distinct and all the individuals clustered together. The Jharkhand ducks formed another cluster, while the three populations along the east coastline of India clustered together**.** Bottleneck analysis revealed that none of the populations exhibited a mode shift, rather a Normal L shaped distribution is observed in all the five duck populations. This shows that there is no bottleneck and the number of individuals is sufficiently high.

There is not much differentiation among the duck populations along the east coast line of India. The ducks of Jharkhand are distinct from other duck populations and there is a

limited gene flow between the ducks inhabiting the land and coast line. There is sufficient genetic diversity in indigenous ducks and can be exploited for selection programs. The results generated in the present study can be utilized in production of improved varieties of ducks by selective breeding in future.

Table 8 Locus Wise Comparison of Fragment Size Range, Allele Number Obtained, Observed Heterozygosity and Polymorphic Information Content Values reported in the Present Investigation With Respect to Indian Duck Populations to the Data Reported in Literature

Locus	Fragment size range		Allele number		Observed Heterozygosity		Polymorphic Content	Information
Name of the locus	Values from literature	Values from Present Study	Values from literature	Values from Present Study	Values from literature	Values from Present Study	Values from literature	Values from Present Study
APH01	198-200	191-201	2	5	0.00	0.27	-	0.28
CAUD01	315-331	277-329	5	19	0.68	0.61	0.51	0.68
CAUD10	112-116	116-134	3	5	0.16	0.29	0.20	0.33
CAUD17	216-262	192-246	3	15	0.25	0.19	0.16	0.68
CAUD13	85-113	88-114	7	11	0.68	0.56	0.63	0.60
CAUD23	163-183	163-183	4	8	0.39	0.53	0.40	0.67
CAUD25	289-291	286-300	3	8	0.63	0.27	0.49	0.55
CAUD33	200-206	200-206	4	4	0.35	0.43	0.39	0.48
CAUD16	189-217	192-218	5	10	0.37	0.35	0.46	0.56
Caud19	132-213	122-210	13	29	0.97	0.73	0.87	0.82
Caud31	112-116	110-140	4	15	0.48	0.55	0.40	0.62
APH09	102-126	102-126	4	9	0.98	0.52	-	0.71
Caud26	140-150	139-151	4	7	0.70	0.23	0.67	0.61
Caud24	270-340	265-345	13	38	0.93	0.62	0.88	0.89
Caud35	223-237	218-238	4	11	0.60	0.37	0.52	0.59
APH07	224-282	221-265	4	12	0.00	0.25	-	0.60
Caud22	128-140	111-137	4	9	0.57	0.33	0.62	0.30
Caud27	111-119	108-124	3	9	0.60	0.53	0.48	0.60
Caud04	199-221	186-227	5	13	0.59	0.68	0.56	0.72
Caud11	121-140	126-142	4	7	0.58	0.43	0.57	0.52
Caud32	115-121	110-126	3	7	0.27	0.41	0.31	0.49

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CERTAIN PERFORMANCE TRAITS OF *CINA HANH* (*CAIRINA MOSCHATA*) DUCKS OF ASSAM UNDER RANGE CONDITION

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A study was undertaken to evaluate certain performance traits of *Cina hanh*, a local type of Muscovy duck of Assam under range condition. For this purpose a total of 90 duck farmers were selected randomly covering Kampur block of Nagaon district and Katigora block of Cachar district of Assam. *Cina hanh* ducks attained sexual maturity at the age of 285.52 days with an average annual egg production of 55.94 ± 0.36 numbers. The average egg weight of ducks laid during 52 weeks of age was 74.69 ± 0.76 g. The ducks exhibited intense broodiness characteristics. The per cent hatchability under natural incubation ranged from 60 to 70 on total egg set. The mortality percentage ranged from 10 to 15 in ducklings and 5 to 10 in adults. The mean body weight showed highly significant ($P<0.01$) differences between male and female at all ages except at day-old and first week of age.

Key words: Performance traits; *Cina hanh* duck

Introduction

Duck is the second most important species of poultry, next to chicken. Assam ranks second in duck population (4.72 million) in the country. Farmers of Assam maintain five distinct groups of waterfowls, viz. *Pati*, Nageswari, Khaki Campbell, *Cina hanh* and *Raj hanh* (Islam *et al*., 2002). Out of these, *Cina hanh* a local type Muscovy (*Cairina moschata*) is mostly reared in small groups under range system of management for meat production. However, no systematic studies of these ducks have been carried out so

far. Therefore, an attempt has been made to study their performance traits in respect of reproductive, productive and growth parameters for exploiting the possibility of their genetic improvement.

Materials and methods

The parameters pertaining to age at first egg (AFE), egg production, broodiness, percentage of hatchability on total egg set under natural incubation and mortality percentage in duckling and adults were determined from the data collected from 90 duck farmers using standard interview schedule. The respondent duck farmers belonging to the districts of Nagaon and Cachar district of Assam were selected on the basis of their flock strength. A person, who had a minimum of 6 numbers of *Cina hanh*, was considered as a duck farmer for the study. The AFE was recorded as the age in days from the date duckling

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was hatched out to the day when she laid her first egg for the groups of *Cina hanh* held by the farmers and average and range were taken into consideration. The egg numbers produced by *Cina hanh* up to 40, 52, and 72 weeks of age were recorded and expressed as averages and ranges. For egg weight and body weight, 118 numbers of day-old ducklings, hatched within one month were wing-banded and reared under range system of management by the farmers. At 16 weeks of age wing bands of growing ducklings were replaced with wing badge. Sexing was done by their distinguished voice and morphological characters. At 40 weeks of age, 103 (28 males and 75 females) adult ducks were survived. Ninety numbers of eggs laid during 52 weeks of age were weighed individually in grams. Body weights were recorded personally in the farmers' house at weekly interval from hatching to 4 weeks of age and thereafter weight was taken at 8, 12, 16, 20, 30 and 40 weeks of age. The data collected were then compiled, computed, tabulated and analyzed as per method described by Snedecor and Cochran (1994).

Results and discussion

The results of the study (Table 1) showed that the mean AFE was 285.52 days with a range of 240 to 310 days. In earlier survey Islam *et al*. (2002) recorded comparatively higher range of AFE in such ducks of Assam. However, the present finding corroborates the results of Hu *et al*. (1993) in Muscovy ducks of Taiwan. The variation in AFE might be due to the influence of hormones or seasonal variations. The average egg numbers up to 40, 52, and 72 weeks of age were 14.71 ± 0.31, 36.16 ± 0.34 and 55.94 ± 0.36, respectively with an annual egg production range of 50 to 60 numbers. Though similar egg production records in *Cina hanh* were reported by Islam *et al*. (2002); however higher annual egg production was observed in Muscovy ducks in different parts of the world (Romboli *et al*., 1987; Pingel, 1990; Hu *et al*., 1993; and Nikolova *et al*., 2000). The reason for lower egg production found in the present study might be due to the fact that selection for egg production has not been carried out in the population under study.

The average egg weight of *Cina hanh* laid during 52 weeks of age was 74.69± 0.76 g with a range from 58 to 86 g. The egg weight recorded in the present study was in close agreement with the reports of Kang *et al*. (1993) and Harun *et al*. (2001) in Muscovy ducks of Taiwan and Netherland, respectively. The manifestation of broody character among the flocks of *Cina hanh* was very common. The broody ducks were found frequently sitting on hatching eggs and were reluctant to move away. Hutt (1977) and Harun *et al*. (1998) also observed similar observations in Muscovy ducks. Duck farmers under study claimed 60 to 70% hatchability on total egg set using broody duck or hen. Ali *et al*. (1989) recorded 88.50% hatchability on fertile egg set in Muscovy ducks. Comparatively higher percentage of hatchability on total egg set was reported under natural incubation in *Pati* (85-95%) and Nageswari (71.4- 86.6%) ducks of Assam (Islam *et al*., 2002 and Sharma *et al*., 2003). The present study indicated that there was a scope of improvement of hatchability in *Cina hanh* through proper management and care. The percentage of mortality (5-15%) of *Cina hanh* recorded in the present study was comparatively higher as reported by Cavalchini *et al.* (1979) in Muscovy ducks (3.2- 6.6%) of France. The higher percentage of mortality found in the present study might be due to scavenging system of rearing.

Table 1. Certain reproductive and productive traits of *Cina hanh* ducks of Assam

Parameter	Mean ± S.E.
Age at first egg in days	285.52 (240-310)
Average egg production up to 40 weeks of age (Nos) 52 weeks of age (Nos) 72 weeks of age (Nos)	14.71 ± 0.31 36.16 ± 0.34 55.94 ± 0.36
Annual egg production (Nos.)	55 (50-60)
Average egg weight at 52 weeks of age (g)	74.69 ± 0.76 (58-86)
Hatchability on total egg set (%)	65.55 ± 4.65 (60-70)
Mortality percentage during 0-8 weeks of age 9 weeks and above	12.50 (10-15) 7.50 (5-10)

Figures in the parentheses indicate range

Table 2. Mean (± S.E.) body weight (g) of *Cina hanh* at different ages

Age in week	Male	Female
Day-old	58.29 ± 1.01	56.27 ± 0.66
1	85.36 ± 1.89	85.53 ± 1.32
2	198.04 ± 2.99[a]	182.27 ± 1.80[b]
3	350.00 ± 6.42[a]	294.67 ± 2.50[b]
4	461.43 ± 4.88[a]	387.73 ± 3.45[b]
8	846.79 ± 5.52[a]	765.27 ± 5.63[b]
12	1303.93 ± 11.63[a]	1129.33 ± 13.14[b]
16	1869.46 ± 18.16[a]	1463.00 ± 13.05[b]
20	2449.29 ± 24.52[a]	1718.47 ± 15.18[b]
30	2851.07 ± 29.21[a]	1918.92 ± 26.03[b]
40	3309.64 ± 34.26[a]	2204.53 ± 15.77[b]

Figures with different superscripts within row differ significantly (P<0.01)

The mean body weight (Table 2) of *Cina hanh* showed highly significant (P<0.01) differences between male and female at all ages above first week of age. The body weights of male and female *Cina hanh* were similar upto first week and thereafter the males had higher weight than the females till 40 weeks of age. Contrary to the present finding, Baeza *et al.* (1998) observed similar body weights of male and female Muscovy upto 4 weeks of age whereas heavier males thereafter till 15 weeks. Most of the reports (Pilla and Quilici, 1973a; Cavalchini *et al.,* 1979; Baeza *et al.*, 1998; and Ngapongora *et al*., 2001) pertaining to growth of Muscovy ducks indicated higher body weight at all ages than the present finding. The reason might be due to the fact that Muscovy ducks of most of the countries like France, Tanzania, Vietnam, Netherland, Mozambique are managed under intensive system of rearing with high stocking rate, scientific feeding and management whereas in the present study range system was used.

Conclusions

Muscovy type *Cina hanh* ducks of Assam attained sexual maturity at the age of 285.52 days with an average annual egg production of 55.94 ± 0.36 numbers. The average egg weight of *Cina hanh* laid during 52 weeks of age was 74.69 ± 0.76 g. The *Cina hanh* ducks were found to have intense broodiness. The per cent hatchability under natural incubation ranged from 60 to 70 on total egg set. The mortality percentage in *Cina hanh* ranged from 10 to 15 in ducklings and 5 to 10 in adults. The mean body weight of *Cina hanh* showed highly significant (P<0.01) differences between male and female above first week of age.

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CERTAIN PERFORMANCE TRAITS OF CHARA-CHEMBALLI DUCKS OF KERALA UNDER RANGE CONDITION IN ASSAM

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An investigation was undertaken to study certain performance traits of Chara-Chemballi ducks native of Kerala state under range condition in Assam. These ducks were raised by about 2352 Self-Help Groups (SHGs) in different districts of Assam since the year 2003. A total of 120 respondents were selected randomly covering 12 villages and 24 SHGs within four districts i.e., Kamrup, Darrang, Jorhat and Dibrugarh. The ducks attained an average weight of 1054.63 g at 12 weeks of age. Age at first egg was 142 days and the corresponding body weight was 1425.23 ± 12.73 g. The ducks laid on an average 181.3 eggs per annum with a weight of 71.6 ± 2.38 g. The egg production and egg weight of these ducks were much higher in comparison to the reported values of local *Pati* ducks of Assam. The farmers have shown increased interest to these ducks due to their better productability and adaptability.

Key words: Chara-Chemballi ducks, performance traits, Assam

Introduction

Ducks have been playing an important role in the socio-economic sphere of the rural people in Assam since time immemorial. Assam is one of the regions of north-eastern India, famous for different varieties of indigenous ducks reared by farmers under traditional system (Islam *et al*., 2002). The desi ducks constitute 86.5 per cent of the total duck population (4.99 million) in the state (Sharma *et al*., 2002). These ducks (*Pati*) are poor in egg production with an annual egg production record of 80 to 90 per duck (Islam *et al*., 2002). In order to improve egg production and profitability from duck farming in Assam, indigenous ducks from the state of Kerala were introduced by the Government of Assam in the year 2003 under range condition of Assam (Anon, 2007-08).

SURVEY PROCEDURE

The present survey was conducted in four districts of Assam namely Kamrup, Darrang, Jorhat and Dibrugarh, where Chara-Chemballi ducks were supplied to the women SHGs under Govt. sponsored project. The primary data were collected through direct contact with the leaders of the different SHGs.

The survey was conducted selecting 3 villages from each district and 2 SHGs from each village. Five respondents were selected randomly from each SHG, thus a total of 120 farmers were selected by adopting the probability proportionate size sampling technique of Lahiri (Snedecor and Cochran, 1989). The required information were collected through a structured schedule (questionnaire) which was developed and administered especially for this purpose, by personal interview with the owner and the secondary sources like records and registers. Body weight at different ages was taken at regular interval. The data collected were then compiled, computed and tabulated by using standard procedure.

Results and discussion

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The agro-climatic conditions of Assam and Kerala are more or less similar. The Chara-Chemballi ducks had shown very good adaptability in Assam (Fig.1). The ducks survived and performed well during the growing period (9-20 weeks) and the production period (21-72 weeks). However, mortality was comparatively higher during the initial stage of life (26.67%) under range condition in Assam.

Table 1. Certain performance traits of Chara-Chemballi ducks

Parameter	Mean ± S.E.
Hatch weight (g)	47.46 ± 1.01
Body weight at 4 weeks (g)	505.45 ± 4.35
Body weight at 8 weeks (g)	715.02 ± 5.16
Body weight at 12 weeks (g)	1054.63 ± 10.27
Body weight at 20 weeks (g)	1425.23 ± 12.73
Body weight at 40 weeks (g)	1640.07 ± 13.47
Body weight at 52 weeks (g)	1580.52 ± 14.61
Body weight at 72 weeks (g)	1985.26 ± 15.22
Age at first egg (AFE) in days	142
Body weight at age at first egg (g)	1425.23 ± 12.73
Annual egg production (Nos.)	181.3
Egg weight at 40 weeks (g)	60.1 ± 2.11
Egg weight at 52 weeks (g)	66.3 ± 2.43
Egg weight at 72 weeks (g)	71.6 ± 2.38
Mortality percentage below 8 weeks of age	26.67

The average hatch weight of duckling observed in this study was similar to the earlier report of Mahanta *et al*. (1998) but was higher than the reports of Senani *et al*. (2005). The mean body weights at 4, 8, 12, 20, 40, 52 and 72 weeks of age are presented in Table 1. Ducks attained an average body weight of 1054.63 g at 12 weeks of age; which was lower than the body weight (1370.1 to 1430.2 g) recorded by Mahanta *et al*. (1998) in both sexes of Chara and Chemballi at Kerala under semi intensive system of rearing. Age at first egg (AFE) was 142 days with corresponding body weight of 1425.23 ± 12.75 g. In contrast to the present finding Mahanta *et al*. (1997) noted the AFE of the flock to be 129 days with corresponding average body weight of 1515.5 g under semi intensive system of rearing at Kerala. Senani *et al*. (2005) also found comparatively delayed sexual maturity (145 days) and lower body weight (1408.57 g) with Chara- Chemballi ducks in Andaman and Nicobar Islands. In comparison to local *Pati* and Nageswari ducks of Assam, Chara-Chemballi ducks laid eggs early. *Pati* ducks laid eggs at 240 days of age (Mahanta *et al*., 2001), Nageswari at 188 days with a range of 174-198 days (Zaman *et al*., 2005). Chara-Chemballi ducks laid 181.3 eggs per annum with an average weight of 71.6 g at 72 weeks of age. Annual egg production figures are lower as compared to eggs produced by these ducks in Kerala

(Jalaludeen *et a*l., 2004). As compared to local *Pati* (80 to 90 eggs and 60.5 g) ducks of Assam, the egg number and egg weight of Chara-Chemballi ducks were much higher; due to which there is a shift in the preference of farmers from *Pati* ducks to Chara-Chemballi ducks in the field.

Conclusions

The study revealed suitability and adaptability of Chara-Chemballi ducks in the hot and humid climate of Assam. Though these ducks performed well under the agro-climatic condition of Assam, however their productivity was slightly below as compared to their counterparts in Kerala. These ducks could be reared on large scale to increase duck production under free-range farming conditions.

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GROWTH AND HATCH PERFORMANCE OF GEESE IN HILLY TERRAIN OF NILGIRIS

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Abbreviated title : Growth and hatch performance of geese

Abstract

Literatures on performance of geese under Indian conditions are very limited. The present work was under taken to study the growth and hatch performance of geese maintained at Sheep Breeding Research Station, Sandynallah, The Nilgiris district. The data related to the performance traits recorded in this station for the period from 1997 to 2009 were taken for analysis. Clutch size, hatchability percentage, survivability, average daily gain and growth pattern were worked out. The effect of year, season of birth, age of dam, hatch weight on the above traits were analyzed using Least squares procedure.

The average clutch size from 181 layings was 7.18±0.14. The clutch size ranged from 5.46 to 9.40 over the years and all the effects studied had non significant effect on clutch size except year ($P<0.01$). The mean hatchability percentage was 62.35 ± 1.92 (168). There was no significant variation in hatchability between seasons and year. The mean body weight at hatching was 90.49±0.46 g (711). The year, seasons and age of dam had significant effect on hatch weight. The mean weight at 1stweek, 4thweek, 2ndmonth, 4thmonth and 6thmonth were 163.70±2.10 g (677), 613.82±11.30 g (595), 1.45±0.02 kg (513), 2.68±0.04 kg (282) and 3.00±0.04 kg (200) respectively. There was an initial higher growth rate (ADG) and it reached its maximum at 3-4 weeks of age (31.50±1.11 g) and gradually it was decelerating and reaching the lowest value of 2.41±0.81 g (200) at 6 months.

While the year and season of hatching had significant effect on growth traits up to sixth month of age, the age of dam had significant effect only up to fourth month. The males were generally heavier than females at all stages of growth phase. However, the weight at 4thweek (673.9±20.51 g), 4thmonth (2.90±0.05 kg) and 6thmonth (3.23±0.05 kg) were significantly higher in males than females (617.02±19.59 g; 2.51±0.05 kg and 2.81±0.05 kg). The mean ADG varied from 19.01 g to 22.45 g in various growth phases studied. The highest body weight gain of 22.45 g was recorded during the growth period from 4th week to 2nd month of age. The ADG was significantly affected by year, season, age of the dam and sex in most of the growth phases. Survivability was higher in gosling born during summer (72.30±2.93 %) and was very poor in north east monsoon period. Hatch weight had significant effect on survivability, gosling with higher hatch weight (91.63±0.54 g vs. 85.19±0.88 g) survived better.

Key words: Geese - Clutch size - Hatchability - growth rate - ADG - Survivability

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Introduction

Waterfowls in general have considerably lower reproduction potential than chickens. The number of eggs laid by each goose during one laying cycle is relatively low (Bednarczyk and Rosinski, 1999). However, geese (Janiszewska, 1993), Pekin ducks (Wiederhold and Pingel, 1997; Bochno et al., 2005), and Muscovy ducks (Wilkiewicz-Wawro et al., 2005) grow faster than broiler chickens (Pasternak and Shalev, 1983; Bochno and Brzozowski, 1998) and turkeys (Lewczuk et al., 1994) at early stage of life.

Various factors like age, season (Anan Nakdee, 1999 and Wang et al., 2009) and environment affect the reproductive performance of geese. Similarly the growth rate was also affected by season of birth of gosling, age of the dam (Braun et al., 2002 and Tilki and Inal 2004), egg weight, hatch weight (Cooch et al., 1991) and sex (Sedinger and Flint, 1991 and Spiller et al., 2005) of the gosling. Genetic group of the geese also seems to affect the growth rate. Chinese goose weighs 3.31 kg at 8 weeks of age, whereas, the Italian Legarth gosling is 5.43 kg at the same age (Stevenson, 1985)

Production of water fowls is becoming popular in many countries in recent years. Geese meat accounted for 2.9 % of poultry meat in 2005 (Windhorst, 2006). Based on the data published by the FAOSTAT (2009) goose meat production has changed to a positive trend after 2001. China accounted for the largest part (93.44 %) in the world followed by Hungary 1.94 %, Egypt (1.82 %) and Taiwan (1.01%).

Literatures on performance of geese under Indian conditions are very limited. The present study was undertaken to study the growth and hatch performance of the geese maintained at Sheep Breeding Research Station, Sandynallah, The Nilgiris District, Tamilnadu

Materials and Methods

Data related to the performance traits recorded in this station for the period from 1997 to 2009 were taken for analysis. The data relating to laying (Start and end of laying), brooding, number of eggs laid, number hatched, growth particulars of goslings hatched were taken for analysis. Clutch size, hatchability percentage, survivability and average daily gain and growth pattern were worked out. The effect of year and season of birth of gosling and age of dam on reproductive traits were analyzed. The effect of year, season of birth and hatch weight of gosling and age of dam on body weight and growth (ADG) were analyzed by least squares procedure (Harvey, 1990). The effect of age of dam and hatch weight on survivability was also analyzed.

Location and climate of the Research Station:

Sheep Breeding Research Station, Sandynallah is located at 11°25' latitude N and 76°46' longitude E, about 13 km away from Udhagamandalam in the Nilagiri Hills at an altitude ranging from 2090 to 2235 metres above mean sea level. The annual rainfall ranges from 848 to 3000 mm. The farm experiences a temperate climate with a maximum temperature of 24°C during the hottest days. During winter the night temperature falls to subzero levels. The climate condition prevailing in this area are clearly marked as

Summer (SUM) – Mar-May; North East Monsoon (NEM) – Jun-Aug;
South West Monsoon (SWM) – Sep-Nov and Winter (Win) - Dec-Feb.

Management of geese and gosling

The geese are maintained under semi intensive system of rearing. The goslings are allowed to be with their dam till they are 2 months of age. Concentrate feed was provided adlibitum to the gosling along with cut grasses and they are slowly introduced to pasture and water bodies. Molting of temporary feathers starts around 1½ month and permanent feather appears around 2-2½ months of age. The goslings are categorized as adult once they reach 6 months of age.

Results

Growth and hatch performance of the geese are presented in table 1. The clutch size ranged from 5.46 to 9.40 over the years with a mean clutch size of 7.18 ± 0.14 (181). Only the year had significant effect on clutch size ($P<0.01$). The laying of eggs was on alternate days and on an average the birds are in lay for 12.65 ± 0.28 (181) days. The days in lay were significantly ($P<0.05$) higher during NEM (13.90 ±

0.48) and SUM (13.11 ± 0.50). Average brooding period was 31.30 ± 0.22 (168). The average age at first brooding was 725.43 ± 80.33 days. Average clutch weight was 393.24 ± 15.93 g and was significantly affected by the age of the dam. The hatchability percentage was 62.35 ± 1.92 (168) without any significant variation between the season, years and age of dam.

Average weight at hatching was 90.49±0.40 g. The growth pattern in gosling was in the shape of a sigmoid curve. There was an initial higher growth rate and it reached its maximum at 3-4 weeks of age (31.50±1.11 g) and gradually it was decelerating and reaching the lowest of 2.41±0.81 g (200) at 6 months (Figure 1).

The effect of year, season of birth, age of dam, hatch weight and sex on growth in gosling from hatching to 6 months are presented in tables 3 and 4.Year of hatch had significant effect on all growth traits up to six months of age. Season of birth had significant effect on the body weight and ADG till 4th month and this effect was vanished at 6 months of age. Gosling born during NEM and SUM had higher ADG and weighed more at 4th month.

The males were generally heavier than females at all stages of growth phase. The difference was significant for the weight at 4thweek (673.9±20.51 vs. 617.02±19.59 g), 4thmonth (2.90±0.05 vs. 2.51±0.05 kg) and 6thmonth (3.23±0.05 vs. 2.81±0.05 kg). Similarly the ADG was significantly higher during the period from 4th week to 2nd month (22.45 ± 0.35) and from 2nd month to 4th month (19.22 ± 0.66).

Age of dam had a significant effect on body weight of gosling till 2 months of age. However ADG was significantly affected by the age of the dam till 6 months of age. Hatch weight significantly affected the weight at 4th week ($P<0.01$).

Survivability of the gosling was significantly affected by year and month of hatch. Survivability was higher in gosling born during summer (72.30 ± 2.93 %) and was poor during NEM (56.71 ± 3.00 %) season. Gosling with higher hatch weight (91.63 ± 0.54) survived better than those died (85.19 ± 0.88) before 6 months of age. Similarly the average age of dam of the gosling that survived (2034.90 ± 50.79) was higher than those died (1627.97 ± 41.52).

Table 1. Reproductive and productive characteristics of geese

Character	Values	Period	ADG in grams
Clutch size	7.18 ± 0.14 (181)	Hatching to 1st week	10.49 ± 0.27 (677)
Number hatched	4.43 ± 0.15 (168)	1st week to 2nd week	13.32 ± 0.35 (660)
Hatchability percentage	62.35 ± 1.92 (168)	2nd week to 3rd week	17.13 ± 0.55 (644)
Days in laying	12.65 ± 0.28 (181)	3rd week to 4th week	31.50 ± 1.11 (595)
Days in brooding	31.30 ± 0.22 (168)	4th week to 2nd month	27.05 ± 0.59 (513)
Hatch weight	89.75 ± 0.70g (711)	2nd month to 3rd month	26.55 ± 0.83 (394)
1st week	163.70 ± 2.10g (677)	3rd month to 4th month	13.90 ± 0.70 (282)
2nd week	258.05 ± 3.30g (660)	4th month to 5th month	5.65 ± 0.58 (231)
3rd week	380.55 ± 6.50g (644)	5th month to 6th month	2.41 ± 0.81 (200)
4th week	613.82 ± 11.30g (595)	Hatching to 4th week	18.68 ± 0.41 (595)
2 month	1.45 ± 0.02 kg (513)	Hatching to 2nd month	22.69 ± 0.36 (513)
3rd month	2.24 ± 0.03 kg (394)	2-4month	20.46 ± 0.54 (282)
4th month	2.68 ± 0.04 kg (282)	4-6 month	3.66 ± 0.53 (200)
5th month	2.89 ± 0.04 kg (231)		
6th month	3.00 ± 0.04 kg(200)		

Table 2. Effect of year, season of birth and age of dam on reproductive parameters of geese

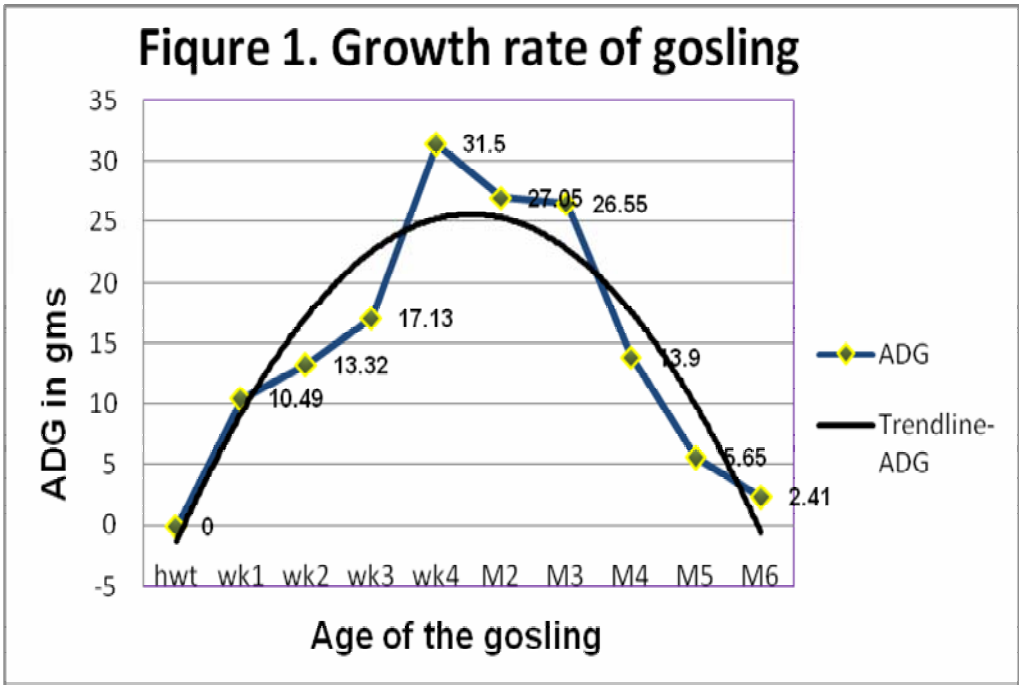
Characters	Clutch size	Days in lay	Clutch weight	Hatchability
Over all	7.19 ± 0.13 (181)	12.71 ± 0.26 (181)	393.24 ± 15.93 (161)	62.35 (168)
Year	**	**	NS	NS
1997	6.06 ± 0.52 (11)	11.40 ± 1.01 (11)		85.80 (7)
1998	5.46 ± 0.40 (19)	9.01 ± 0.78 (19)	418.82 ± 51.77 (15)	70.90 (15)
1999	6.90 ± 0.48 (13)	11.93 ± 0.94 (13)	404.74 ± 63.74 (10)	67.84 (10)
2000	6.23 ± 0.30 (30)	10.59 ± 0.59 (30)	306.74 ± 37.15 (28)	58.41 (28)
2001	7.98 ± 0.38 (21)	14.18 ± 0.74 (21)	458.95 ± 43.86 (21)	67.41 (21)
2002	8.77 ± 0.37 (20)	15.32 ± 0.72 (20)	469.71 ± 41.20 (20)	58.55 (20)
2003	7.55 ± 0.50 (11)	14.63 ± 0.98 (11)	417.47 ± 55.93 (11)	65.32 (11)
2004	7.23 ± 0.49 (12)	12.42 ± 0.95 (12)	426.16 ± 56.91 (12)	64.26 (12)
2005	6.34 ± 0.48 (13)	11.28 ± 0.93 (13)	272.09 ± 54.95 (13)	50.28 (13)
2006	6.49 ± 0.56 (9)	10.97 ± 1.09 (9)	387.71 ± 64.54 (9)	67.90 (9)
2007	7.88 ± 0.53 (10)	13.71 ± 1.04 (10)	361.38 ± 61.32 (10)	51.37 (10)
2008	9.40 ± 0.48 (12)	17.08 ± 0.95 (12)	401.87 ± 58.06 (12)	52.95 (12)
Sea	NS	*	NS	NS
SUM	7.48 ± 0.26 (49)	13.11 ± 0.50 (49)	397.54 ± 28.67 (47)	57.71 (47)
SWM	6.72 ± 0.28 (46)	11.79 ± 0.54 (46)	401.53 ± 33.56 (41)	70.13 (43)
NEM	7.65 ± 0.25 (53)	13.90 ± 0.48 (53)	419.80 ± 30.87 (43)	62.66 (48)
WIN	6.92 ± 0.31 (33)	12.05 ± 0.60 (33)	354.09 ± 35.67 (30)	57.95 (30)
Age of the dam	NS	NS	significant effect P<0.05)	NS

Table 3. Effect of year, season of birth, sex and hatch weight of gosling and age of dam on body weight of gosling from hatching to 6 months

Character	**Hatch weight (grams)**	**4th week (grams)**	**2nd month (kilograms)**	**4month (kilograms)**	**6month (kilograms)**
Over all	**90.49 ± 0.46 (711)**	**613.82 ± 11.30 (595)**	**1.45 ± 0.02 (513)**	**2.68 ± 0.04 (282)**	**3.00 ± 0.04 (200)**
Year	**	**	**	**	**
1998	93.99 ± 1.49 (66)	505.19 ± 36.63 (46)	1.16 ± 0.08 (40)	2.11 ± 0.11 (33)	2.67 ± 0.09 (30)
1999	91.03 ± 1.85 (42)	415.06 ± 39.98 (39)	0.93 ± 0.08 (36)	2.59 ± 0.13 (28)	3.12 ± 0.15 (9)
2000	81.19 ± 1.17 (100)	486.95 ± 28.95 (75)	1.30 ± 0.06 (63)	2.76 ± 0.11 (28)	3.12 ± 0.12 (14)
2001	85.07 ± 1.17 (110)	322.07 ± 27.54 (90)	1.16 ± 0.06 (56)	2.41 ± 0.10 (36)	3.08 ± 0.14 (9)
2002	95.21 ± 1.11 (100)	795.12 ± 24.89 (90)	1.62 ± 0.05 (87)	3.03 ± 0.09 (40)	3.22 ± 0.08 (32)
2003	87.48 ± 1.56 (53)	597.74 ± 34.28 (47)	1.75 ± 0.07 (45)	2.92 ± 0.10 (29)	2.74 ± 0.09 (22)
2004	91.52 ± 1.56 (57)	692.67 ± 33.14 (54)	1.90 ± 0.07 (49)	3.02 ± 0.14 (25)	3.19 ± 0.13 (11)
2005	92.48 ± 1.80 (44)	817.02 ± 39.59 (41)	1.55 ± 0.08 (40)	2.19 ± 0.17 (20)	3.00 ± 0.24 (3)
2006	95.16 ± 1.82 (40)	774.14 ± 39.99 (37)	1.41 ± 0.09 (24)	2.01 ± 0.30 (3)	
2007	95.28 ± 1.83 (41)	711.99 ± 42.53 (33)	1.57± 0.08 (31)	2.59 ± 0.11 (28)	3.05 ± 0.09 (28)
2008	86.92 ± 1.62 (58)	736.33 ± 38.15 (43)	1.48 ± 0.07 (42)	2.96 ± 0.09 (42)	3.02 ± 0.08 (42)
Sea	**	**	**	*	NS
SUM	91.26 ± 0.85 (199)	634.92 ± 18.61 (178)	1.32 ± 0.04 (160)	2.71 ± 0.08 (64)	2.94 ± 0.07 (52)
SWM	91.45 ± 0.93 (196)	674.62 ± 21.70 (164)	1.55 ± 0.04 (133)	2.51 ± 0.07 (80)	2.99 ± 0.07 (40)
NEM	90.19 ± 0.87 (192)	653.10 ± 19.95 (154)	1.52 ± 0.04 (128)	2.72 ± 0.08 (72)	3.16 ± 0.07 (60)
WIN	89.05 ± 1.08 (124)	529.83 ± 25.16 (99)	1.36 ± 0.05 (92)	2.47 ± 0.08 (66)	2.99 ± 0.08 (48)
SEX	NS	*	NS	**	**
Male	91.55 ± 0.87 (186)	673.94 ± 20.51 (186)	1.55 ± 0.04 (185)	2.90 ± 0.05 (126)	3.23 ± 0.05 (99)
Female	90.41 ± 0.84 (204)	617.02 ± 19.59 (204)	1.46 ± 0.03 (201)	2.51 ± 0.05 (133)	2.81 ± 0.05 (101)
Age of the dam	significant effect (P<0.01)	significant effect (P<0.05)	significant effect P<0.05)	significant effect P<0.05)	NS
Hatch weight		significant effect (P<0.01)	NS	NS	NS

Table 4. Effect of year, season of birth, sex and hatch weight of gosling and age of dam on Average daily gain and survivability in gosling from hatching to 6 months

Period	**Hatching to 4th week)**	**4th week 2nd month**	**2nd to 4th month**	**4th to 6th month**	**Survivability**
Over all	**19.01 ± 0.37 (595)**	**22.45 ± 0.35 (513)**	**19.22 ± 0.66 (282)**	**5.60 ± 0.63 (200)**	**65.38 ± 1.59 (711)**
Year	**	**	**	**	**
1998	14.80 ± 1.39 (46)	17.81 ± 1.26 (40)	16.10 ± 1.69 (33)	5.14 ± 1.46 (30)	49.54 ± 5.18 (66)
1999	11.58 ± 1.43 (39)	13.95 ± 1.33 (36)	27.04 ± 2.08 (28)	11.05 ± 2.37 (9)	54.50 ± 6.38 (42)
2000	14.15 ± 1.03 (75)	20.19 ± 1.03 (63)	23.73 ± 1.75 (28)	1.97 ± 1.90 (14)	61.53 ± 4.19 (100)
2001	8.26 ± 0.98 (90)	17.80 ± 1.08 (56)	22.55 ± 1.57 (36)	5.98 ± 2.26 (9)	47.02 ± 4.09 (110)
2002	25.15 ± 0.89 (90)	25.40 ± 0.81 (87)	23.39 ± 1.37 (40)	1.85 ± 1.27(32)	77.14 ± 3.91 (100)
2003	18.10 ± 1.22 (47)	27.67 ± 1.12 (45)	20.32 ± 1.56 (29)	3.22 ± 1.45 (22)	74.06 ± 5.39 (53)
2004	21.49 ± 1.18 (54)	30.13 ± 1.13 (49)	18.08 ± 2.20 (25)	4.05 ± 2.08 (11)	70.64 ± 5.39 (57)
2005	25.93 ± 1.41 (41)	24.37 ± 1.29 (40)	12.20 ± 2.72 (20)	11.46 ± 3.96 (3)	83.17 ± 6.22 (44)
2006	24.40 ± 1.43 (37)	21.90 ± 1.54 (24)	10.06 ± 4.79 (3)	--	77.47 ± 6.33 (40)
2007	22.18 ± 1.52 (33)	24.66 ± 1.40 (31)	14.23 ± 1.74 (28)	7.30 ± 1.42 (28)	58.95 ± 6.39 (41)
2008	23.05 ± 1.36 (43)	23.11 ± 1.24 (42)	23.69 ± 1.50 (42)	4.00 ± 1.24 (42)	65.19 ± 5.60 (58)
Sea	**	**	**	NS	**
SUM	19.43 ± 0.67 (178)	20.51 ± 0.63 (160)	24.36 ± 1.22 (64)	6.15 ± 1.09 (52)	72.30 ± 2.93 (199)
SWM	20.85 ± 0.78 (164)	24.24 ± 0.75 (133)	15.00 ± 1.14 (80)	4.49 ± 1.21 (40)	63.09 ± 3.24 (196)
NEM	20.08 ± 0.71 (154)	23.87 ± 0.72 (128)	19.92 ± 1.22 (72)	6.12 ± 1.10 (60)	56.71 ± 3.00 (192)
WIN	15.68 ± 0.90 (99)	21.20 ± 0.85 (92)	17.59 ± 1.26 (66)	5.65 ± 1.25 (48)	69.43 ± 3.72 (124)
SEX	*	NS	**	NS	
Male	20.80 ± 0.50 (186)	24.32 ± 0.60 (185)	22.25 ± 0.79 (126)	5.91 ± 0.80 (99)	
Female	18.81 ± 0.70 (204)	22.81 ± 0.57 (201)	18.73 ± 0.77 (133)	5.30 ± 0.79 (101)	
Age of the dam	Significant P<0.05)	significant P<0.05)	significant (P<0.01)	significant P<0.05)	NS
Hatch weight	NS	NS	NS	NS	significant P<0.01)



Discussion

In the present study the clutch size ranged from 5.46 to 9.40 over the years with a mean clutch size of 7.18 ± 0.14 (181) which were less than those observed by Whitehead and Tschirne (1990), Sedinger and Flint (1991); Wang et al. (2005) and Wang et al. (2009). However, the clutch size was similar to those observed by Yeh et al. (1999) for White Roman Geese and Spiller et al. (2003) in Turkish geese. Under natural condition the White Roman Geese had a regular breeding season extending from Oct-May (Wang et al., 2009) from Jan-Jun in France (Sauveur, 1982) and Oct-Mar in Israel (Pyrzak et al., 1984). However, the geese reared at this station had no significant variation in eggs laid among the seasons. The average days in lay were significantly ($P<0.05$) higher during NEM (13.90 ± 0.48) and SUM (13.11 ± 0.50), which was extended to clutch size with a non significant increase in clutch size during NEM (7.65 ± 0.25) and SUM (7.48 ± 0.26). Average age at first egg was much longer than those observed by Yeh et al. (1999) and Wang et al. (2005).

Hatchability percentage of 62.35 ± 1.92 per cent observed in this study was higher than those observed by Spiller et al. (2003) in Turkish geese and was lower than Whitehead and Tschirne (1990) and Bednarcyk and Rosinski (1999) (75.8 to 80.9 % in white Italian geese). There was no significant effect of season on hatchability percentage in the present study. However, Anan Nakdee (1999) observed higher hatchability percentage during winter months (Nov-Feb) in Chinese geese in comparison to summer and rainy season. Similarly, Sedinger and Flint (1991) also recorded a significant effect of season on the hatchability percentage in Arctic geese. Age of the dam had no significant effect on hatchability in the present study. Similarly Spiller et al. (2005) observed no difference in hatchability among the dams of different age groups.

Average hatch weight was 90.49±0.40 g and is similar to hatch weight of Turkish geese (Saatci et al., 2005) and higher than Magpie Goose (74.6 g; Whitehead and Tschirne, 1990).

Among all poultry species geese is characterized by the highest initial growth rate (Janiszewska, 1993). The goose in the present study had highest growth at 3-4 weeks of age (31.50±1.11 g) and gradually it was decelerating and reaching the lowest of 2.41±0.81 g at 6 months (Figure 1). Several

authors have observed similar trends in the growth of goslings (Shalev, 1995; Spiller et al., 2003 and Murwska and Bochno, 2008).

Cooch et al. (1991) observed a highly significant positive correlation between the weight at hatch and final adult size. However, in the present study the hatch weight was having a significant effect on body weight till 4th week only and thereafter the effect was non significant.

Tilki and Inal (2004) found that the weight of the egg increased with the age of the geese and it is extended to hatch weight also. Braun et al (2002) also found that the offspring from young breeders grow at a slower rate after hatch when compared to clutches from older breeder goose. Age of the dam had significant effect on body weight till 2 months of age.

Similar to the present study, Ankney (1990) in lesser snow geese and Spiller et al (2003) in Babel Grey Landen geese found that the hatch weight of the gosling from young dam was lower than from older dams.

The male and female goslings were of similar weight at hatching and the sexual dimorphism became expressive at 4 weeks. The sexual dimorphism became expressive at 9 weeks in Landen and Hungarian geese (Spiller et al., 2005) and at 4 weeks in White Koluda geese (Murwska and Bochno, 2008).

The hatch weight had significant effect on survivability of gosling with heavier gosling at hatch (91.63 ± 0.54) survived better than the lighter gosling (85.19 ± 0.88). The hatch weights of gosling were lower in gosling from younger dams than older dams. Similar to our studies, Braun et al. (2002) found the gosling born to young dams grow at slower rate after hatch and had lower body weight gain and higher mortalities than gosling from older dams. Survivability was the least during NEM, which correlated with highest rain fall and cooler conditions recorded at this station during this period.

In conclusion the hatching performance and growth rate of geese in the hilly terrains of Nilgiris are comparable to those found in most other countries. They survive better in this conditions and there is lot of scope for improvement in the all the traits studied with better management practices.

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APPROACHES IN SEXING OF DUCKS
(*Anas platyrhynchos*)

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In the present scenario, duck rearing is gaining importance especially in the coastal areas of India. The preference and demand for the duck eggs resulted in popularising duck rearing among rural farmers in India. Identification of males and females is necessary when selecting birds for breeder flocks and for exhibition. Even in those breeds possessing sex-differentiated plumage colour pattern, both sexes may resemble each other in their summer plumage. In general, identifying the sex of a duck, just like any species of bird, can be quite a hard task. Sex determination being one of the key points in duck breeding, it would be desirable to supply sexed ducklings for commercial purposes to the farmers and also with respect to maintenance of parental lines. Often, people who raise ducks want to know their ducklings' sex right after hatching. Sexing of monomorphic birds is practiced in zoos, breeding centres, safari-parks and game facilities for management and censuses or for research purposes in the wild.There are many ways of identifying ducks as male or female.This article reviews various techniques employed in sex identification of ducks, their advantages, disadvantages and feasibility.

Vent examination:

Vent sexing is a method popularized in 1930s by a Japanese professor, Kiyoshi Masui.Venting a duck or duckling in order to sex is one of the most accurate but the hardest way to determine the sex. Before examining the vent, the ducklings' excretions shall be discharged by lightly pressing on both sides of the abdomen in a downward motion (Purchase, 1978). For sexing, duckling should be held on its back with its head pointing down the examiner's wrist in the right hand and its legs up in the air pointing away. Then the vent should be held by the tail up, and pressing in and up between the duck's legs with the thumb and forefinger of right hand. With very slow, gentle pressure, the vent should be opened. Sex is then determined by visualization of the interior of cloaca. The genitalia in female ducklings have a cone-shaped organ while males have a smaller, longer, pointed organ inside the cloaca. However, the male's organ may not even appear for several seconds after the vent is opened. Hence, the art of vent or cloacal sexing of day-old ducklings is difficult to master.

The advantage of this method is that many ducklings can be sexed by this method**.** However, disadvantage of this method is that non-specialist people who learnt the basic techniques of this method would be doing well to obtain 60-70% accuracy at best, even though specialists could be wrong in identifications (Bramwell, 2003). Additionally, this approach appears to be stressful to chicks causing increase in early chick mortality. It can also lead to microbial cross contamination.

Color / plumage:

This method is suitable in case of Mallard ducks as identification of gender by body color is possible. Male mallards will exhibit bright colors such as greens, purples, blues and a white ring around the neck. Female mallards are a dappled brown, with the exception of the speculum marking. This holds true for many breeds of duck, with the males being brighter in color than the female. This is not useful until the duck is full-grown, as with most methods. A female will have an orange bill, while the male's beak is usually yellow. It should be noted that most Mallard-colored drakes, and some others, undergo an *Eclipse* moult in late summer, after which they are colored, like females adopting a more feminine appearance (Ashton and Ashton, 2007).

Behavioural changes:

This criteria can be useful in revealing gender in case of mallards. The male mallard will be the partner that forages for food, approaches aggressors, and appears to be in charge. The female mallard will hang back from aggressors (nearby humans), or may even stay in one isolated area guarding a nest.

Although domestic ducks (except for Muscovies) are all descended from Mallards *(Anas platyrhynchos),* most of them have been bred so that their bodies are too heavy and wings too small to support flying. Of the mallard-derived breeds, only calls and some of the other bantam ducks can fly. Muscovies also can fly well, especially the females. Male Muscovies can lumber up in the air and flap about a bit (Ashton and Ashton, 2007).

Body size and appearance:

Looking to the size of the ducks to determine their sex can always be a great solution. Some breeds of duck are similar in size no matter what the gender is. In others, it can be of great help. In breeds such as the Mallard or Black East Indie, the drakes are larger than the duck hens. Although young Muscovy drakes are very similar in size and appearance, as they age, males grow larger than females and have more elaborate and bulbous facial masks. By three months or so, the males are nearly twice as large as the females (Dikken and Meulen, 2004; Ashton and Ashton, 2007). While studying sexual size dimorphism

of the musk duck, McCracken *et al.*(2000) found that body mass ratios (male: female) for Musk Ducks area among the highest reported for birds (more than 3:1).

When looking at the ducklings in profile, drakelets are typically going to be longer front to back or bill to tail. The legs could be used as the center point of reference for this. Comparing the length from the leg to the tip of the tail and the length from the leg to the bill on one duckling to that of another duckling, the difference will be noticeable on the different genders. Drakelets also have more pronounced and prominent breasts. They will have a long tail and their 'underline' will be fairly 'flat'. They have thick legs with a wide stance and larger feet. They will also begin to obtain their caruncling sooner. They will not get their flight feathers as soon as ducklets when comparing them to ducklets of the same age. Ducklets on the other hand will remain 'petite' and feminine. They will have round, compact bodies. Their legs are thinner and their feet will be smaller. They won't have the breast that sticks out from their body but will be close to the body.

Voice:

All the Mallard-derived ducks, young ducks will start quacking at around 8 weeks, while the drakes will have a lot of trouble making any noise. The voice of a drake is soft and whispery. They sometimes even have a slight whistle until they reach full maturity. Males will make a "*woorp woorp"* noise, rather quiet. The voice of a female duck is a loud *"Quack-Quack!"* (Coats and Ernst, 2000) slowly decreasing in volume after each quack. Females are far noisier than the drakes. At about 10 weeks of age, the voices of all domestic ducks (except Muscovy ducks) take on easily distinguishable male and female characteristics.

The call of a Muscovy Duck sounds like a trill. Females are more vocal than males, although males are more likely to hiss (often while "wagging" their tail and fluffing up the feathers on their crown). Sex was recognised in the white faced whistling duck based on the frequency of sound produced, those with higher frequency were found to be male and vice versa (Volodin *et al.,* 2009).

Feathers:

As a male duck matures, it acquires a 3 or 4 curled up feathers at the tips of their tails that will

be present even if they have moulted for the summer (Coats and Ernst, 2000). These feathers are called as a drake feathers, and also contain 1 black feather on their back underneath the wings. Usually, a male

will have 3 or 4 curled up feathers at the base of tail. Females will not have the curled tail feathers. There are rare occasions when a hen will sprout a deceptive curly tail feather. This tends to occur when there
are no drakes in the flock. Sometimes one hen will temporarily take on a mock-drake roll. Drakes moult their tail feathers once a year so
looking at the tail feathers of a duck during this time, can temporarily fool into believing seeing a hen-until a new tail feather grows back in anyway. If a flock of Pekin ducks, the females will be missing feathers on the back of neck due to the it's grabbing and holding the back of the neck during mating.

Characters of wing:

The white bar anterior to the speculum extends onto the greater tertial coverts on all female wings but terminates at the proximal edge of the speculum on nearly all male wings. Approximately 2-1/2-3 percent of males show some white edging on their tertial coverts. Adult males can be identified because the white is not continuous with that over the secondaries. Immature males with white over the tertial coverts are difficult to tell from immature females. The white bar is the easiest sex character to use, because of its high degree of reliability and the fact that it is rarely lost when a wing is detached. Vermiculated scapulars are found only on males. Early in the hunting season (September and October) many males possess barred scapulars which are remnants of their summer plumage. Proximal under wing coverts are vermiculated or flecked on adult and most immature males. These feathers are barred on females and on a few immature males (NPWRC website).

DNA Based Techniques:- Random amplified polymorphic dna (rapd): This technique employs in PCR reaction a single and randomly chosen 10-nucleotide primer. Low annealing temperature (35^0-40^0 C) reduces specificity of reaction and hence repeatability of the test. Low annealing temperature enables amplification of wide range of fragments (Williams *et al*., 1990). Markers could be used in sex identification. If the selected RAPD marker is on the W chromosome, it would be amplified only in females and provide a female specific marker (Welsh and Mc Clelland, 1990). However reliability of RAPD markers is questionable. RAPD was developed to study genetic polymorphism. A PCR with single primer amplifies usually 10-20 DNA fragments therefore, RAPD analysis starts with testing a few dozens of primers to detect specificity for females. Despite large number of tested primers, female specific product may not be found. Lessels and Mateman (1998) were unable to identify suitable primer for 3 out of 10 studied species after screening up to 69 different primers per species. RAPD was developed to study genetic polymorphism. Therefore, difference between 2 individuals may be generated by autosomal or Z chromosomal polymorphism. In order to locate marker which is most likely linked to W chromosomes, pooled DNA, i.e. DNA samples from different individuals of same sex should be used. In this way, most of common polymorphism in

population are amplified within each pool, enabling identification of product that are found in female pool. However, their low reproducibility, sensitivity to reaction conditions and/or competition between different DNA fragments cause more weakly amplified bands, which disappear in the presence of bright polymorphic bands. Their technical simplicity and low cost make RAPD markers as an attractive method (Lessells and Mateman, 1998). Since the length of primers determines the length of target size, when it's length decreases, primers could encounter a great number of target sites and increase the chance of amplifying a sex specific locus (Griffiths and Tiwari, 1993). Random primers were used for RAPD fingerprinting in Chinese, White Roman and Landaise geese to detect female specific DNA sequences (Huang *et al*., 2006). They found that one of the primers used in this study produced a 938-bp sex-specific fragment in all females and in no males of Chinese geese only. Also data showed that a simple and effective PCR-based sexing technique could be used in the three goose breeds studied.

Microsatellite:

Microsatellites are the short tandem repeats (STRs) of two, three, or four base pairs long that are short regions in the genome. Nesje and Røed (2000) reported microsatellite loci NVHfp 102 and fp 49 for sex identification in peregrine, gyrfalcon, merlin, kestrel, and hobby. Amplification of locus NVH fp 102 and locus NVH fp49 easily identifies female falcons and peregrines respectively. But the results must be evaluated carefully, since there is a possibility that some females could be classified as males as a result of failure of the PCR reaction. This problem will be avoided in the gyrfalcon, merlin and kestrel, if a radioactively-labelled primer and electrophoresis on acrylamide gel is used for locus NVH fp49 (Nesje and Røed, 2000). Further, nuclear microsatellite amplification using DNA extracted from museum feathers was reported by Ellegren (1991). However, it was demonstrated by Mills *et al.* (2000) that various errors can occur as results of microsatellite genotyping from highly fragmented DNA and template DNA in low concentration. Using microsatellites, genetic structure of Pekin and Moscovy duck populations were studied (Ahmadi *et al.,* 2007).

Minisatellite:

Minisatellites are otherwise called variable number of tandem repeats (VNTRs) contain a number of tandem repeat sequences and their numbers differ between minisatellite alleles. The repeat size is about five to a few tens of base pairs long and there are ten to thousands of tandem copies in a particular allele (Russel, 2002). The human minisatellite probe 33.15 was used for sex identification in 33 species belonging to 13 genera of South American parrots by Miyaki *et al.* (1997). Probe 33.15 was invaluable for sexing macaws and conures. This method could not be used to sex the short-tailed and long wide-tailed parrot species. Graves *et al.* (1993) have determined sex specific bands by Probe 33.6. RAPD and minisatellite methods were criticized by Lessells and Mateman (1998) for being species-specific and their laborious and time-consuming protocol. Lambert (1993) successfully amplified polymorphic regions which provided appropriate nuclear DNA markers useful in the study of hybridisation between mallard and grey ducks in New Zealand**.** Huang *et al.*(2006) prepared genetic and cytogenetic map which was helpful for the mapping QTL in duck for breeding applications and for conducting genomic comparisons between chicken and ducks using minisatellites.

Amplified fragment length polymorphism (aflp):

Amplified Fragment Length Polymorphism combines PCR with digesting DNA and restriction enzymes. Single reaction results in 100s of DNA fragments. The first step of the AFLP technique includes DNA digestion with 2 different restriction endonucleases: a 4-base cutter and a 6-base cutter. The next step is ligation, during which oligonucleotide adaptors (20-30 bp) attach to 'cohesive ends' produced by endonucleases. This step is followed by a pre selective amplification with selected primers complementary to an adaptor and a single specific nucleotide in the original fragment sequence. This reduces the pool of fragments from the original mixture. The last step of AFLP includes a selective amplification with the same primers, but usually with a 3-nucleotide extension. The products are displayed on polyacrylamide gels. Similar to RAPD, the identification of sex-specific markers is difficult because of the high polymorphism of DNA sequences. However, unlike in RAPD, the use of pooled DNA samples to detect female-specific fragments is not recommended, because the PCR products may not always reflect each of the individual samples in the pooled DNA. Therefore, sex-specific markers should be detected by surveying the primers in 3 males and 3 females individually (Griffiths and Orr, 1999). This method has been used by Griffiths and Orr (1999) in ostrich (*Struthio camelus*) and shag (*Phalacrocorax aristotelis*) to sex identification. The limitations of the technique includes requirement of acrylamide gels, radioactive markers or high-pressure liquid chromatography (HPLC) purified primers, the safety requirements, high cost and preparation time (Griffiths and Orr, 1999).

In both RAPD and AFLP, it is advisable to select a positive control: a band of lower intensity on a gel than a W-linked fragment (Griffiths, 2000). The positive control is necessary to exclude the possibility of incorrect sexing. Such a possibility may arise when non-optimal PCR reaction results in invisible W-linked marker, consequently leading to identification of females as males. A male specific DNA profile can be identified only if a positive control is present and a female-specific sequence is absent on a gel. W-linked sequences located by RAPD and AFLP may also be used to design the primers that are subsequently used in a standard PCR (sequence characterized amplified region, SCAR). Application of such primers would clearly simplify the whole procedure of sex identification and is costlier in comparison with the AFLP technique. However,

PCR results in this case yields one band in females and none in males, emphasizing the need for a positive control. This is achieved by selecting the primers amplifying the DNA fragment in both males and females, which may be successfully applied together with the primer pair targeted at a W-linked sequence in a multiplex PCR. Control primers should amplify a DNA fragment larger and of lower intensity than the sex-specific fragment. The primers designed on the basis of the W-specific sequence detected by AFLP, have been successfully used to separate males from females in the ostrich. This species as well as other ratites cannot be sexed by CHD-based PCR due to undifferentiated sex chromosomes (Griffiths and Orr, 1999). Further, Huang *et al.,*2009 used Amplified fragment length polymorphism (AFLP) with multicolored fluorescent molecular markers to analyze duck (*Anas platyrhynchos*) genomic DNA and to construct the first AFLP genetic linkage map no reference of its use in sexing studies of ducks was found.

Chromo-helicase dna-binding gene (chd) based sex identification:

CHD-W gene was discovered by Griffiths and Tiwari (1995). Griffiths and Korn (1997**)** discovered CHD-Z located on Z chromosomes. Since, intron size of CHD-W and CHD-Z genes are identical in Ostrich and Emu (ratites) both female and male exhibit single band by 1237L-1237H and P2 -P8 (Kahn *et al*., 1998) primer pairs.

CHD-Z and CHD-W genes evolve independently. It is now known that CHD1-Z and CHD1-W protein structures are very similar to each other in terms of their amino acid sequences. There are very few differences between CHD1-Z and CHD1-W proteins (Fridolfsson and Ellegren, 1999). Helicase domain of the CHD gene is highly conserved. Molecular evolutions of CHD-Z and CHD-W genes are affected in different ways by their genomic location (Fridolfsson and Ellegren, 1999). In most avian species the length of the CHD gene is slightly longer in the W chromosome as compared to the Z due to the presence of additional DNA bases in intron region.

The evolution of these genes dates from the time that the sex chromosomes were autosomes and each gene would have a duplicate gene on its autosomal partner. The CHD1-Z gene was conserved and would also be amplified by the PCR primers to CHD1-W. It would have ruined the sexing test, as it would provide a PCR product of identical size to CHD1-W and appear in both females (WZ) and males (ZZ). This apparent disaster could, however, be put to good use if the introns were exploited. One problem that did exist was that if a PCR was designed to only amplify CHD1-W, a female would yield a single band and a male would provide nothing. The lack of a band could also mean that the PCR reaction had failed and could easily result in wrong sexing. If the test was used to amplify both genes, the CHD1-Z band would appear in all individuals and show that the test had worked, leaving the CHD1-W band to indicate sex. Because of the similarity of CHD1-W and CHD1-Z, this provided a problem, but the universal sex identification test now exploits the fast evolving introns for discrimination. It uses the exons as targets for the primers, but these allow amplification across the introns that differ in size. As a result, this gives females two bands, whereas the male has one. CHD gene based approach was adopted by Volodin *et al.,* 2009 for reliable sexing in four whistling duck species and compared it with molecular and cloacal inspection techniques. In this study, acoustic-based sexing showed 100% accordance to the

DNA-PCR analysis, while the cloacal inspection showed only 89.8% accuracy. For accomplishing molecular sexing authors used P2/P8 set of primers and found two bands in case of females and one for males. Further, Itoh *et al*., 2001 used the the W- and Z-linked EE0.6 sequences, cloned from 12 different species, and successfully sexed Domestic duck. Chiba *et al*., 2002 sexed Pintail *Anas acuta* using the primer sequences used by Itoh *et al.*, 2001 and found only one band of 250 bp in case of males, whereas in females, W specific band at 190 bp with additional Z specific band was observed. Recently, Murhty *et al.,* 2009 determined the sex in Khaki Campbell ducks by PCR using primers 2550F /2718R, where in, there was a single bright band of 600 bp in the case males as compared to 500 bp in females. Except 25550F/2718R primer pairs, all the primers resulted in two bands for females, even though it is possible to determine sex using this primer pair by matching the amplified fragments against DNA ladder. Similarly, in the other studies on the members of anatidae, primer set P2/P8 (Griffiths *et al.*, 1998), 2550F/2718R (Ong and Vellayan, 2008) and 1237L/1272H (Kahn *et al*., 1998) targeting CHD gene, were commonly employed for molecular determination of sex.

In conclusion, sex determination is one of the key points in duck breeding. Conventional determination of sexing on the basis of external morphology is difficult due to sexual monomorphism. Other conventional approaches based on color, behaviour, size /appearance, voice, feathers, wing characters can be employed with some compromise, subject to the availability of the expertise. Recently, developed PCR based molecular tools and its versions have become popular due to high accuracy. However, these advanced tools are yet to be adopted in large scale for accurate sexing of ducks at the field level.

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ORIGIN AND DOMESTICATION OF DUCK

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Ducks (*Anas platyrynchos*) occupy an important place next to chicken production in India. Most of the ducks reared in India are indigenous or non – descript types, which are hardy, with mediocre egg production and highly suitable for extensive system of rearing. Domestication of Duck occurred during the New Stone age between 4000 and 10,000 years ago. Ducks were reared to satisfy the preference of high officials and feudal landlords and served roast duck during the Ming dynasty. Domestic ducks derived from the wild Mallard duck. Muscovy (*Cairina moschata*), a native Duck of South America, not derived from the Mallard. Muscovy duck originally domesticated by Colombian and Peruvian Indians and introduced to Europe by Spanish and Portuguese in the 16th century. Campbell ducks were developed in England by Mrs. Campbell during the beginning of the 19th century by crossing Rouen with Indian Runner and later with Wild mallards. The Indian Runner ducks derives its name from its place of introduction – East India. Pekin ducks originated in China and White pekin is the most popular duck. Aylesbury duck is native of England. Rouen ducks originated in France. The Rouen duck formed the basis for developing Campbell ducks. Hybrid ducks includes Cherry valley (meat and egg type), Hytop (Mule duck) and Legarth (meat type) and ornamental type includes buff Orpington, Mandarin and crested white. In India, Ducks are mostly concentrated in the Eastern and Southern States of the country mainly coastal region. Central Duck Breeding Farm was established in the year 1981 with technical collaboration of Government of United Kingdom in order to introduce high yielding varieties of ducks. Government of India imported the meat variety Vigova Super – M from Vietnam under bilateral program between Government of India and Vietnam during the year 1996. Indigenous breeds reared in India are as follows: Sythetmet, Nageswari ducks of North Eastern states, Kuttanad ducks of kerala (Chara and Chemballi) and Aarani ducks of Tamil Nadu.

Key Word: Duck , origin, Domestication

Introduction

Duck farming in India is characterized by nomadic, extensive, seasonal, and is still held in the hands of small and marginal farmers. India has 24 breeds and 34 varieties of local ducks. While there are several small sedentary groups of breeders, nomadic duck herders keep moving their herds in a cyclic fashion from one region to another, depending on the amount of feed available, on rainfall and cropping patterns.

The distribution and demographic dynamics of duck population revealed that they are concentrated in Eastern, North eastern and Southern states of the country. Traditionally West Bengal and Kerala are the major consumer states for duck egg and meat and one of the reasons is that duck egg and meat highly suits and remains tastier for their fish based culinary preparations. The leading states in duck population are West Bengal, Assam, Kerala, Andhra Pradesh, Tamil Nadu, Bihar and Orissa.

In India, 90-95 percent of ducks and indigenous or non-descript types, which are hardy, with mediocre egg production and highly suitable for extensive system of rearing. The important Indian breeds are Sythet mete and Nageswari of eastern region, Aarani ducks of Tamil Nadu, Chara and Chemballi of Kerala, desi breeds of West Bengal and other states. Apart from these, distinct local varieties have also been identified. Pati, Deo, Cinahanh and Raj Hanh are local indigenous breeds found in Assam.

Among improved varieties distinct breeds for egg and meat production is available. Khaki Campbell and Indian Runner are the most popular breeds for egg laying. White Pekin, Muscovy and

Aylesbury are known for meat production. High-laying strains of ducks are available at the Central Duck Breeding Farm, Hessarghatta, and Bangalore.

DOMESTICATION OF DUCK

- Pottery ducks excavated in the Yan –Shi-Menkou Mountains in Fu Jian in Southern China provide evidence that domestication of duck occurred during the New Stone Age between 4000 and 10,000 years ago (Wucheng, 1988).

Clay models unearthed in Shanxian country, central Henan province suggests that ducks were domesticated during the Yangshao culture about 4000 years ago (Jianhua, 1984). According to Clayton (1984), ducks were domesticated in China at least 3000 years ago.

- Roasted ducks were served to satisfy the high officials and feudal landlords (Jung and Zhou, 1980). Peng (1984) describes that ducks were utilized to control locusts, leafhopper and rice shield bug in Zhujiang river rice paddies.
- The archaeological evidence along with a favorable environment and agriculture suggest that ducks were probably domesticated in Southern China at last 1500 years before they were separately domesticated in Western Europe. The present day domestic ducks derives from the characteristically green-headed wild mallard *(Anas platyrhynchos)*.
- In 18th century, Australian aboriginal captured the duck by swimming under water, breathing with the aid of read tubes (Flood, 1996). They collected duck eggs during the breeding season and trapped adult ducks where they molted and became temporarily flightless following the summer solstice.
- More than 3000 years ago migratory water fowl were hunted and trapped with nets in the swamplands of the Nile delta.
- During the period of Roman Empire, ducks were used in festival season. It was well supported by painting, mosaics and archaeological evidence and duck bones excavated from middens of Roman Empire. Primary feathers and down were used insulation in clothing and bedding.
- Duck were not domesticated in Western Europe much before the middle Ages (Delacour, 1956). Pictures of domestic duck appear in the 17th century and a painting in the National gallery in London by Jon Steen (1660) entitled 'The Poultry-yard' included white feathered domestic ducks.

Mallard Duck (*Anas Platrhynchos*) : Progenitor to Domestic Duck

Mallard ducks have been classified as fallows.

Order : *Anseriformes*
Sub order : *Anseres*
Family : *Anatidae*
Sub family : *Anatinae*

Mallard ducks are dabbling or surface feeding ducks, genus and species *Anas platyrtynchos* and seven sub species are listed below

A. p.platyrhynchos - Common mallard
A. p. conboschas - *Greenland mallard*
A. p. fulvigula - *Florida mallard*
A.p. maculosa - *Mottled mallard*
A. p. diazi - *Mexican mallard*
A. p. wyvilliana - *Hawaiian mallard*
A. p. laysanensis - *Laysan mallard*

The common mallard is probably the sole progenitor of the domestic form. There are two closely related species that are sometimes grouped with *A. platyrhynchos* under the general term mallards (Delacour, 1956). These are *A.rubripes* (American black duck) of eastern North America and *A. poecilorhyncha* (grey or spot-billed duck) of India, South East Asia and Australia.

Common mallards have an extremely wide distribution in the Northern Hemisphere (Johnsgard, 1978). In Europe and Asia the breeding range extends from about the Arctic Circle and sometimes beyond. They have a similarly extensive range in North Amercia, except for the eastern Arctic, Quebec, the Atlantic Provinces and New England. Other subspecies of mallard have very limited distribution. Common mallards have been introduced successfully in eastern North America, Bermuda, Australia, and New Zealand (Long, 1981).

Watson (1969) indicated that the possibility of even earlier domestication in describing the finding of pottery models of ducks and geese at Lung Shan site in Hupei (about 2500 B.C) in company with models of sheep, dogs, turtles, and fish. Zeuner (1963) has speculated that duck domestication may also have occurred in Mesopotamia from Sumerian times (beginning 2800 B.C.) into the Assyrian period (900-600 B.C.)

There is no indication that ducks were kept as domestic birds in ancient Egypt (Zeuner, 1963). According to Harper (1972), translations of Egyptian papyri confirm that geese, chickens, and pigeons were being raised from the fifth century B.C. to the seventh century A.D., but ducks were seldom mentioned and any reference probably was to wild fowl. According to the early writers the Greeks and Romans kept ducks, but indications are that the birds were wild and had to be confined within netting enclosures (Harper, 1972).

Darwin (1883) and Delacour (1956) consider that the domestic duck derives from the characteristically green-headed wild mallard, *Anas Platyrhynchos*, Which is widely distributed over the northern hemisphere. Mallard are included among dabbling ducks or surface feeders is the *tribe Anatina,* subfamily *Anatinae of the Anatidae*, which includes most wildfowl. He described the downward curving bill of the hook-billed duck, in 1676 and originating in China as extraordinary.

History and Domestication of Muscovy Duck

The Muscovy duck was domesticated in pre-Columbian times from the wild muscovy *cairina moschata.*

Order : *Anseriformes*
Sub order : *Anseres*
Family : *Anatidae*
Sub farmily : *Anatinae, tribe Cairini, Genus and species: Cairina moschata.* There are no recognized subspecies.

The Muscovy, Brazillan or Barbary duck is popular in Australia where work has been done to improve its table qualities. It is generally accepted that muscovies were domesticated in the South Americas during pre-Columbian times, but there is little information to indicate where and how many centuries before the Spanish Conquest is had occurred. According to Delacour (1964), the Spanish Conquistadores found domesticated muscovy ducks, including color variants, on the northern coast of Columbia and in Peru. Pillips (1922), citing De Armas (1893), identified the Colombian location as Cartagena, the capital of the state of Bolivar, where according to Oviedo domesticated muscovies were being kept by the Indians in 1514.

There is still doubt as to whether it should be classed as a duck or a goose. It grazes like a goose and the males have no curled feathers in the tail, which distinguish the sex in other domesticated breeds of duck. These are no feathers on the face, but the skin is bright red, whilst the drake has a knob on the head which gives the appearance of a crest. Neither sex has a voice and their sole means of communication is by hissing.

The incubation period is 35 days. If a Muscovy is mated to another breed the progeny will be sterile called Mule ducks having high growth rate and lean meat and meant for meat purpose.Muscovy

ducks have been known by a great variety of names. Brown (1929) listed some of them - Brazilian, Peruvian, Guinea, musk, Muscovite, Turkish, Barbary. He believed that the word Muscovy is a corruption of musk duck, so named because of the peculiar odour emitted by old birds. That odour was frequently mentioned by early writers, but it is not known to moderns.

There are seven varieties: The most popular one is white winged black; white winged blue; black; white; black-and white; blue and white; pure white. The bill is yellow and black with some red shading lighter towards the tip. The legs are yellow rather than orange.

The ducklings usually take not less than 16 weeks to mature; in many instances much longer. The flesh is dark and has rather a gamey flavour. A feature of this breed is that the male is about twice the size
of the female. Adult drakes usually weigh between 4-5kg and 6.4kg and ducks between 2.2 and 3.1kg. The eggs are white.

There are 2 standard varieties of Muscovy ducks, the white and the dark. The head and face of the Muscovy are partly bare, with red, rough, carunculated skin. It has a long, broad body, with greater breadth. The white variety has pure white plumage, pale orange or yellow legs, and a pinkish, flesh coloured beak. The dark variety has got a lustrous blue black, broken with some white breast, body and back. Muscovy has sharp claws.

Egg laying breeds

Although some breeds a duck, notably the khaki Campbell and Indian Runner, are efficient egg producers, only a few flocks of laying ducks are kept in this country because of the modern preference for hens eggs. This is probably due to the stronger flavour of duck eggs and the hazard from Salmonella infections associated with them. Thus ducks are kept almost entirely for meat production. Formerly the egg laying varieties consisted of the Khaki Campbell, White Campbell, Dark Campbell, Indian Runner and Buff Orpington, and of these breeds, only the Khaki Campbell has survived in appreciable numbers as an economic egg producer while others may appear as exhibition varieties.

Campbell

The Campbell was evolved by Mrs. A Campbell and introduced in 1901as the result of crossing strains of Fawn and White runner, Mallard and Rouen. It was intended solely as a high egg producing breed. The plumage of the original duck was the color of withered grass while the drake followed the coloring the Mallard male but was rather lighter and had no white collar.

From the Campbell, the Khaki Campbell was evolved. It is a variety of the Campbell resulting directly from color selection of the original Campbell. The female is a warm khaki throughout with head, neck and wings a slightly darker shade of khaki. The rest of the body has each feather narrowly laced with a slightly lighter shade of khaki which, on close examination, is seen to form a pattern. The drake's head, neck, stern and wing-bar plumage is a lustrous green-bronze, the remainder an ever shade of warm khaki. The legs and feet the original duck were an orange-brown, but today the khaki's legs and feet should be near to body-color as possible. The legs and feet of the drake are orange.

The khaki Campbell became increasingly popular during the first half of this century, particularly during the 1920s and 1930s, as successful breeders raised potential egg production considerable. Indeed, very high performance has been achieved. Individual production records of almost an egg a day for well over 12 months have not been uncommon and flocks have averaged in excess of 300 eggs per annum. Standard weights for this breed are: drakes 2.2 -2.4 kg, duck (when in lay) 2.0-2.2 kg. In Asia the breed is used for improving the productivity of local breeds.

Indian Runner

The Indian Runner or Runner ducks derives its name its place of introduction, East India. It is having perpendicular carriage which is the outstanding feature of this breed. It does not have pronounced

shoulders and the body shape and carriage resemble the penguins. There are 3 standard varieties of Runner ducks. Indian Runner is also layer having an average record of more than 250 eggs per annum and is second only to Khaki Campbell.

The Fawn and White Runner:

The breed is fawn or grey and white, with a white neck and a line of white running up to the eyes and extending around the bill. The back and shoulders are fawn, the upper part of the breast and wings are fawn, but the lower part is white. The breast is full; the body is long and narrow, sloping gradually into the neck, and is carried erect, with no indication of a keel, the body resembling somewhat that of a penguin in shape. The shanks and toes are orange red. The bill of the young drake is yellow, later
becoming greenish yellow, while a young duck has a yellow bill spotted with green, which later becomes a dull green.

The White Runner:

It is pure white in all sections. The bill is yellow and the shanks and toes are orange.

The Pencilled Varaity:

The head of the male is a dull bronze-green and white and the back has a soft, fawn ground, finely stippled with a slightly darker shade of fawn; the body and the upper section of the breast are medium fawn and the tail is a dull bronze-green. The head of the female is a medium fawn and white, while the white markings in the plumage resemble those of the male. The coloured markings are a medium fawn throughout, with a light line of fawn colour running round the edge of each feather, the border being a darker shade.

Meat type ducks

Though duck meat is widely accepted among the non-vegetarians but still it is not popular due to its non-availability. In comparison to hen, duck meat is slightly rich in fat (14.5 per cent) total energy (190 Kcal/100 gm). The protein content is very close to hen and averages to about 13 per cent. White Pekin is the most popular meat-type duck in the world. Muscovy and Aylesbury are the next best types.

Pekin

The Pekin originated in China where breeding has apparently been carried out for many centuries. In 1873 a flock of these birds was imported to Connecticut, USA, Where the breed soon gained wide popularity. Since then the breed has served as a basis for table duck production in America. These are no positive evidence to show whether they came to England via America or direct from China. The Pekin tends to be smaller than the Aylesbury. The Peking duck grows quicker than the Muscovy duck. it is generally a better layer and more fertile, Plumage is creamy-white, the flesh yellow and bill and legs deep orange. It is well fleshed, matures quite quickly and is now considered to be as good as the Aylesbury, with which it is sometimes crossed. One of the characteristics, which indicate that the pekin duck is good for meat production, is that it can reach a weight of 3 kg by the age of 7-9 weeks. Drakes usually attain a maximum weight of 3.5- 4 kg and females 3-3.5 kg. Peking duck meat is quite fatty, unlike that of the Muscovy duck. Peking ducks lay eggs from an age of 5-6 months and can lay more than 200 eggs a year. There are two clear laying periods with a break of 12 weeks; the first lasts 30 weeks and the second 22 weeks, which makes than valuable for the small-scale farmers. Egg is white although odd birds lay pale blue or green eggs. Egg production in excess of 200 in 40 weeks has been obtained with hatchability in excess of 80 percent. It is a quiet breed that tends to walk rather than fly. Incidence of brooding behaviour is rare.

Aylesbury

White duck been known for centuries in many countries and as white- feathered duck sometimes appear as sports from darker-colored breeds, it is thought that this may have been the origin of the Aylesbury. Its present characteristics have been established by domestication and selective breeding, and it was named during the early 19th century, when large-scale duck breeding was widely carried out in the vale of Aylesbury in Buckingham-shire, England. Plumage of both sexes is white, the legs and feet bright orange, the bill of the utility Aylesbury is often yellow and differs in shape from the exhibition bird, whose bill a pinky-white or flesh colored. The standard weight for adult drakes is 4.5 kg and for ducks 4.0 kg.

Rouen ducks

These birds originated from France. Once upon a time, this formed the basis (male line) for developing Campbell ducks. It is heavy breed; Good layer. Male duck is light grey with a green neck and the female is light brown like mallards.

White ducks

These are mainly through the crossing of White pekins and Aylesbury ducks.

Ornamental type

Buff Orpington, Mandarin, Call, Black East India, Crested white etc. are ornamental type used for fancy purpose.

Hybrid Ducks

Cherry valley (Meat type and Egg type,) Hytop (Mule duck), Legarth (Meat-type)

Indigenous breeds

Nageswari

. Nageswari ducks are also called "Nagi", the snake deity, may be due to its head-high snake like posture with a white stripe in the neck extending up to the breast and for the eggs which have a bluish tinge. The Nagis are also called White Breasted Nageswari.

Chara

Drakes are squat in posture. Head is lustrous greenish black and neck is brownish black plumage with full or half white band on the front. Bill and feet are orange. Body weight at 20 weeks is 1.6 kg. Head and breast are brownish black and back and tail is brownish black. Bill is yellowish black and feet are orange. Body weight at 20 weeks is 1.5 kg.

Chembally

Drakes are squat in posture and gait. Head is dull greenish black, neck is brown with full or half white bands and back is brownish black. Bill is yellow with black spot and feet is bright orange. Body weight at 20 weeks is 1.6 kg. Duck are erect in gait and squat in posture. Head is primarily brownish black, neck is brown with or without white bands and back is brownish grey. Breast is light brown or brownish black. Body weight at 20 weeks is 1.5 kg.

A sort of broiler type of ducks is reared at Kolluru lake area of Andhra Pradesh; specially for meat. They are similar to broiler chicken, but these are marketed at the age of about 6-8 months. The meat of such ducks is said to be more tasty besides, being more nutritive.

Conclusion

With the available Bio-technological tools, duck egg and meat production can be increased to meet out the food demand.

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GENETIC COMPARISON BETWEEN INDIAN RUNNER AND MOTI NATIVE DUCK BREEDS USING MICROSATELLITE MARKERS

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Genetic architecture provides information about conservation and exploitation of a breed/ species. Molecular markers are excellent tools for such analysis. In this study, microsatellite markers were used to analyze genetic structure of two native duck breeds, Moti and Indian Runner, of Orissa. Genomic DNA samples from 30 birds, maintained at Institute's Regional centre were analyzed using nine microsatellite markers. Having checked the PCR products on Agarose, microsatellite alleles were identified on 8% denaturing Polyacrylamide gel. Allelic data were analyzed using POPGENE population genetic analysis software (ver 1.32). Out of 9 loci, CAUD027 and CAUD030 demonstrated monomorphic pattern in Indian Runner, but polymorphic in Moti ducks. None of the microsatellite loci revealed Hardy-Weinberg equilibrium in Moti while some loci were in H-W equilibrium in Indian Runner. Number of alleles at polymorphic loci varied from 2 to 5 and from 2 to 4 in Moti and Indian Runner ducks, respectively. Average observed and effective allele numbers at different loci were 3.22 and 2.27 in Moti and 2.78 and 2.07 in Indian Runner ducks. Effective number of alleles was less than the observed number of alleles in both of the populations. Thus, more genetic diversity was found in Moti than Indian Runner native ducks. Average expected heterozygosity (0.53) was more than observed heterozygosity (0.34) in Moti, which points to deficiency of heterozygotes. Contrastingly, in Indian Runner, observed heterozygosity (0.47) was more than expected heterozygosity (0.44). Nei's genetic identity and genetic distance estimates between Moti and Indian Runner ducks were 0.15 and 0.9, respectively. F_{IS} value averaged 0.13, although three out of nine loci showed negative values. Most of the loci in Moti population showed more F_{IS} value than Indian Runner ducks indicating more inbreeding like effect in Moti ducks, which might be due to nonrandom mating in Moti ducks. Except for three loci, migration rate was less than one that indicated less migration between populations, hence, an equilibrium based on the rate of mutation, migration, and genetic drift might have been established. The findings may be useful in characterization of genetic diversity, which is a prerequisite in developing strategies for conservation and utilization of duck genetic resources.

Key Words: Duck, Moti, Indian Runner, microsatellite, PIC, Heterozygosity

Introduction

Duck is considered as an alternate to chicken for supply of animal protein in India. It is mostly reared in coastal regions. In order to exploit the genetic potential of native duck breeds, their genetic characterization is a pre-requisite. DNA based markers, particularly; microsatellites are the marker of choice for such studies and are also recommended by FAO (FAO, 2007). Microsatellites or simple sequence repeats (SSR) or short tandem repeats (STR) are tandem repeated motifs of 1–6 bases found in both coding and non-coding regions in prokaryotic and in all eukaryotic genomes. Lot many breeds have been characterized with the help of a number of micro satellite markers in different parts of the country/ world. Microsatellite loci are found in large numbers, relatively evenly spaced throughout the genome and most of these loci are selectively neutral which makes them compatible with the assumptions of most population genetic theories. Hyper variability, co-dominant nature, uniform and pervasive nature in

genome, easiness of detection and reliability, and possibility of analysis of large numbers simultaneously makes it more popular than the minisatellites. Reports on the genetic characterization of ducks using microsatellite markers are scanty in the literature and are slowly accumulating in recent years (Maak et al., 2003; Stai and Hughes. 2003; Slavenaite et al., 2004; Huang et al., 2005; Fuentes et al., 2005; Zhao et al., 2005; Hsiao et al., 2006; Li et al., 2006; Khan Ahmedi et al., 2007; Sruoga et al., 2007; Wu et al., 2008). Therefore, present investigation was carried out to study genetic comparison between two duck breeds viz; Moti and Indian Runner native ducks. Indian Runner is a well recognized duck breed (Country Report India) and Moti is a duck breed from Orissa (Mohapatra, *et al.,* 2006).

Materials and methods

Thirty random bred birds from each Moti and Indian Runner native duck breeds, maintained at CARI regional station Bhubaneshwar (Orissa, India), were randomly chosen and their genomic DNA were isolated using Phenol extraction method (Kagami *et al*., 1990). DNA of good quality (having intact

bands without smearing on gel) and satisfactory purity were used for further analysis. They were subjected to microsatellite analysis with 9 duck specific microsatellite as reported by Huang *et al*., 2005. Primer characteristics are presented in Table 1. Microsatellite analysis was performed in a total volume of 25 µl containing 50 ng of genomic DNA, 10 picomoles of each of the reverse and forwards primers, 200 µM of each of the dNTPs, 2.5 µl of 10 X PCR reaction buffer, 1.5 mM $MgCl_2$ and 1U of Taq DNA polymerase. Amplification was carried out in a programmable thermal cycler (PTC-200, MJ Research, USA) with programme as heat inactivation at 94ºC for 5 min followed by 30 cycles of denaturation at 94ºC for 1 min, annealing (optimized for each microsatellite primer pair) for 1 min, extension at 72ºC for 1 min and a final extension at 72ºC for 5 min. PCR products were run on an 8-10% denaturing poly acrylamide Gel and photographed after silver staining. Molecular sizes of the amplified products were estimated with the help of Quantity one software of Biorad, USA through Gel Doc 2000.

Microsatellite allelic data were subjected to statistical analysis like Hardy-Weinberg equilibrium, Average observed and effective allele numbers, Effective number of alleles, Average expected heterozygosity and observed heterozygosity, Fis , Nei's genetic identity and genetic distance etc using POPGENE population genetic analysis software (ver 1.32).

Results and Discussion

Gene diversity and allele frequencies

The total number of alleles in 9 microsatellite loci of 2 populations was 48. Out of 9 loci, CAUD027 and CAUD030 demonstrated monomorphic pattern in Indian Runner, but polymorphic in Moti ducks. Number of alleles at polymorphic loci varied from 2 to 5 and from 2 to 4 in Moti and Indian Runner duck, respectively. . Average observed and effective allele numbers at different loci were 3.22 in Moti and 2.78 in Indian Runner ducks, respectively. Allelic size ranges has given in table 2.

Polymorphic Information Content

The PIC was a good index for genetic diversity evaluation. Bostein *et al*. (1980) first pointed out that PIC index can be used to evaluate the level of gene variation. When PIC > 0.5, the locus has high diversity; when PIC< 0.25, the locus has low diversity and locus has intermediate diversity when PIC between 0.25 and 0.5.

The microsatellite loci CAUD 13 showed highest PIC value (0.61) and CAUD 17 had lowest PIC value (0.15). The overall PIC value of Indian Runner was higher (0.49) than Moti (0.45) when the monomorphic loci are excluded. Microsatellite-wise and population-wise comparison of PIC value has presented in tables 3 and 4, respectively.

The average PIC value was 0.47. The average PIC value noticed in study of Huang et al 2005 was 0.42 and was in accordance with present study. The PIC value of most of loci was intermediate to high indicating that the selected microsatellite loci had satisfactory diversity and can reflect the genetic relationship of different population on a molecular level. But this average PIC value was less than that (PIC=0.76) reported by Wu et al., (2008).

Table 1: **Characteristics of microsatellite primers**

S.N	Primer	Sequences (5'-3')	Repeat
1	CAUD004	FP TCC ACT TGG TAG ACC TTG AG	(AC)20
		RP TGG GAT TCA GTG AGA AGC CT	
2	CAUD005	FP CTG GGT TTG GTG GAG CAT AA	(TC)18
		RP TAC TGG CTG CTT CAT TGC TG	
3	CAUD013	FP ACA ATA GAT TCC AGA TGC TGA A	(AC)25
		RP ATG TCT GAG TCC TCG GAG C	
4	CAUD016	FP TTT AGG TAA AAC TGT GAA TCA A	T8(TTTC)8T13
		RP ATC AAA GCA GGG AGC TAA G	
5	CAUD017	FP AGA AAT ACA CTT ACA GCA CT	TC4(TTTC)2CTTC(TTTC)2CT TC(TTTC)9(TC)20
		RP TGT CAT AAA ATG GTT AAT TGC	
6	CAUD023	FP CAC ATT AAC TAC ATT TCG GTC T	(AC)17
		RP CAG CCA AAG AGT TCA ACA GG	
7	CAUD027	FP AGA AGG CAG GCA AAT CAG AG	(CA)11
		RP TCC ACT CAT AAA AAC ACC CAC A	
8	CAUD030	FP ATT ATT CCT GAT GGC GTG GT	(CA)9…(AT)6T10
		RP TCA TGC TGA ATT TGG CTG TT	
9	CAUD035	FP GGC CTA ACC CTG ATG GAT G	(CA)n
		RP CTT ATC AGA TGG GGC TCG GA	

Table 2: Allele Range, H-W equilibrium comparison

Locus	Allele Range	HW equilibrium			
		Moti		Indian Runner	
		X^2	P	χ^2	P
CAUD04	186-242	13.0737	0.0044	14.8070	0.02181
CAUD05	238-284	37.9440	0.0000	0.5279	0.4674
CAUD13	95-139	34.1242	0.0002	6.8667	0.3334
CAUD16	189-219	12.9657	0.0047	4.1614	0.2445
CAUD17	135-236	21.0462	0.0018	19.5784	0.0002
CAUD23	171-193	32.3650	0.0000	14.5492	0.02468
CAUD27	116-127	21.1764	0.0000	Monomorphic	Monomorphic
CAUD30	260-274	13.7754	0.0032	Monomorphic	Monomorphic
CAUD35	224-276	30.6247	0.0000	3.3157	0.3454

Table 3: Comparison of loci for Number of alleles, Effective number of alleles, Observed Heterozygosity, Expected Heterozygosity, PIC, F statistics, Gene flow

Locus	Na^*	Ne^*	Obs_He^*.	Exp_He^*.	PIC	F_{IS}	Nm^*
CAUD04	7	3.63	0.4884	0.73	0.52	0.09	0.65
CAUD05	5	4.51	0.2955	0.78	0.46	0.34	0.63
CAUD13	7	4.79	0.68	0.81	0.61	-0.13	1.27
CAUD16	5	3.67	0.30	0.74	0.47	0.40	0.56
CAUD17	6	3.11	0.2	0.69	0.48	0.55	0.48
CAUD23	6	3.48	0.44	0.72	0.57	0.13	1.37
CAUD27	3	2.1	0.02	0.53	0.15	0.78	0.04
CAUD30	4	3.09	0.55	0.68	0.43	-0.58	0.18
CAUD35	5	2.52	0.53	0.61	0.51	-0.01	2.93
Over all	5.3+1.3	3.43+0.86	0.39+0.2	0.70+0.09	0.47+0.1	0.13	0.52

Na^* = Number of alleles Ne^* = Effective number of alleles , Obs_He^* = Observed Heterozygosity, Exp_He^* = Expected Heterozygosity , Nm^* = Gene flow

Table 4: Population wise comparison

Population	Na	Ne	Obs_He.	Exp_He.	PIC	FIS
Moti	3.2+0.83	2.27+0.57	0.34+0.2	0.54+0.15	0.45+0.1	0.27
Indian Runner	2.8+1.2	2.1+0.88	0.47+0.36	0.44+0.27	0.49+0.2	-0.36

Heterozygosity

It is one of the indices used to assay the genetic variation of each population. The value of heterozygosity indicates the diversity level of molecular marker. The overall observed Heterozygosity was higher in Indian runner (0.47) than in Moti (0.34) while the expected heterozygosity was higher in moti (0.54) than the Indian Runner (0.44). The overall mean observed and expected heterozygosity were 0.39 and 0.7, respectively. The expected heterozygosity was high for CAUD13 in both populations. The overall expected heterozygosity of 0.7 was in accordance of overall heterozygosity (0.78) reported by Wu et al. (2008) in 6 duck populations. Microsatellite-wise and population-wise comparison of observed and expected Heterozygosity values have presented in tables 3 and 4, respectively.

Test of Hardy-Weinberg equilibrium

The test of Hardy-Weinberg equilibrium was used to judge whether the genotypes were maintained in balance or deviated from balance. The Moti populations were in Hardy Weinberg disequilibrium while Indian runner showed H-W equilibrium (Table 2) for some markers (CAUD05, CAUD13, CAUD16 and CAUD35).

F statistic analysis

The F statistic was used for testing the genetic differentiation among sub populations. The results of F statistic were shown in tables 3 and 4. The F_{IS} value ranged from -0.13 (CAUD13) to 0.78 (CAUD27). The Moti population showed a F_{IS} value of 0.27 while it was (-) 0.37 for Indian Runner indicating that Moti is more homozygous/inbred than Indian Runner. Presence of negative inbreeding coefficient (F_{IS} value) indicated more heterozygotes.

Effective number of alleles

The effective number is also an index used to reveal the genetic diversity of the populations. Tables 3 and 4 demonstrated results for effective number of alleles. The E value of 9 microsatellite loci

was highest (2.3) in Moti duck population and varied from 1.2 to 2.6 while it was less in Indian Runner duck (2.1), where it varied from 1.0 to 3.2; average E was 3.4.

Genetic distance and gene flow

Nei's genetic identity and genetic distance estimates between Moti and Indian Runner ducks were 0.15 and 0.9, respectively. The Nei's genetic similarity or identity matrix is just reciprocal of the genetic distance matrix. The higher the genetic distance, the lower the genetic identity and *vice versa*. Except for three loci, migration rate was less than one that indicated less migration between populations, hence, an equilibrium based on the rate of mutation, migration, and genetic drift might have been established.

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MIGRATORY WATER BIRDS – A GLIMPSE

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"Water birds" means those species of birds that are ecologically dependent on wetlands for at least part of their annual cycle, have a range which lies entirely or partly with the Action Plan area. In addition to these groups, there are other birds also dependent on wetlands such as the kingfishers, birds of prey and passerines. India is known to support 1225 species of bird species, out of these 257 species are water birds. India has about 81 species of migrant waterfowls which are seasonal immigrants, mostly from Palae-arctic Region beyond the Himalayas – in central and northern Asia, and eastern and northern Europe. The most abundant and regular winter migrants are the ducks and geese, waders or shore birds and cranes.

Keywords: Migratory, Water birds, Seasonal Immigrants.

Introduction

Indian subcontinent plays host to a number of migratory water fowls in summers as well as winters, either in search of feeding grounds or to escape the severe winter of their native habitat. The numerous wildlife sanctuaries set up in the country serve as their temporary habitat. Bird lovers from all over the country visit these sanctuaries to get a glimpse of some of the rarest species of birds in the world. The beauty of the birds, combined with the splendor of the natural environment provides the perfect setting for a nature lover.

Migratory Water Fowls Coming to India in Winter Season

- Siberian Cranes
- Greater Flamingo
- Ruff
- Black winged Stilt
- Northern Pintail
- Yellow Wagtail
- White Wagtail
- Northern Shoveler
- Rosy Pelican
- Gadwall
- Spotted Sandpiper
- Eurasian Wigeon
- Black tailed Godwit
- Spotted Redshank

Migratory Water Fowls Coming to India in Summer Season

- Black crowned Night Heron
- Comb Duck

Migratory Water Fowls Coming to India in Winter Season

Siberian Crane

The Siberian Crane, *Grus leucogeranus*, also known as the Siberian White Crane or the Snow Crane, is a bird of the family Gruidae, the cranes. This species breeds in arctic Russia in Yakutia and western Siberia. It is a long distance migrant. The eastern population winters on the Yangtze River and Lake Poyang in China, the central population at Keoladeo National Park, India (the last Siberian Crane in this population was observed in 2002), and the western population in Fereydoon Kenar in Iran. It breeds and winters in wetlands, where it feeds on the shoots, roots and tubers of aquatic plants.

This is a large white crane, typically 4.9-8.6 kg (10.8-19 lbs), 140 cm (55 in), and 210-230 cm (83-91 in) across the wings. Large males can exceed 152 cm (60 inches) and weigh over 10 kg (22 lbs). Adults are all white, except for a dark red mask extending from the bill to behind the eye and black primary wing feathers. It has a yellow iris and reddish legs. The male is slightly larger than the female. Juveniles have a feathered mask and buff or cinnamon plumage. The voice is flute-like and musical.

Greater Flamingo

The Greater Flamingo (*Phoenicopterus roseus*) is the most widespread species of the flamingo family. It is found in parts of Africa, southern Asia (coastal regions of Pakistan and India) and southern Europe (including Spain, Sardinia, Albania, Turkey, Greece, Cyprus, Portugal, and the Camargue region of France). Some populations are short distance migrants, and records north of the breeding range are relatively frequent; however, given the species' popularity in captivity whether these are truly wild individuals is a matter of some debate. A single bird was seen on North Keeling Island (Cocos (Keeling) Islands) in 1988. Greater flamingo is the state bird of Gujarat, India.

This is the largest species of flamingo, averaging 110-150 cm (43-60 in) tall and weighing 2-4 kg (4.4-8.8 lbs). The largest male flamingoes have been recorded at up to 187 cm (74 in) tall and 4.5 kg (10 lbs). It is closely related to the American Flamingo and Chilean Flamingo, with which it is has sometimes been considered conspecific, but that treatment is now widely seen (e.g. by the American and British Ornithologists' Union) as incorrect and based on a lack of evidence.

Ruff

The Ruff (*Philomachus pugnax*) is a medium-sized wader which breeds on marshes and wet meadows across northern Eurasia. The male is much larger than the female (the reeve), and has a breeding plumage which includes brightly coloured head tufts and the large collar of feathers which led to the species' current name. The head and neck ornaments are erected as part of an elaborate display at a lek in which three differently plumaged types of male utilise a variety of strategies, including female mimicry, to gain access to the reeves. The female lays four eggs in a well-hidden ground nest, incubating and rearing the chicks on her own. Predators of chicks and eggs include mammals such as foxes, feral cats and stoats, and birds including large gulls, corvids and skuas.

The Ruff breeds in extensive lowland freshwater marshes and damp grasslands. It avoids barren and areas badly affected by severe weather, preferring hummocky marshes and deltas with shallow water margins. The wetter areas provide a source of food, the mounds and slopes may be used for leks, and dry areas with sedge or low scrub offer nesting sites. Moderately intensive grazing of grassland, with more than one cow per hectare (2.5 acres), was found to attract more nesting pairs in one Hungarian study. When not breeding, a wider range of shallow wetlands is used, such as irrigation, flood lands, lake margins and mining subsidence. Dry grassland, tidal mudflats and the seashore are less frequently used.The Ruff breeds in Europe and Asia from Scandinavia and Great Britain almost to the Pacific.

Black-winged Stilt

The Black-winged Stilt, *Himantopus himantopus*, is a widely distributed very long-legged wader in the avocet and stilt family (Recurvirostridae). Opinions differ as to whether the birds treated under the scientific name *H. himantopus* ought to be treated as a single species and if not, how many species to recognize. Most sources today accept 2-4 species.

Adults are 33-36 cm long. They have long pink legs, a long thin black bill and are blackish above and white below, with a white head and neck with a varying amount of black. Males have a black back, often with greenish gloss. Females' backs have a brown hue, contrasting with the black. In the populations that have the top of the head normally white at least in winter, females tend to have less black on head and neck all year round, while males often have much black, particularly in summer. This difference is not clear-cut however, and males usually get all-white heads in winter.Immature birds are grey instead of black and have a markedly sandy hue on the wings, with light feather fringes appearing as a whitish line in flight.

Northern Pintail

The Pintail or Northern Pintail (*Anas acuta*) is a widely occurring duck which breeds in the northern areas of Europe, Asia and North America. It is strongly migratory and winters south of its breeding range to the equator. Unusually for a bird with such a large range, it has no geographical subspecies if the possibly conspecific Eaton's Pintail is considered to be a separate species. This is a fairly large duck, with a long pointed tail that gives rise to the species' English and scientific names. The male has a very distinctive brown, grey and white appearance, whereas the female has mainly light brown plumage and a shorter tail. The male's call is a mellow whistle, whereas the female quacks like a Mallard.

The Northern Pintail is a bird of open wetlands which nests on the ground, often some distance from water. It feeds by dabbling for plant food and adds small invertebrates to its diet during the nesting season. It is highly gregarious when not breeding; forming large mixed flocks with other species of duck. In non-breeding males (eclipse) plumage, the drake Pintail looks similar to the female, but retains the male upper wing pattern and long grey shoulder feathers. Juvenile birds resemble the female, but are less neatly scalloped and have a duller brown speculum with a narrower trailing edge.

Yellow Wagtail

Vagrant individuals occur around the winter quarters at migration time. For example, on Palau in Micronesia migrant flocks of this species – apparently of the Bering Sea Yellow Wagtail, and including many adult males – are regularly seen, while further north on the Marianas, only the occasional stray individual – usually females or immatures as it seems – is encountered.

It is a slender 15-16 cm long bird, with the characteristic long, constantly wagging tail of its genus. It is the shortest tailed of the European wagtails. The breeding adult male is basically olive above and yellow below. In other plumages, the yellow may be diluted by white. The heads of breeding males come in a variety of colours and patterns depending on subspecies. The call is a characteristic high-pitched *jeet*. This insectivorous bird inhabits open country near water, such as wet meadows. It nests in tussocks, laying 4-8 speckled eggs.

White Wagtail

The White Wagtail (*Motacilla alba*) is a small passerine bird in the wagtail family Motacillidae, which also includes the pipits and longclaws. This species breeds in much of Europe and Asia and parts of north Africa. It is resident in the mildest parts of its range, but otherwise migrates to Africa. It has a toehold in Alaska as a scarce breeder. In some areas, notably the United Kingdom, the sub-species Pied Wagtail (*M. a. yarrellii*) predominates.

This is an insectivorous bird of open country, often near habitation and water. It prefers bare areas for feeding, where it can see and pursue its prey. In urban areas it has adapted to foraging on paved areas such as car parks.It nests in crevices in stone walls and similar natural and man-made structures.

There are a number of other subspecies, some of which may have arisen because of partial geographical isolation, such as the resident British form, the Pied Wagtail *M. a. yarrellii*, which now also breeds in adjacent areas of the neighbouring European mainland. Pied Wagtail, named for naturalist William Yarrell, exchanges the grey colour of the nominate form with black (or very dark grey in females), but is otherwise identical in its behaviour. Other subspecies, the validity of some of which is questionable, differ in the colour of the wings, back, and head, or other features. Some races show sexual dimorphism during the breeding season. As many as six subspecies may be present in the wintering ground in India or Southeast Asia and here they can be difficult to distinguish.Phylogenetic studies using mtDNA suggest that some morphological features have evolved more than once including the back and chin colour. Breeding *M. a. yarrellii* look much like the nominate race except for the black back, and *M. a. alboides* of the Himalayas differs from the Central Asian *M. a. personata* only by its black back.

Northern Shoveler

The Northern Shoveler (*Anas clypeata*), sometimes known simply as the Shoveler is a common and widespread duck. It breeds in northern areas of Europe and Asia and across most of North America, and is a rare vagrant to Australia. In North America, it breeds along the southern edge of Hudson Bay and west of this body of water, and as far south as the Great Lakes west to Colorado, Nevada, and Oregon. This species was first described by Linnaeus in his *Systema naturae* in 1758 under its current scientific name. Usually placed in *Anas* like most dabbling ducks, it stands well apart from such species as the Mallard and together with the other shovelers and their relatives forms a "blue-winged" group that may warrant separation as genus *Spatula*.

This species is unmistakable in the northern hemisphere due to its large spatulate bill. The breeding male has a green head, white breast and chestnut belly and flanks. In flight, pale blue forewing feathers are revealed separated from the green speculum by a white border. In early fall the male will have a white crescent on each side of the face. In non-breeding (eclipse) plumage, the drake resembles the female.

This is a bird of open wetlands, such as wet grassland or marshes with some emergent vegetation. This bird winters in southern Europe, Africa, northern South America, and the Malay Archipelago. In North America it winters south of a line from Washington to Idaho and from New Mexico east to Kentucky, also along the Eastern Seaboard as far north as Massachusetts.

Rosy Pelican

This bird is found in great congregations on jheels and lagoons, it is white or rose tinged with a tuft of yellow feathers on the breast, has a slight crest and the feathers of the forehead end in a point above the bill. Sexes are alike but females are somewhat smaller.

The bird can be branded as partly resident and partly a winter visitor. It is found all over northern India from Punjab to Assam. It can be sighted occasionally in the southern part of the country also. One of the interesting things about it is that it nests in the old nests of flamingoes in the Rann of Kutch. It lays two ivory white eggs, surprisingly the juveniles are sooty black in colour. The bird breeds limitedly in Eastern Europe and the Middle East.

Gadwall

The Gadwall, *Anas strepera* is a common and widespread duck of the family Anatidae. This species was first described by Linnaeus in his *Systema naturae* in 1758 under its current scientific name.Its conservation status is Least Concern.

The Gadwall is a bird of open wetlands, such as prairie or steppe lakes, wet grassland or marshes with dense fringing vegetation, and usually feeds by dabbling for plant food with head submerged. It nests on the ground, often some distance from water. It is not as gregarious as some dabbling ducks outside the breeding season and tends to form only small flocks. This is a fairly quiet species; the male has a hoarse whistling call, and the female has a Mallard-like quack. The young birds are fed insects at first; adults also eat some molluscs and insects during the nesting season. The Gadwall is one of the species to which the *Agreement on the Conservation of African-Eurasian Migratory Waterbirds* (AEWA) applies.

Spotted Sandpiper

The Spotted Sandpiper (*Actitis macularia*) is a small shorebird, 18-20 cm long. Together with its sister species, the Common Sandpiper (*A. hypoleucos*) they make up the genus *Actitis*. They replace each other geographically; stray birds may settle down with breeders of the other species and hybridize.

Their breeding habitat is near fresh water across most of Canada and the United States. They migrate to the southern United States and South America, and are very rare vagrants to Western Europe. These are not gregarious birds and are seldom seen in flocks.

Adults have short yellowish legs and an orange bill with a dark tip. The body is brown on top and white underneath with black spots. Non-breeding birds, depicted below, do not have the spotted underparts, and are very similar to the Common

Sandpiper of Eurasia; the main difference is the more washed-out wing pattern visible in flight and the normally light yellow legs and feet of the Spotted Sandpiper. The *Acititis* species have a distinctive stiff-winged flight low over the water. Spotted Sandpipers nest on the ground. Females may mate with more than one male, leaving incubation to them.

Eurasian Wigeon

The Wigeon or Eurasian Wigeon (*Anas penelope*, previously *Mareca penelope*) is one of three species of wigeon in the dabbling duck genus *Anas*. It is common and widespread within its range. This species was first described by Linnaeus in his *Systema naturae* in 1758 under its current scientific name.

It breeds in the northernmost areas of Europe and Asia. It is the Old World counterpart of North America's American Wigeon. It is strongly migratory and winters further south than its breeding range. It migrates to southern Asia and Africa. In Great Britain and Ireland the Wigeon is common as a winter visitor, but scarce as a breeding bird in Scotland, the Lake District, the Pennines and occasionally further south. It can be found as an uncommon winter visitor in the United States on the mid-Atlantic and Pacific coasts. It is a rare visitor to the rest of the United States except for the Four Corners and the southern Appalachians.

Black-tailed Godwit

The Black-tailed Godwit, *Limosa limosa*, is a large, long-legged, long-billed shorebird first described by Carolus Linnaeus in 1758. It is a member of the *Limosa* genus, the godwits. There are three subspecies, all with orange head, neck and chest in breeding plumage and dull grey-brown winter coloration, and distinctive black and white wingbar at all times.

Its breeding range stretches from Iceland through Europe and areas of central Asia. Black-tailed Godwits spend winter in areas as diverse as Australia, western Europe and west Africa. The species breeds in fens, lake edges, damp meadows, moorlands and bogs and uses estuaries, swamps and floods in winter; it is more likely to be found inland and on freshwater than the similar Bar-tailed Godwit. The world population is estimated to be 634,000 to 805,000 birds and is classified as Near Threatened.

Spotted Redshank

The Spotted Redshank *Tringa erythropus* is a wader in the large bird family Scolopacidae, the typical waders. It is an Arctic bird, breeding across northern Scandinavia and northern Asia. It is a migratory species, wintering around the Mediterranean, the southern British Isles, France, tropical Africa, and tropical Asia, usually on fresh or brackish water. It is an occasional vagrant in Australia and North America.

It is 29-33 cm long. It is black in breeding plumage, and very pale in winter. It has a red legs and bill, and shows a white oval on the back in flight. Juveniles are grey-brown finely speckled white above, and have pale, finely barred under parts. It nests on open boggy taiga, laying four eggs in a ground scrape. The call is a creaking whistle *teu-it* (somewhat similar to the call of a Roseate Tern), the alarm call a *kyip-kyip-kyip*. Like most waders, it feeds on small invertebrates.

The Spotted Redshank is replaced as a breeding bird further south by the Common Redshank, which has a shorter bill and legs, and is brown and white above with some dark patterning below, becoming somewhat lighter-toned in winter.

Migratory Water Fowls Coming to India in Summer Season

Black-crowned Night Heron

The Black-crowned Night Heron (or just Night Heron in Eurasia), (*Nycticorax nycticorax*) is a medium-sized heron.

The breeding habitat is fresh and salt-water wetlands throughout much of the world. The subspecies *N. n. hoactli* breeds in North and South America from Canada as far south as Patagonia, and the nominate race *N. n. nycticorax* in Europe, Asia and Africa. Black-crowned Night Herons nest in colonies on platforms of sticks in a group of trees, or on the ground in protected locations such as islands or reedbeds. Three to eight eggs are laid. This heron is migratory outside the tropical parts of its extensive range, where it is a permanent resident. The North American population winters in Mexico, the southern United States, Central America, and the West Indies, and the Old World birds winter in tropical Africa and southern Asia.

Comb Duck

The Comb Duck (*Sarkidiornis melanotos*), formerly known as the Knob-billed Duck, is an unusual, pan-tropical duck, found in tropical wetlands in sub-Saharan Africa, Madagascar and south Asia from Pakistan to Laos and extreme southern China. It also occurs in continental South America south to the Paraguay River region in eastern Paraguay, southeastern Brazil and the extreme northeast of Argentina, and as a vagrant on Trinidad.

It is the only known species of the genus *Sarkidiornis*. The supposed extinct "Mauritian Comb Duck" is based on misidentified remains of the Mauritian Shelduck (*Alopochen mauritianus*); this was realized as early as 1897 but the mistaken identity can still occasionally be found in recent sources.

Conclusion

Usually, birds start migrating towards other areas when they perceive the tailwind to be favorable. However, once they start their migration journey, nothing can stop them, except extremely bad weather. The timing of the migration is usually a mixture of internal and external stimulus. Migrating birds start on a journey when they feel that they have put on enough fat to provide them energy throughout the journey. Then, the tendency to aggregate into flocks is another determinant of the time of migration. Even after the flock, which has to fly together, has gathered, the birds keep on feeding till the weather conditions become favorable. Thus, apart from the internal clock of the birds and their flock, it is also the availability of food and the weather conditions that play a role in the determination of the time of migration.

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EVALUATION OF BILL LENGTH AND SHANK LENGTH IN KUTTANAD DUCKS OF KERALA

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An experiment was carried out in both sexes of Chara and Chemballi varieties of Kuttanad ducks which are native to Kerala state, in order to study the variations in bill and shank lengths.

Layer ducks of 72 weeks of age, 25 each in Chara and Chemballi varieties and seven drakes each in the corresponding groups were used for the study. Length of bill and shank were measured and the data were subjected for statistical analysis to test the difference between the sexes. Body weight and circumference were recorded in the above four groups. The results showed that the bill length averaged 6.10, 6.30, 6.70 and 6.80 cm in Chara and Chemballi females and their males respectively. In the same groups, the mean shank length was 6.03, 6.04, 6.81 and 6.66 cm respectively. Bill and shank lengths were significantly ($P<0.01$) higher in males in comparison with respective females. However, no significant variation was observed in body weight and circumference between the sexes. Significantly longer bills and shanks in drakes indicate better longitudinal growth in these body parts. Moreover, the correlation of 0.59 between bill length and shank length was also significant ($P<0.01$).

The mean body weight was 1630, 1660, 1697 and 1701 g in Chara female, Chemballi female, Chara male and Chemballi male respectively. In these groups the circumference of body was 36.5, 37.5, 38.4 and 37.7 cm respectively. The observations of body weight and circumference between the sexes were statistically non significant..

NUTRICIAN PHYSIOLOGY

THE INFLUENCES OF FEED RESTRICTION ON GROWTH AND FAT DEPOSITION OF MEAT-TYPE DUCK

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Abbreviated title: FEED RESTRICTION OF DUCK

Summary: The objective of this trial was to study the influences of feed restriction on growth and fat deposition pattern of duck. 360 one-day-old male ducks(Cherry Valley duck, SM_3 line) were randomly divided into 2 groups with 9 replicates of 20 birds. Group 1 was fed *ad libitum*(FAD), and group 2 restrained(FR, given 85% of FI of FAD). All birds reared in auto-temperature-controlled room to the age of 8 weeks were given a typical China's commercial pellet diet. Daily feed intake of FAD was recorded which was used to calculate the next day feed supply of FR. Day one and every weekend BW were measured, and one duck per replicate close to average BW was sacrificed to measure skin and subcutaneous fat(SF) and abdominal fat(AF). The growth and fat deposition data were fit to the four sigmoid growth models containing Logistic, Gompertz, Von Bertalanffy and Richards models and the polynomial models(cubic and quartic) using SPSS16.0 nonlinear regression procedure. The residual sum of squares(RSS) and the coefficient of determination(R^2) were regarded as goodness of fit. We found that feed restriction significantly decreased the each weekend BW($P<0.01$) and the BWG before the 7^{th} week($P<0.01$), but surprisingly increased the BWG of the 7^{th} week($P<0.01$), improved the FCR of the 2^{nd}, the 7^{th} and the 8^{th} weeks($P<0.01$) and reduced the FCR of the 3^{rd} and 4^{th} weeks($P<0.01$). FR decreased the SF yield($P<0.01$) except for the 5^{th} weekend, and the AF on the 2^{nd}, the 3^{rd}, the 4^{th}, the 7^{th} and the 8^{th} weekend. Gompertz, Von Bertalanffy and Richards models can goodly fit the growth curves of ducks under two feeding levels but without up to the goodness of quartic polynomial and the Richards model had the highest goodness of fit in the four sigmoid models. The FR changed the growth curve via altering the asymptotic BW and the inflexion age and BW. To AF deposition of FR and FAD, the best feasible curves in the four sigmoid models were Logistic and Gompertz model, respectively. Von Bertalanffy model was the best fit for SF deposition curves of both FR and FAD in the sigmoid models, respectively. Feed restriction decreased the asymptotic fat deposition(both AF and SF) and the inflexion age. In conclusion, it seemed that feed restriction altered the growth and fat deposition models of meat-type duck and decreased the fat deposition.

Key words: duck; feed restriction; growth curve; skin and subcutaneous fat; abdominal fat

Introduction

Being one of the four species of domestic birds, duck second only to chicken play a important role in livestock industry. China has the maximum quantity of breeding ducks in the world(Qiao et al., 2004) and produce more than three forth of the world ducks(Yan, 2008). The experiments for duck growth, development, physiology and nutrition should be conducted essentially. China's researchers had been focused on energy, protein, amino acid and some additives nutritional values for meat-type ducks(Li and Zhong, 2006, review). Otherwise, few of them paid attention to duck's growth, development and fat deposit pattern. The duck's BW and tissue composition including subcutaneous fat(SF) change with age because particular components show different growth rates(Bochno et.al., 2005). These changes, maybe varying with animal's species, strains, diets and environment(Gong et.al, 2006), are more radical in ducks

than in chickens or turkeys(Bochno et.al., 2005). In our China, Cherry Valley duck(SM_3) is commonly used for the commercial production. Nowadays, available literature provides scant information on the location about age-related changes in BW, skin and subcutaneous fat(SF) and abdominal fat(AF) for this duck. The results of researching on birds indicated that age-related changes including BW and internal organs can be modeled by sigmoid and/or polynomial functions(Kzeng et al., 1981; Knížetová et al., 1991a,b; Maruyama et al., 1999; Ji et al., 2002; Zhang et al., 2005). Thereby, we hypothesize that the age-related changes of BW, SF and AF for Cherry Valley duck can be modeled by sigmoid and polynomial models also.

Compared to broiler chicken, meat-type duck has more fat deposit especially in subcutaneous tissue(Knížetová et al., 1991b; Bochno and Brzozowski, 1998; Bochno et al., 2006). In china, researchers had applied some additives to regulate fat deposit and carcass quality of duck(Ma et al., 2005; Tang et al., 2005; Liu et al., 2006). In poultry production, feed restriction had been regarded as one of the means to regulate growth performance for breeding birds, improve feed conversion ratio and decrease fat deposition for meat-type birds. Limited several papers explored the influence of feed restriction on growth performance and fat deposit of meat-type duck. Nematallah(2003) found mild feed restriction (80-90% of the *ad libitum* feeding) reduced carcass fat without any adverse and physiological effects on Muscovy ducklings up to 11 weeks of age and similarity was seen by Tan and Ohtani(2000) in Peking duck. Otherwise, the result of Solomon(2007) indicated that different levels of feed restriction in the whole experimental period had no statistical influence on fat mass for Peking duck. To the end, it is necessary to further investigate the effect of feed restriction on meat-type duck's fat deposition. Therefore, the objectives of this trial are to investigate: 1)the effects of whole period feed restriction on growth performance and fat deposit mass every week. 2) the age-related changes in BW, skin and subcutaneous fat(SF) and abdominal fat(AF) for this duck. 3)whether the sigmoid curves and polynomial functions can fit the weight growth, SF and AF deposition patterns.

Materials and methods

ANIMALS, DIETS, MANAGEMENT AND DTERMINED INDICATORS

360 one-day-old male ducks(Cherry Valley duck, SM_3 line) were randomly divided into 2 groups with 9 replicate pens of 20 birds. Group 1 was fed *ad libitum*(FAD), and group 2 restrainedly(FR, given 85% of FI of FAD from D 3 to the end). All birds reared in auto-temperature-controlled room to the age of 8 weeks. The environmental temperature was controlled as: 32-30□ for D 1 to 3, 28-25□ for D 4 to 7, 25-23□ for D 8 to 14 and gradually falling to 17□ below to the end. The relative humidity was controlled between 65% and 75%. The lighting program was provided with continuous illumination for D 1 to 3 and after that 23 h of illumination. The diet was typical china's commercial diet (see *Table 1*). Daily FI of FAD during the whole period was recorded which was used to calculate the next day feed supply of FR. Day one and every weekend BW were measured, and one duck per replicate with the average BW was sacrificed to measure skin and subcutaneous fat(SF), and abdominal fat(AF). Mortality was applied to modify the feed conversion ratio (FCR).

STATISTIC ANALYSIS

The independent T-test was used to analyze the differences of BW, body weight gain (BWG), FCR, SF and AF between the two groups. In order to describe the age related changes in BW and fat deposit mass, the growth and fat deposition data were fit to the four common growth models containing Logistic, Gompertz, Von Bertalanffy and Richards models, and the polynomial models(cubic and quartic) using SPSS16.0 nonlinear regression procedure. The residual sum of squares (RSS) and the coefficient of determination(R^2) were regarded as goodness of fit of the models. Logistic model(Zhu et al., 2005 is described as: $W_t=W_A/[1+Bexp(-Kt)]$, Where W_t is the weight at time t, W_A is the asymptotic weight, B is the time parameter of asymptotic growth rate and K is the exponential growth rate. The inflexions of age

and weight of Logistic model are computed by (lnB)/K and $W_A/2$, respectively. The Laird form of the Gompertz model(Laird, 1966) was fitted to the data. And the growth curve is: $W_t=W_A\exp[-Bexp(-Kt)]$, Where W_t is the weight at time t, W_A is the asymptotic weight, B is the regulation parameter and equal to $\ln(W_A/W_0)$, W_0 is the estimated hatching weight of bird, K is the growth rate parameter when approaching the asymptotic weight and also called "*exponential rate of decay of the specific growth rate"*. The inflexions of age and weight are determined by (lnB)/K and W_A/e, respectively. Von Bertalanffy model(Zhu et al., 2005) is described as: $W_t=W_A[1-Bexp(-Kt)]^3$, Where W_t is the weight at time t, W_A is the asymptotic weight, B is regulation parameter, K is the exponential growth rate. The inflexions of age and weight are computed by (ln3B)/K and $8W_A/27$, respectively. Richards model(Knizetova et al., 1991) is described as: $W_t=W_A[1+Bexp(-Kt)]^{-1/n}$, Where n>-1, n≠0, K>0, W_t is the weight at time t, W_A is the asymptotic weight, B is regulation parameter, K is the exponential growth rate, n is the parameter of curve shape which determined the point of growth inflexion. The inflexions of age and weight are determined by $-K^{-1}\ln(n/B)$ and $W_A/(n+1)^{1/n}$, respectively. The cubic polynomial(Mao et al., 2009) is described as: $W_t=b_0+b_1t+b_2t^2+b_3t^3$, and its inflexion of age is calculated by $-b_2/3b_3$. The quartic polynomial function(Chen and Hu, 2005) is: $W_t=b_0+b_1t+b_2t^2+b_3t^3+b_4t^4$, Where W_t is the weight at time t and b_0, b_1, b_2, b_3, b_4 are parameters, and its inflexion of age is calculated by $\{[(8b_4b_2-3b_3^2)/3]^{1/2}-b_3\}/4b_4$. The inflexions of weight of polynomial functions(cubic and quartic) are calculated by the value of the inflexion of age through the functions.

Results

Daily feed intake of the ducks

The daily FI of the ad libitum duck was recorded and based on it we calculated the daily feed supply for the restriction group(*Figure 1*). It is worth the whistle that in order to accurately record the daily FI it is necessary to determine the wasting feed on the floor every day. The quadratic function can goodly fit the relationship between daily FI and days of age for ad libitum group(R^2=0.9753), although the observed daily FI of duck do not always ascend accompanying with the days of age increasing.

The growth performance, af and sf mass of the two group ducks

The results of this experiment(*Table 2*) indicated feed restriction significantly decreased the each weekend BW(P<0.01) and the weekly body weight gain(BWG) before the 7th week(P<0.01), but surprisingly increased the BWG of the 7th week(P<0.01), improved the FCR of the 2nd, the 7th and the 8th weeks(P<0.01) and reduced the FCR of the 3rd and 4th weeks(P<0.01). FR had no significant influence on the FCR of the whole period. FR decreased the SF yield(P<0.01) except for the 5th weekend, and the AF on the 2nd, the 3rd, the 4th, the 7th and the 8th weekend.

The parameters estimation of the growth functions

The parameters of the growth curves for the ad libitum feeding ducks are shown in *Table 3* and *Figure 2* give us a visual predicted values of the models. As far as R^2 and RSS are concerned, the four sigmoid functions and the polynomial models can goodly fit the weight growth curve of FAD group(All R^2 were greater than 0.995) and the Logistic model has the lowest R^2 and the biggest RSS. The quartic polynomial (R^2=0.9996, RSS=5999.780) followed by Richards model(R^2=0.9996, RSS=6383.976) has the optimal goodness of fit. The inflections of age and BW calculated by Richards function are the 25.997th day and 1668.869 gram very close to the 26.762th day and 1734.607 gram by quartic polynomial. The asymptotic BW from Richards approaching to Bertalanffy(5374.185g vs. 5534.218g) is higher than Gompertz(4846.360g) and Logistic models(4142.172g). As same to the FAD, Richards model(R^2=0.9990, RSS=12531.439) has the highest goodness of fit in the sigmoid curves inferior to the goodness of quartic polynomial(R^2=0.9990, RSS=12226.182) for FR(*Table 4* and *Figure 3*) and the two functions have approximate inflexions of age(33.016th vs 33.504th day) and BW(1842.484g vs.

1881.717g). The inflexions of age(both deduced from sigmoid and polynomial models) are delayed by feed restriction in contrast to ad libitum feeding and the delayed duration computed by Richards function is about 7 days. The inflexions of BW both deduced from Richards and quartic polynomial functions have a little increase induced by feed restriction.

Table 1. Composition and nutrients levels of diets(air-dry basis, %).

Ingredients	Composition		Calculated nutrient level		
	0-21d	22-56d		0-21d	22-56d
Corn	58.37	62.87	Metabolizable energy(MJ/kg)	12.05	11.63
Soybean meal	26.3	13	Crude protein	19.10	15.85
Rapeseed meal	5	8	Calcium	0.73	0.66
Wheat bran	5	12	Total phosphate	0.67	0.66
Soy oil	2	1	Available phosphate	0.41	0.34
Sodium chloride	0.3	0.3	Lysine	0.95	0.75
Sodium bicarbonate	0.3	0.3	Methionine	0.48	0.38
Choline chloride	0.2	0.2	Metionine+Cysteine	0.79	0.66
Dicalcium phosphate	1.1	0.8	Tryptophan	0.22	0.17
Limestone	0.7	0.8	Threonine	0.72	0.58
L-Lysine.HCl	0.1	0.15	Histidine	1.24	0.93
DL-Methionine	0.2	0.15	Valine	0.87	0.71
Mould inhibitor	0.1	0.1	Leucine	1.58	1.30
Mineral-vitamin premix[1]	0.33	0.33	Isoleucine	0.75	0.57
Total	100	100			

[1]Supplied per kilogram of diet: vitamin A 15,000 IU; vitamin D_3 3,000 IU; vitamin E 7.5 IU; vitamin K_3 1.5mg; vitamin B_1 10mg; vitamin B_2 4.8 mg; vitamin B_6 1.8 mg; vitamin B_{12} 18 mg; nicotinic acid 10.5 mg; calcium pantothenate 7.5 mg; folic acid 150 μg; Cu 20 mg; Fe 80mg; Mn 60mg; Zn 60mg; Se 0.2 mg; I 0.2 mg; chlortetracycline 50 mg; antioxidant 200 mg.

Table 2 The growth performance and fat deposits of the two experimental groups.

Week	0	1	2	3	4	5	6	7	8
Body weight(BW), g/bird									
FAD	54.194 ± 0.291	202.485^{A} ± 4.823	615.000^{A} ± 9.014	1218.202^{A} ± 15.934	1894.861^{A} ± 18.288	2435.026^{A} ± 34.206	3031.970^{A} ± 46.107	3568.936^{A} ± 29.908	3916.229^{A} ± 23.876
FR	54.444 ± 0.227	166.462^{B} ± 1.130	497.623^{B} ± 2.038	968.295^{B} ± 2.621	1497.143^{B} ± 6.166	1968.175^{B} ± 15.076	2461.325^{B} ± 19.130	3092.091^{B} ± 23.578	3453.625^{B} ± 26.325
Body weight gain(BWG), g/bird/wk									
FAD		148.291^{A} ± 4.712	412.515^{A} ± 4.704	603.203^{A} ± 7.943	676.659^{A} ± 11.583	540.165^{a} ± 21.030	596.943^{A} ± 23.036	536.966^{A} ± 20.546	347.293 ± 21.143
FR		112,018^{B} ± 1.052	331.161^{B} ± 1.522	470.671^{B} ± 2.292	528.849^{B} ± 4.890	471.031^{b} ± 16.038	493.150^{B} ± 9.771	630.766^{B} ± 18.355	361.534 ± 13.095
Feed conversion ratio(FCR)									
FAD		1.208 ± 0.019	1.530^{A} ± 0.006	1.707^{A} ± 0.011	2.086^{A} ± 0.025	2.780 ± 0.071	3.020 ± 0.062	3.758^{A} ± 0.198	5.978^{A} ± 0.370
FR		1.226 ± 0.011	1.436^{B} ± 0.007	1.794^{B} ± 0.007	2.178^{B} ± 0.017	2.743 ± 0.072	3.068 ± 0.042	2.849^{B} ± 0.073	4.761^{B} ± 0.155
Abdominal fat(AF) weight, g/bird									
FAD	unrecorded	unrecorded	3.000^{A} ± 0.277	6,956^{A} ± 0.793	13.022^{A} ± 1.041	16.300 ± 0.981	24.467 ± 1.400	31.000^{A} ± 2.060	48.233^{A} ± 3.564
FR	unrecorded	unrecorded	1.700^{B} ± 0.082	3.656^{B} ± 0.236	7.856^{B} ± 0.580	13.500 ± 1.589	21.300 ± 1.734	19.289^{B} ± 2.858	25.633^{B} ± 3.171
Skin and subcutaneous fat(SF) weight, g/bird									
FAD	5.074± 0.208	27.422^{A} ± 1.202	121.34^{A} ± 3.681	228.389^{A} ± 9.596	332.200^{A} ± 11.327	334.433 ± 13.452	511.211^{A} ± 19.558	549.922^{A} ± 17.896	748.178^{A} ± 27.337
FR	5.456± 0.233	20.089^{B} ± 0.565	87.367^{B} ± 1.692	171.033^{B} ± 3.338	249.156^{B} ± 4.321	314.867 ± 12.793	382.089^{B} ± 10.187	445.711^{B} ± 19.937	561.033^{B} ± 17.689

1) The FCR of whole period is not provided in the table and the FCR of FAD and FR are equal to 2.5684±0.0240 and 2.4845±0.0117, respectively. No significance between them exit.
2) A,B means within a column with different superscript are significantly(P□0.01).
3) Values represent the Mean±SEM.
4) The AF on 0 and 1 wk are not recorded because of the too little pads.

Table 3 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for weight growth in ad libitum duck.

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	82742.378	12066.601	6672.800	6383.976	RSS	10406.011	5999.780
R^2	0.9951	0.9993	0.9996	0.9996	R^2	0.9994	0.9996
W_A	4142.172	4846.360	5534.218	5374.185	b_0	9.647	49.254
B	22.966	4.354	0.868	-0.782	b_1	15.690	-3.257
K	0.102	0.054	0.037	0.040	b_2	2.544	4.1420
n				-0.275	b_3	-0.028	-0.073
IA	30.835	27.402	25.636	25.997	b_4		0.0004
IW	2071.086	1782.876	1639.768	1668.869	IA	30.286	26.762
					IW	2040.443	1734.607

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

Table 4 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for weight growth in restriction duck

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	69745.967	20068.719	12738.049	12531.439	RSS	12955.035	12226.182
R^2	0.9945	0.9984	0.9990	0.9990	R^2	0.9990	0.9990
W_A	3889.412	4926.154	6163.879	6562.515	b_0	20.100	36.209
B	23.430	4.247	0.836	-0.900	b_1	13.066	5.360
K	0.091	0.044	0.028	0.025	b_2	1.846	2.500
n				-0.393	b_3	-0.0175	-0.0355
IA	34.493	32.639	32.798	33.016	b_4		0.00016
IW	1944.706	1812.231	1826.335	1842.484	IA	35.154	33.504
					IW	1999.942	1881.717

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

Table 5 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for abdominal fat deposit in ad libitum duck

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	162.862	16.071	20.294	16.452557	RSS	7.869	4.344
R^2	0.888	0.989	0.986	0.989	R^2	0.995	0.997
W_A	64.305	59956.176	120500.104	2246.533	b_0	-19.174	15.776
B	15.220	10.374	0.984	16.087	b_1	2.290	-2.807
K	0.0564	0.00665	0.00105	0.0254	b_2	-0.0638	0.189
n				0.411	b_3	0.000789	-0.00436
IA	48.243	351.665	1026.782	144.352	b_4		0.0000367
IW	32.153	22056.645	35703.735	972.003	IA	26.944	25.105
RSS					IW	11.669	10.185

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

Table 6 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for abdominal fat deposit in restriction duck

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	9.372	10.683	12.206	10.684	RSS	11.645	8.694
R^2	0.982	0.980	0.977	0.980	R^2	0.978	0.984
W_A	25.586	29.111	32.349	29.112	b_0	7.471	39.446
B	118.280	10.333	1.603	-0.00201	b_1	-1.091	-5.755
K	0.142	0.0759	0.0540	0.0759	b_2	0.0550	0.286
n				-0.000194	b_3	-0.000535	-0.00524
IA	33.626	30.759	29.096	30.758	b_4		0.0000336
IW	12.793	10.709	9.585	10.709	IA	34.273	28.989
					IW	13.137	9.326

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

Table 7 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for skin and subcutaneous fat deposit in ad libitum duck

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	17793.941	13636.585	12006.046	13635.768	RSS	8118.614	6013.931
R^2	0.965	0.973	0.976	0.973	R^2	0.984	0.988
W_A	959.539	1363.883	1956.976	1364.071	b_0	-44.540	-1.056
B	18.585	3.821	0.784	-0.000653	b_1	15.245	-0.813
K	0.0710	0.0316	0.0180	0.0316	b_2	-0.202	1.062
n				-0.000171	b_3	0.00317	-0.0308
IA	41.161	42.432	47.506	42.434	b_4		0.000292
IW	479.770	501.747	579.845	501.771	IA	21.258	16.905
					IW	218.596	163.627

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

Table 8 The estimation of Logistic, Gompertz, Von Bertalanffy, Richards and the polynomial regression model parameters for skin and subcutaneous fat deposit in restriction duck

	Sigmoid models				Polynomial models		
	Logistic	**Gompertz**	**Bertalanffy**	**Richards**		**Cubic**	**Quartic**
RSS	5566.292	2861.747	2005.652	2862.102	RSS	1346.970	37.451
R^2	0.982	0.991	0.993	0.991	R^2	0.996	0.9999
W_A	619.727	776.834	957.684	776.793	b_0	-24.633	9.667
B	19.172	3.946	0.804	0.000518	b_1	8.367	-4.300
K	0.0849	0.0422	0.0273	0.0422	b_2	0.0320	1.029
n				0.000131	b_3	0.00003	-0.0268
IA	34.806	32.504	32.265	32.504	b_4		0.000231
IW	309.864	285.781	283.758	285.785	IA	-351.689	19.070
					IW	-329.390	146.682

IA mean inflection of age, IW mean inflection of weght(body weight or fat weight).

The parameters estimation of abdominal fat(af) deposit functions

From *Table 5* and *Figure 4*, we can see that the Gompertz model has the highest R^2(0.989) and lowest RSS(16.071) in the sigmoid curve functions which is responsible for the best feasible curve for the AF deposit of FAD. The mature weight(W_A) from Gompertz, Bertalanffy and Richards models are too big meaning not fit for the truth which is similarity to the inflections of age and fat mass. Compared with the four sigmoid models, the cubic and quartic polynomial models with a higher R^2 can better fit the AF deposit pattern of FAD and the infections of age are 26.944th day and 25.105th day, respectively. To AF deposit curve of FR(*Table 6* and *Figure 5*), the Logistic model has the highest R^2(0.982) and lowest RSS(9.372) approaching to the quartic polynomial function(R^2 =0.984, RSS=8.694) resulting in optimization in the four sigmoid functions. Similar to the changing trend of weight growth, FR increased the inflexion of age.

The parameters estimation of skin and subcutaneous fat (sf) deposit functions

The parameters of SF deposition curves are presented in *Table 7*(FAD) and *Table 8*(FR) and the visual graphs are seen in *Figure 4*(FAD) and *Figure 5*(FR). Being second only to the quartic polynomial function, the Bertalanffy function has the biggest R^2 and the least RSS in the sigmoid models for both FAD and FR groups. The inflexion of age deduced from Bertalanffy model was advanced about 15 days by FR in contrast to FAD and the inflexion of SF mass was reduced by half approximately.

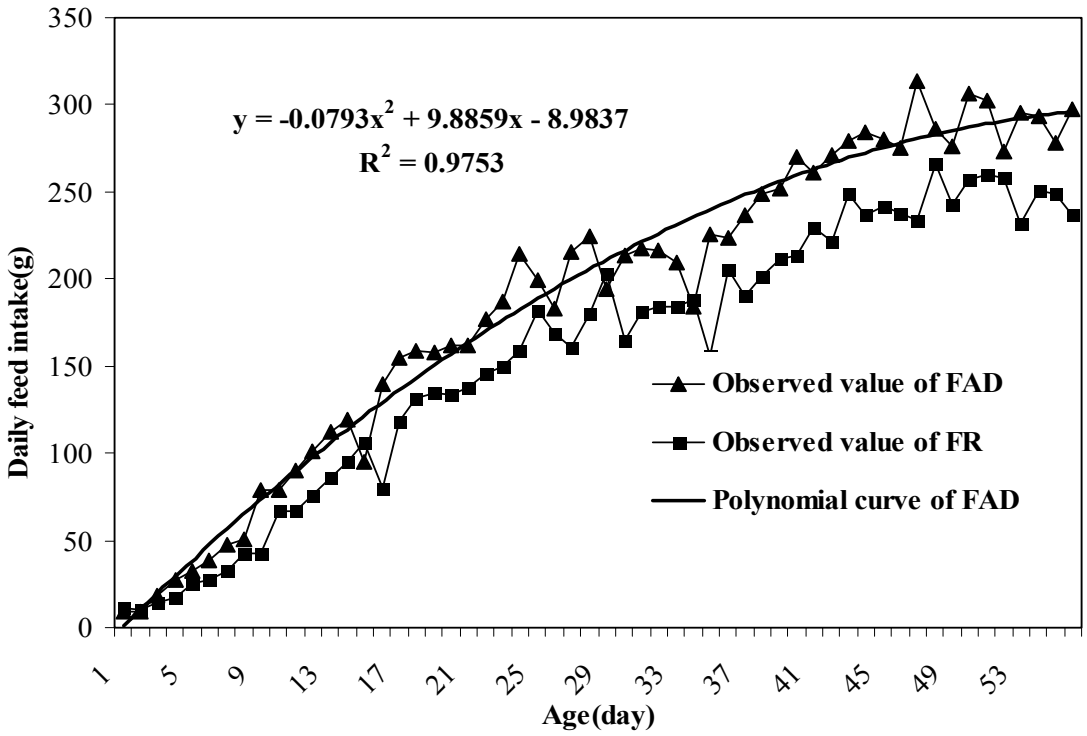

Figure 1. The daily feed intake variation trend and the fitting polynomial curve of FAD. The daily feed intake of FR was equa to 85% of the daily feed intake of FAD on the previous day.

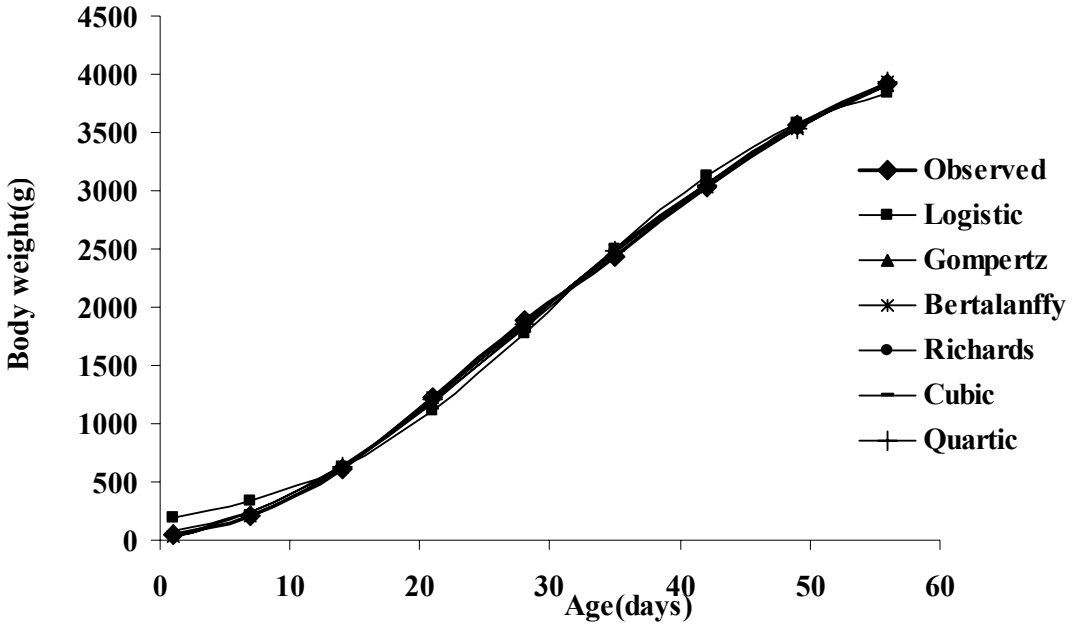

Figure 2. The observed and predicted values of BW for FAD group.

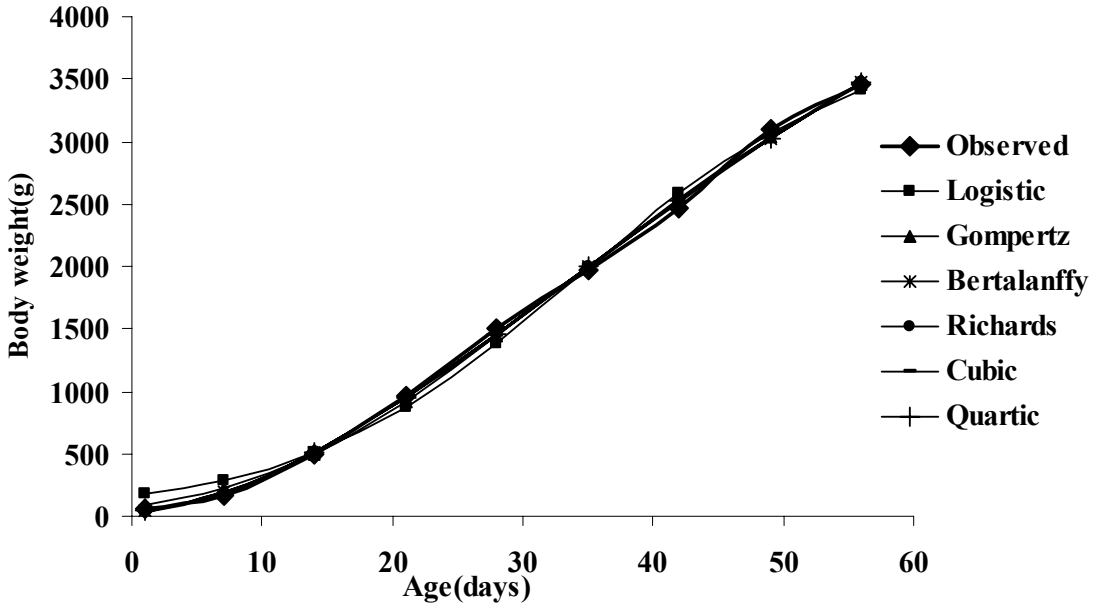

Figure 3. The observed and predicted values of BW for FR group.

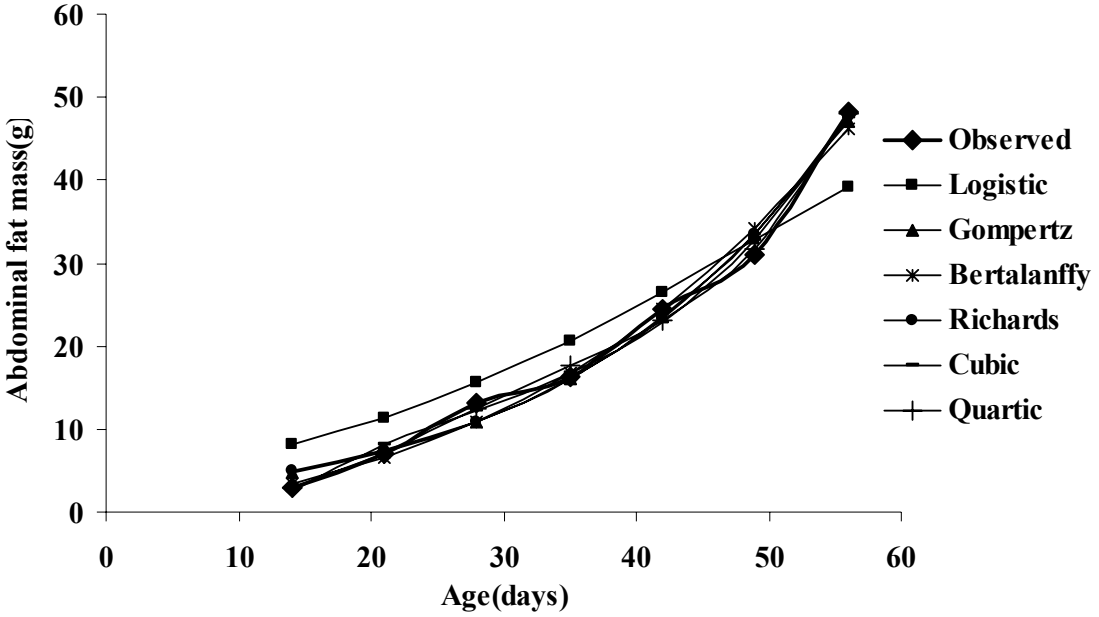

Figure 4. The observed and predicted values of AF mass for FAD group

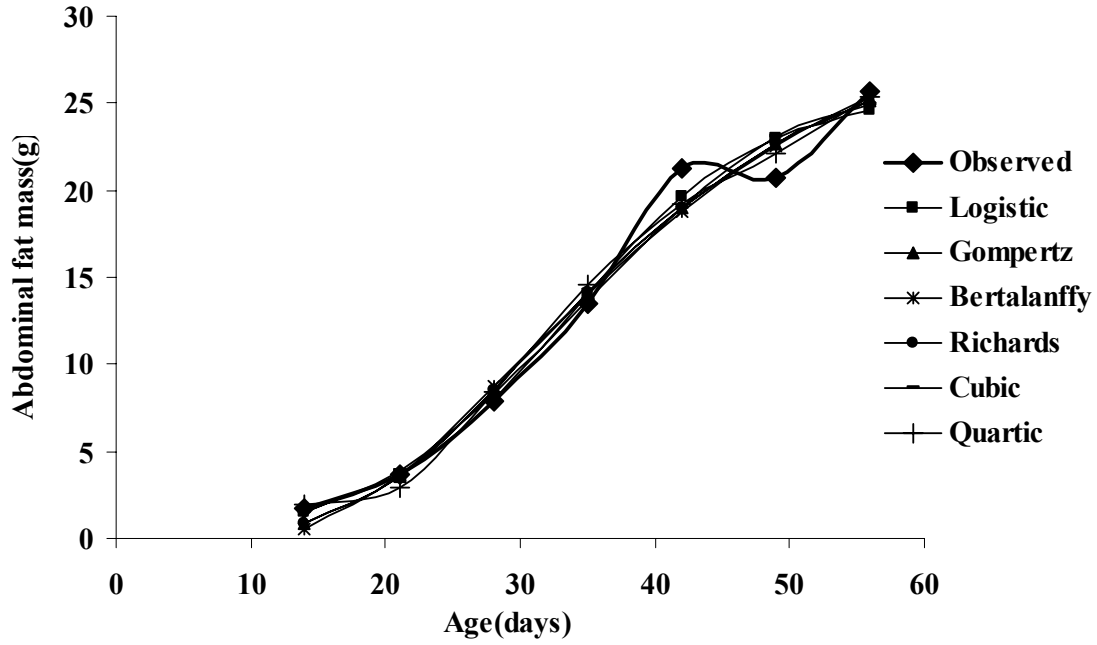

Figure 5. The observed and predicted values of AF mass for FR group

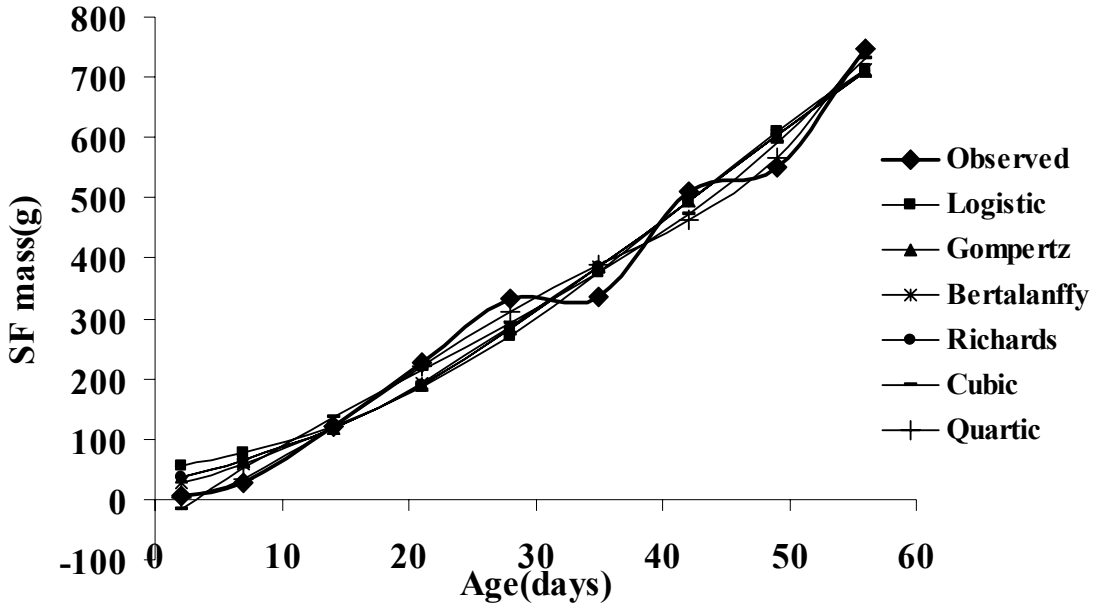

Figure 6. The observed and predicted values of SF mass for FAD group.

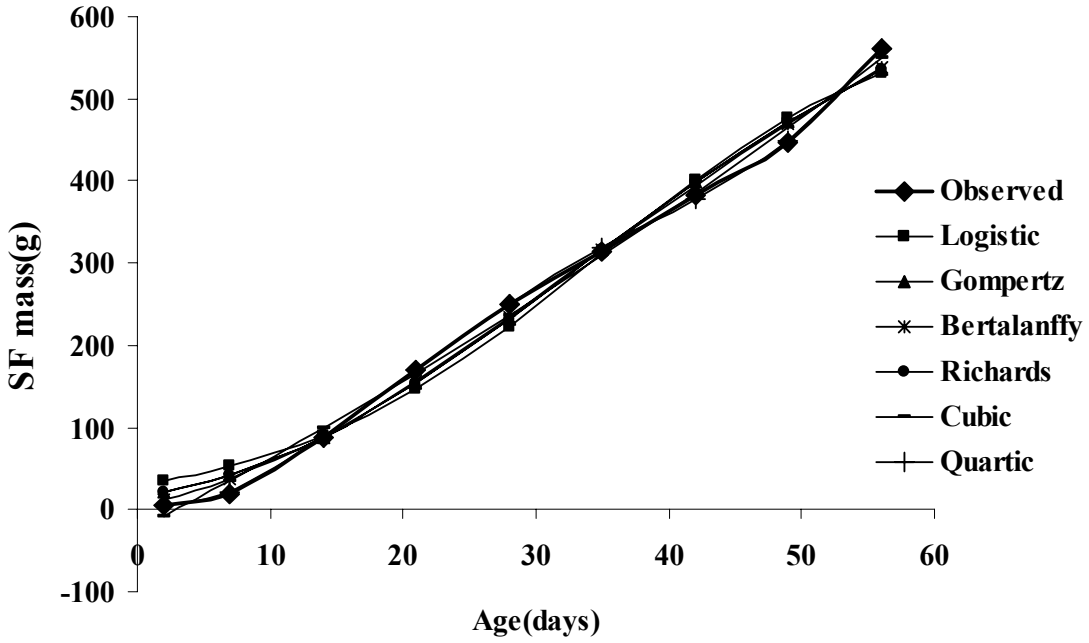

Figure 7. The observed and predicted values of SF mass for FR group.

Discussion

The influences of feed restriction on growth performance and fat deposit of meat-type duck

In our study, we found that the whole period feed restriction decreased the BW of Cherry Valley ducks on every weekend, which was similarity to the result in Pekin ducks(Solomon et al., 2007) and Muscovy ducklings(Nematallah et al, 2003). In our experiment, the feed restricted by 15% from the 3rd day to the end was approaching to by 18% from the 1st day until the end of the rearing period (Solomon et al., 2007). Bochno(2007) observed that the feed restricted by 20% from the 1st weekend to the 12th weekend decreased the final BW of Koluda geese. The influence of feed restriction on the final BW may vary with the levels, period and regimen in waterfowl(Tan and Ohtani; 2000; Solomon et al., 2007; Bochno, 2007). The early feed restriction of ducks may not significantly reduce the final BW(Tan and Ohtani; 2000) owing to the compensatory growth, which is seen in broilers commonly(Hornick et al., 2000; Pinheiro et al., 2004). The catch-up growth may depend on the severity, duration and timing of feed restriction and a long duration will lead to a final BW decreasing(Yu and Robinson, 1992, review). In the study, a whole period restriction was adopted, responsible for the BW falling on every weekend. Surprisingly, the body weight gain(BWG) of restriction ducks was significantly greater than ad libitum ducks during the 7th week(P□0.01), that was not because of the higher feed intake obviously. Otherwise, the mechanism of catch-up growth mainly lies in the higher feed intake in the refeeding period(Yu and Robinson, 1992, review). In a word, the reason of lower FI leading to higher BWG during the 7th week need to be further investigated. The influence of feed restriction on FCR had not been confirmed completely. Some researches found that FR were beneficial to FCR (Auckland and Morris, 1971; Plavnik et al., 1986; Plavnik and Hurwitz, 1991), whereas others failed to better FCR(Zhan et al., 2007; Solomon et al., 2007). Although the FCR of whole experimental period had no difference between the two treatments, feed restriction improved the FCR of the 2nd, the 7th and the 8th weeks($P<0.01$) and reduced the FCR of the 3rd and 4th weeks($P<0.01$). Solomon(2007) found the similar result, but did not measure the FCR during every week. The result of my study indicated that the influence of whole period feed restriction on FCR depended on the weeks of age. It is worth notice that one of the important aims for adopting feed restriction in poultry production is to decrease the fat deposition and some results had been observed this point (Jones and Farrell, 1992; Nielsen et al., 2003). The present experiment showed that FR deceased SF and AF deposits of most weeks and it seem that the decreasing range of AF mass was stronger than SF mass(*Table 2*). The fat of meat-type ducks mainly deposit in subcutaneous tissue not abdominal tissue, which is reversed in chickens. Therefore, the desired aim of regulating fat deposit for ducks is reducing SF not AF mass. It should be highlighted is the measured SF of the trial include two components named skin and subcutaneous fat. The age-related changes of skin is not same to the subcutaneous fat(Bochono et al., 2005), which result in the SF should be treated separately to discuss in the next investigation.

The growth curves of meat-type duck

Mathematical models of growth are useful because they summarise information obtained from a sequence of points(weights or ages) into relatively few generalisations, which facilitate a more objective comparison of the growth efficiency of the species, breeds, lines or hybrid combinations(Knížetová. et al., 1991a). Numerous growth equations have been developed to describe and fit the nonlinear relationship between growth and time. Growth curves for poultry generally have the following characteristics: an accelerating phase of growth from hatching, a point of inflection in the growth curve at which the growth rate is maximum, a phase where growth rate is decelerating, and a limiting value (asymptote) mature weight (Roush, 2005). In our study, we used four common sigmoid models including Logistic, Gompertz, Von Bertalanffy and Richards functions to fit the growth data of Cherry Valley ducks. We found that Richards equation(R^2=0.9990-0.9999) followed by Bertalanffy, Gompertz and Logistic models had the best goodness of fit both for FAD and FR groups, which confirmed the result(R^2=0.9991-0.9997) of Pekin ducks from Knížetová(1991b). The Richards function can best

describe the weight growth of ducks may resulting from its variable inflection point(Knížetová. et al., 1991a; Zhu et al., 2005). The lowest R^2 of Logistic function in the present study indicate it is well fit for describing the low growth rate animals(Zhang et al., 2005; Zhu et al., 2005), which may be related to the invariable inflection of age and weight. The high order polynomial functions may better fit the growth data for poultry data(Tzeng and Becker, 1981) that is supported by the present result, but the parameters have no biological meaning. In spite of having the above limitation, the polynomial functions can be applied to calculate the inflections of age and weight. The result of our study indicate that the inflections of age deduced from quartic polynomial approach the Richards function. The young age at the inflection point of FAD(25.997 d, deduced from Richards model) is evidence of the earliness of Cherry Valley ducks growth, which is in agreement with the inflection age of Pekin ducks(24.1-27.6 d; Knížetová. et al., 1991b). The differences of the inflections of age and BW between FAD and FR imply feeding levels not only affect the final BW but also change the growth curve shape.

The fat deposit curves of meat-type duck

Applying the functions to fit the animals' tissue growth is rarely reported by literatures. Ji(2002) had used Logistic model to successfully describe growth pattern of the internal organs in Avine breeder hens. Gompertz function was applied to fit the visceral organs growth in Cherry Valley duck by Zhang(2005). In the present research, we try to fit the models of fat deposit pattern. We find that, as compared with the growth curve, the R^2 of fat deposits(both AF and SF) curves, accompanying with the too big asymptotic AF weight(W_A) from Gompertz, Bertalanffy and Richards models to overstep the truth, are lower which mean the poor goodness of fit. The fitting models for visceral organs are inferior to the growth curves in breeder hens (Ji et al., 2002) and meat-type ducks(Zhang et al., 2005). Considering the reasons, it may attribute to the limited replicates and not enough duration of the experiment because the fat deposits mainly happen in the finishing period of rearing. Therefore, in the future research we should enlarge the replicates of birds and prolong the experimental duration. Comparatively speaking, the polynomials have the better goodness of fit for fitting growth and fat deposit curves which indicate its abroad application. In our research, feed restriction change the fat deposition curve through altering the inflections of age and mass result in the final fat deposit decreasing. In conclusion, it seemed that the whole period feed restriction decreased the BW, BWG and fat mass and altered the growth and fat deposition curves of meat-type duck.

Acknowledgements

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INCORPORATION OF RAPESEED MEAL IN MULE DUCK DIETS

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Summary

Two experiments were undertaken in order to evaluate the possibilities of incorporation of rapeseed meal in the diets of mule ducks, during the starting period from hatching to 4 weeks, and during the growing period between 5 and 12 weeks. The first trial has shown that rapeseed meal can influence negatively the growth of mule ducks during the starting period. However as far as a compensative growth rate is noticed subsequently, incorporation of rapeseed meal at the level of 7 % in the starting diets appears possible. Mule ducks appear less sensitive to rapeseed during the breeding period, and thus a higher incorporation rate should be possible. However a last trial in extensive conditions of production seems necessary before delivery of a recommendation at a precise level.

Key words

Mule ducks, nutrition, rapeseed meal, growth, feed conversion ratio.

Introduction

Due to a programmed failure in mixture of petrol, green gasoline has hardly developed. Among these new sources of gasoline, oil methyl ester originating from oilseed constitutes an increasing and significant proportion (Vilarino, 2006). The production of oil methyl ester from oilseed is accompanied by a co-product: meal. Among these products, rapeseed meal is a consistent source of protein (average level ranking between 33 and 35% of Crude Protein) with its amino acid content being well balanced (Sauvant *and al* 2004). This meal represents a large amount of raw material available for animal feeding, 800 000 thousands tons in 2006, 3.1 millions tons expected in 2010 solely for rapeseed in France. However the nutritional value of rapeseed meal has been reported to be affected by its content in glucosinolates (Shahidi, 1997, Valbion, 2006).Glucosinolates confer a bitter taste to the diets which influences the palatability (Albar, 2001); furthermore they can lead to an hypertrophy of the thyroid glands, and subsequently to lower growth (Sturkie, 1986; Tadelle, 2003). In spite of these disadvantages, rapeseed meal represents an opportunity to diversify the raw material range, and to valorise local productions, and to reduce the use of imported sources of proteins like soyabean meal, even if this raw material remains by far the most commonly used for animal feeding. In this report, we will deal with the opportunity to introduce rapeseed meal in the diets of mule ducks dedicated for "foie gras" production, but only during their raising period.

Experiment 1

Material and method

672 day old ducklings of a commercial strain (CF80*M14) are randomly placed in a 16 pens building, at the number of 42 birds per pen. The experimental period runs from 1 day to 28 days. During the trial, birds are fed *ad libitum* with four experimental diets exhibiting the same analytical characteristics, (188g CP/Kg and 2780 Kcal/Kg), but with different levels of rapeseed meal: 0, 7, 14 and 21% respectively for diets 1, 2, 3 and 4. Each diet is set as four replicates. The diets are presented in pellets form, and the feed consumption per pen is registered. Onward four weeks of age all ducks are fed with the same commercial diet (155g CP/Kg and 2850 Kcal/Kg) until they are 12 weeks old. From 4 to 6

weeks they are fed *ad libitum,* and thereafter they are feed restricted to the same amount of food, but varying in the time: 260g per day and per bird from 7 to 10 weeks, and 230g up to 11 weeks and the food is then daily progressively increased to reach 350g at 12 weeks. This alimentary schedule is classical and specific with birds dedicated to force feeding. This last procedure has the aim to check that the capacity of "foie-gras" production was not affected by the diets. However these last results are not presented in this paper. All along the breeding period individual body weight is registered at 2, 4, 6, 8, 10 and 12 weeks. The quality of feathering is inspected at 8 weeks. At 4 weeks and 12 weeks a representative sample of 20 birds per treatment is slaughtered, meat production and fatness is measured after anatomical dissections. The thyroid gland of the left position is collected and weighed. Statistical analyses are performed using the Statview software. Data are submitted to variance analysis and when appropriate, the means are compared using a PLSD Fisher test. Non parametrical data are submitted to the Kruskall-Wallis test.

Results and discussion

The zootechnical performances are presented in table 1. At 2 weeks of age control birds exhibit a significant higher body weight than birds fed with the highest level of rapeseed (573 *vs* 539g), while ducks fed with diets 2 and 3 are intermediary. In spite of this the relation between the percentage of rapeseed meal and the body weight is very low ($R^2 = 0.016$). At 4 weeks, the body weight of birds fed with diets 1 and 2 (1647g and 1639g respectively) is significantly higher than ducks of treatment 4 (1586g). The ducks fed with diet 3 are intermediary. The same result is confirmed at 6 weeks of age where the different groups are ranking at the same. At 8 and 10 weeks of age ducks of group 4 which have received 21% of rapeseed remained lighter but curiously the birds of group 3 (14% of rapeseed) are the heaviest. At 12 weeks no significant differences subsist between the four treatments. Globally we found that rapeseed meal affects scarcely but significantly the growth at first and that later a compensative growth has cancelled these differences. The differences when they exist in the youngest stages are not related to feed consumption or feed conversion ratio since no differences appear for these parameters. These results agree with bibliographic data (Albar, 2001; Lessire 2009). However the low number of replicates (4) and the fact that after six weeks birds are fed at the same level can partly (at least) explain this result.

Anatomical dissection results are presented in table 2. Whatever the age of the dissection, and whatever the level of incorporation, the rapeseed does not influence the meat production (*pectoralis major* muscle and thigh and shanks) nor the abdominal fat pad. By contrast all the birds which receive rapeseed, exhibit a significant increase in thyroids glands at four weeks compared with the control birds, a result globally in accordance with body weight registered at this stage. This result however is not found any more at 12 weeks of age where no difference is registered. In addition no effect is found regarding feathering or mortality rate (data not shown). xperiment 2

Material and method

560 day old ducklings of a commercial crossbreeding (CF80*M15) are placed in 16 pens, with four treatments in quadruplicates. Two alimentary periods are defined, the starting period 0 to 4 weeks where all birds receive starting diets with the same characteristics of: 180 g CP/kg and 2850 Kcal/kg. Birds of group 1 are considered as control birds and they are fed a diet without rapeseed meal; the birds of groups 2, 3, and 4 are given a diet with 7 % of rapeseed meal according to the recommendations suggested after the first trial (Bernadet, 2008). The second stage of the experiment is the breeding period which last from 5 weeks to 12 weeks. Four experimental diets, that have the same characteristics (155g CP/kg and 2850 Kcal/kg) but differing with their rapeseed content are provided. Again diet 1, the control is rapeseed free, the others diets 2, 3, and 4 contains respectively 7, 14 and 21% of rapeseed. Beside the diets, the alimentary schedule in terms of food provided was the same as in the first experiment: *ad libitum* from birth to six weeks of age, feed restricted afterwards. At 4, 8 and 12 weeks of age, all ducks

are individually weighed, feed consumption is measured and feed conversion ratio is calculated. As in the previous trial a representative sample of 20 birds per treatment is slaughtered for meat and fat evaluation and thyroid weight determination both at 8 and 12 weeks of age.

Results and discussion

In accordance with the results of the first experiment no significant difference is found for body weight at 4 weeks of age, mule ducks support a 7% introduction of rapeseed during the starting period (table 3). Four weeks later the same result is observed. At the end of the experiment (12 weeks), some differences are registered but not as a linear response. Indeed control birds (group 1) are the heaviest, and differ significantly from ducks of group 2 and 4, ducks of group 3 being intermediary. After anatomical dissections (table 4) all the parameters which deal with meat production or fatness don't exhibit any difference according to the diet utilised. This observation is consistent both for birds to be slaughtered at 8 or 12 weeks. Again with the same reservation that only four replicates are used and that the same amount of food is provided during the last six weeks, there is no significant difference found for feed consumption or feed conversion ratio. This result is in accordance with observations related by Tadelle (2003) and Lessire (2009). No differences are found either for feathering at 8 weeks. By contrast thyroid glands exhibit tremendous differences either at 8 weeks of age or at 12 weeks. Globally it appears that thyroid weight was directly related to the percentage of rapeseed in the diet and that the weight of those of group 4 was approximately three fold heavier than those of the control group (table 4).

Table 1: Effect of rapeseed meal during the starting period on body weight (g), feed consumption (Kg) and feed conversion ratio.

	D 1 (0%)	**D 2 (7%)**	**D 3 (14%)**	**D 4 (21%)**	Statistical meaning
Growth					
2 weeks	573 ± *90* ***b***	553 ± *95* ***ab***	560 ± *93* ***ab***	539 ± *94* ***a***	***
4 weeks	1647 ± *154* ***b***	1639 ± *186* ***b***	1621± *191* ***ab***	1586 ± *197* ***a***	**
6 weeks	2956 ± *234* ***b***	2956 ± *284* ***b***	2903 ± *306* ***ab***	2859 ± *315* ***a***	***
8 weeks	3615 ± *293* ***ab***	3656 ± *355* ***ab***	3673 ± *376* ***b***	3565 ± *392* ***a***	**
10 weeks	4001 ± *330* ***a***	4037± *424* ***ab***	4118 ± *451* ***b***	3983 ± *466* ***a***	**
12 weeks	4193 ± *398*	4245 ± *449*	4260 ± *448*	4230 ± *505*	ns
Feed Consumption and Feed Conversion Ratio					
0 to 4 weeks	2.92	2.93	2.91	2.89	-
5 to 12 weeks	15.24	14.96	14.71	14.73	-
FCR 0 to 4 weeks	1.86	1.88	1.87	1.88	-
FCR 5 to 12 weeks	6.36	5.85	5.69	5.81	-

*, **, *** : significant effect at the respective level of P<0.05, <0.01, <0.001 ; ns : non significant effect; Means affected with the same letter do not differ significantly.

Table 2: Effect of rapeseed meal during the starting period (0-4 weeks) on meat production, fatness, and thyroids at 4 and 12 weeks of age.

	D 1 (0%)	**D 2 (7%)**	**D 3 (14%)**	**D 4 (21%)**	Statistical meaning
Meat production, fatness and thyroids at 4 weeks					
Thyroid weight (g)	0.054 ± *0.014* **a**	0.077 ± *0.019***b**	0.088 ± *0.403***b**	0.083 ± *0.218***b**	***
Pectoralis major muscle (g)	17.62 ± *2.83*	17.76 ± *4.32*	17.32 ± *3.82*	16.24 ± *4.07*	ns
Thigh and Shank (g)	139.3± *11.55*	139.5 ± *16.73*	135.9 ± *13.75*	135.9 ± *15.17*	ns
Abdominal fat (g)	13.30 ± *3.99*	13.17 ± *4.28*	15.04 ± *5.31*	14.39 ± *4.29*	ns
Meat production, fatness and thyroids at 12 weeks					
Thyroid weight (g)	0.158 ± *0.037*	0.166 ± *0.033*	0.184 ± *0.046*	0.181 ± *0.041*	ns
Carcasses weight (g)	3661 ± *363*	3662 ± *300*	3712 ± *318*	3687 ± *300*	ns
Filet skin (g)	77.7 ± *13.1*	72.6 ± *11.3*	75.6 ± *13.3*	76.3 ± *14.5*	ns
Pectoralis major muscle (g)	287 ± *27.2*	290 ± *23.4*	295 ± *34.0*	284 ± *22.9*	ns
Thigh and Shank (g)	347 ± *39.6*	342 ± *35.6*	344 ± *34.4*	343 ± *33.1*	ns
Abdominal fat (g)	53.5 ± *19.6*	41.0 ± *15.1*	52.5 ± *20.3*	48.0 ± *17.1*	ns

Table 3: Effect of rapeseed meal during the breeding period (5-12 weeks) on body weight (g), feed consumption (Kg) and feed conversion ratio.

	D 1 (0%)	**D 2 (7%)**	**D 3 (14%)**	**D 4 (21%)**	P Value
Growth					
4 weeks	1477 ± *162*	1501 ± *175*	1473 ± *216*	1460 ± 188	ns
8 weeks	3622 ± *354*	3545 ± *374*	3548 ± *374*	3545 ± *363*	ns
12 weeks	4384 ± *330* ***a***	4247 ± *393* ***b***	4317 ± *347* ***ab***	4257 ± *360* ***b***	0.0147
Feed Consumption and Feed Conversion Ratio					
0 to 4 weeks	2.59± *0,06*	2,64 ± *0,11*	2,94 ± *0,14*	2,65 ± *0,09*	-
5 to 12 weeks	13,44 ± *0,46*	13,09 ± *0,35*	13,25 ± *0,30*	13,27 ± *0,30*	-
0 to 12 weeks	16,04 ± *1,28*	15,73 ± *0,41*	15,90 ± *0,24*	15,92 ± *0,22*	-
FCR 0 to 4 weeks	1,84	1,86	1,90	1,92	-
FCR 5 to 12 weeks	4,71	4,83	4,63	4,80	-

Table 4: Effect of rapeseed meal during the breeding period (5-12 weeks) on meat production, fatness, and thyroids at 8 and 12 weeks of age (all parameters in gram).

	D 1 (0%)	**D 2 (7%)**	**D 3 (14%)**	**D 4 (21%)**	P Value
Meat production, fatness and thyroids at 8 weeks					
Bled plucked weight	2860 ± *268*	2815 ± *306*	2816 ± *319*	2792 ± *303*	*Ns*
Thyroids	0.181 ± *0.054* ***d***	0.375 ± *0.188* ***c***	0.490 ± *0.144* ***b***	0.621 ± *0.175* ***a***	<0.0001
Pectoralis major	153.2 ± *22.4*	140.0 ± *31.5*	138.4 ± *29.0*	136.9 ± *27.9*	*Ns*
Filet skin	62.0 ± *11.1*	64.78 ± *15.5*	60.91 ± *12.4*	61.10 ± *10.2*	*Ns*
% fat (skin) in filet	28.8 ± *2.9*	31.7 ± *5.2*	30.7 ± *3.4*	31.1 ± *3.2*	*Ns (0.08)*
Thigh and Shanks	332.8 ± *29.9*	332.7 ± *34.0*	337.2 ± *37.5*	328.4 ± *36.1*	*Ns*
Abdominal fat	66.1 ± *14.5*	69.9 ± *21.6*	67.9 ± *19.4*	64.4 ± *20.2*	*Ns*
Meat production, fatness and thyroids at 12 weeks					
Bled plucked weight	3435 ± *264*	3406 ± *352*	3461 ± *303*	3428 ± *331*	*Ns*
Thyroids	0.284 ± *0.068* ***c***	0.508 ± *0.102* ***b***	0.577 ± *0.159* ***b***	0.702 ± *0.201* *a*	<0.0001
Pectoralis major	298.9 ± *25.0*	288.8 ± *31.4*	286.8 ± *27.7*	292.4 ± *25.7*	*Ns*
Filet skin	71.0 ± *12.9*	73.9 ± *17.6*	74.9 ± *16.8*	72.9 ± *17.0*	*Ns*
% fat (skin) in filet	19.2 ± *2.8*	20.3 ± *3.9*	20.3 ± *3.3*	19.8 ± *3.5*	*Ns*
Thigh and Shanks	345.5 ± *31.9*	343.3 ± *57.6*	352.4 ± *37.1*	348.4 ± *37.7*	*Ns*
Abdominal fat	64.8 ± *20.0*	60.0 ± *20.7*	67.3 ± *26.6*	68.7 ± *29.3*	*Ns*

Conclusion

Considering the results of these two trials, there may be an opportunity to use rapeseed meal for mule duck nutrition. However it is probably necessary to use this new raw material with care. Since no detrimental effect has been observed in the starting period at the level of 7 %, and this in the two trials, it seems that such a supplementation should be recommended, but 7 % constitutes the maximum level. The total amount of rapeseed that should be used is much more important in the breeding period as far as this stage represents more than 80% of the total food consumed at the age of 12 weeks. Additionally, contrary to what was recorded during the starting period, it seems that older birds are less sensitive to rapeseed, which allows the use of a higher percentage in the breeding period. Indeed even if the live body weight was significantly affected by rapeseed at 12 weeks, no difference was established for meat production, and on this basis one could say that 21% of incorporation should possible. This argument should be reinforced by the fact that birds fed with rapeseed have produced the same amount of "foie gras" when force fed, Bernadet *et al* 2008. (Data not discussed in this session). On another hand we cannot assume that nothing happened with the highest level of rapeseed in that the weight of the thyroid was dramatically increased. This suggests that even at a low level the glucosinolates have affected the thyroid functioning and probably the thyroxin production. However this hypothesis was not supported by the fact that any evidence of fatness occurs in animals fed with rapeseed. There is by the way a need for further investigation before being able to recommend the use of rapeseed at a high level. Such a program will be

scheduled, integrating larger flocks of ducks, and rearing them in extensive systems close to the commercial conditions of production.

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UTILISATION OF DRIED CUTTLE FISH (SEPIA OFFICIALIS) WASTE SILAGE IN LAYER DUCK RATION

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An experiment was conducted in Department of Poultry Science, Kerala Agricultrural University to assess the feeding value of dried cuttle waste silage in layer duck rations. Ninety six (96) Kuttanad breed of layer ducks that are indigenous to Kerala state were used for the study. These ducks were housed in cages at the rate of two ducks per cage and were divided into three groups of 32 each and fed rations T1 , T2 and T3 containing dried cuttle fish waste silage (DCFWS) at the rate of 0 , 11.45 , 22.9 per cent respectively. All the diets were made isocaloric and isonitrogenous . The results of the study revealed that the egg production during the period from 25 to 44 weeks of age were comparable in all groups. The mean daily feed consumption and the overall FCR were similar in the three dietary groups . However, the overall mean egg weight was significantly higher in both groups fed 11.45 and 22.9 per cent DCFWS compared to the control group. It was concluded that dried cuttle waste silage can be included in layer duck rations at 11.45 and 22.9 per cent levels recording significantly higher egg weight.

Key words: Dried cuttle fish waste silage; production; layer ducks

Introduction

Duck production serve as a boon to the livelihood of the poor and marginal farmers in the backward strata of the society but the farmers strive hard to locate foraging fields under extensive system of rearing. Studies conducted under the NATP proved that ducks also could be reared under cage system without adversely affecting the production performance. India has very long coastal belt and seafood export is the potential source of foreign exchange. Processing plants generate huge quantity of fish wastes. Improper disposal of fish wastes pollutes water, air and environment and high quantum of animal protein present in wastes is being lost. Cuttle fish is considered to be superior over other fishes because of higher lysine and methionine content with added advantage of its fat rich in omega 3 fatty acids DHA and EPA. Attempts are being made to convert fish wastes into livestock feeds as a substitute for fish meal or dried fish but feeding experiments with fish wastes in ducks are scanty. Therefore, the present study was planned in layer ducks assess the effect of incorporation of dried cuttle fish waste silage on production characteristics of layer ducks.

Materials and methods

At 24 weeks, ninety six (96) indigenous layer ducks were housed in 48 cages at the rate of two ducks per cage. They were divided into three groups T1, T2 and T3, consisting of 32 ducks in each

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treatment group having eight replicates with four ducks in each replicate. The diet T1 contained 10 per cent dried fish (DF) and zero per cent dried CFWS. Dietary group T2 had a combination of 5 per cent DF and 11.45 per cent dried CFWS while diet T3 was having 22.9 per cent dried CFWS replacing DF completely. All diets were made iso-caloric and iso-nitrogenous The production performance of ducks was recorded from 25 to 44 weeks of age. Egg production was recorded on daily basis while the feed consumption was recorded fortnightly and the feed conversion ratio was arrived per dozen and per kg egg mass basis. All eggs were weighed individually throughout the experimental period and egg mass was calculated per duck basis. Statistical analysis of data was done according to Snedecor and Cochran (1985).

Results and discussion

The duck housed number (DHN) averaged between 0.34 to 11.31 eggs in various fortnights from 25 to 44 weeks but it was differed significantly only during fortnights 41-44 weeks of age. While the overall DHN was 75.06 , 67.25 and 63.72 eggs in T1, T2 and T3 respectively and the differences between mean values were non significant ($P<0.05$). The overall mean DHP from 25 to 44 weeks of age was 53.61, 48.03 and 46.21 in T1, T2 and T3 respectively were statistically non significant ($P<0.05$) each other. The overall mean daily feed consumption were 166.36, 166.80 and 168.35 in T1, T2 and T3 respectively were statistically comparable each other. The fortnightly mean daily feed consumption also was not influenced by incorporation of varying levels of dried CFWS. The overall feed conversion ratio per dozen eggs was 3.58, 4.23 and 4.32, while that per kg egg mass was 4.65, 5.14 and 5.22 in T1, T2 and T3 respectively. Although better in T1, the varying levels of dried CFWS replacing DF in diets, FCR did not show significant difference in overall mean EW between groups. However, the FCR per dozen eggs and per kg egg mass were significantly better in the control group during fortnights at 41-44 weeks of age. Overall mean egg weight (EW) was 63.80, 67.74 and 67.09 g in T1, T2 and T3 respectively resulting significantly lower EW in T1 than that of T2 and T3. The EW was comparable by feeding dried CFWS at levels 11.45 and 22.90 per cent, by partial and complete replacement of DF

Table 1. Production performance in indigenous layer ducks influenced by incorporation of varying levels of dried cuttle fish waste silage replacing dried fish in duck layer ration.

Parameter	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
Overall mean from 25 to 44 weeks			
1. Duck housed number	75.06	67.25	63.72
2. Duck housed per cent production	53.61	48.03	45.51
3. Duck day number	75.06	67.25	64.70
4. Duck day per cent production	53.61	48.03	46.21
5. Daily feed intake (g)	166.36	166.80	168.35
6. FCR/doz eggs (29 -44 weeks)	3.58	4.23	4.32
7. FCR/ kg eggs (29 - 44 weeks)	4.65	5.14	5.22
8. EW (g)	63.80 [a]	67.74 [b]	67.09 [b]
9. Egg mass (kg/duck)	4.81	4.59	4.40

Figures with different superscripts, row-wise differ significantly ($P<0.05$)

Conclusion

Considering the above findings, it was concluded that dried CFWS can be included in duck layer rations with significant improvement in mean EW by partial and complete replacement of dried fish on crude protein basis without affecting production traits DHN, feed consumption, FCR and egg mass, under cage system of rearing.

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INFLUENCE OF DIETARY CALCIUM AND PHOSPHORUS LEVELS ON PRODUCTION PERFORMANCE IN INDIGENOUS LAYER DUCKS IN CAGES

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Abstract

A 3x3 factorial experiment was carried out in the department of Poultry Science, KAU to establish the optimum requirements of Calcium (Ca) and Available Phosphorus (AP) in the diets for indigenous layer ducks of Kerala in cage system of rearing. Ninety female ducks at 18 weeks of age housed in California type cages at the rate of two ducks per cage. Nine experimental diets containing three levels of Ca viz., 3.0, 3.5 and 4.0 per cent with three levels of AP viz., 0.4, 0.5 and 0.6 per cent were formulated and were fed to nine treatments. The Ca and AP levels did not influence significantly the 40 th week body weight. The duck housed number 68.2 and Duck housed per cent (60.7±1.12) were significantly higher with ducks fed 4.0 per cent Ca ($P<0.05$). The Ca and AP levels in the diet did not influence the mean daily feed consumption and FCR. There was no mortality during the period of study. The study revealed that 4.0 per cent Ca and 0.6 per cent AP will be the optimum level for layer ducks. Contains 3 tables

Key words: Indigenous ducks, cages, calcium, phosphorus and egg production.

Introduction

In poultry production, the minerals are equally important as other nutrients. Since its imbalances, deficiencies or excess level may produce severe consequences in biological system. The major minerals viz., calcium and phosphorus are vital for egg production and shell formation in laying ducks and they use variety of mechanisms to control the calcium-phosphorus ratio and its metabolism. The ratio of these elements in the diet has been the subject of interest since calcium and phosphorus compete each other for absorption in the intestines. The availability of mineral resources for inclusion in the diets to maintain the egg production and shell quality has been a crucial problem faced by duck farmers in this region. In order to address the above problem, the present study was undertaken to assess the requirements of dietary calcium and AP in indigenous layer ducks under cage system of rearing.

Materials and Methods

At 20th week of age, the individual body weight were recorded and housed in California type cages at the rate of two ducks per cage. The dimensions of the cages were 60 x 45 x 40 cm with the floor area of 1350 cm^2 per duck. Three levels of calcium viz., 3.0, 3.5 and 4.0 per cent with three levels of AP viz., 0.4, 0.5 and 0.6 per cent were employed in the diet in a 3 x 3 factorial arrangement.

The feed ingredients used in the ration were analysed for proximate composition and for calcium and total phosphorus contents as per the procedure described in AOAC (1990). The experimental rations with 18 per cent CP and 2650 Kcal ME/Kg was formulated as suggested by Srivastava and Panda (1982). The calcium and AP levels in the experimental diets were maintained by adding varying quantities of oyster shell grit and dicalcium phosphate.Feed was given as wet mash and water was provided *ad lib*.The experiment consisted of four periods of 28 days each from 25 to 40 weeks of age. Individual body weights recorded at 40 weeks of age also.

Daily egg production under different treatment groups was recorded. Feed intake was measured at the end of each period and the mean daily feed consumption calculated. Feed efficiency was calculated based on egg number as well as egg mass. The mean egg weight was arrived based on the individual egg weights recorded daily.

The data collected were subjected to statistical analysis as per Snedecor and Cochran (1980).

Results and Discussion

The statistical analysis revealed that there was no significant difference in body weights at 40 week of age (Table 1 and 2).

The 40th week BW recorded in the present study were higher than the body weight of 1380 g reported by Chen (1992) in Tsaiya ducks and 1311 g reported by Andrews *et al*. (1984) in indigenous ducks of Kerala fed with diet containing 3.31 per cent Ca and 1.17 per cent total Phosphorus. This value was lesser than the body weight (1552±42.8 g) reported in the present study at 3.0 per cent Ca and 0.4 per cent P levels.

The absolute values of age at first egg in the flock of ducks fed diets containing 3.0, 3.5 and 4.0 per cent Ca level was 154, 158 and 148 days (Table 1) and that fed 0.4, 0.5 and 0.6 per cent AP levels was161, 154 and 148 days respectively (Table 2).

The cumulative per cent production was comparable between 3.0 and 3.5 per cent Ca levels and that recorded with 4.0 per cent Ca was significantly higher than other levels. The interaction effect on production (Table3) with 4.0 per cent Ca and 0.6 per cent P level was significantly higher (71.9±2.27 per cent) than other diets ($P<0.05$). These results are in agreement with 69.1 per cent production in Khaki Campbell ducks with 2.74 per cent calcium and 0.52 per cent available phosphorus (Reddy *et a*l., 1981). However the production was 64.6±3.4 per cent in the present study (at 3.0 and 0.4 per cent) was lesser than the above said values.

Andrews *et al.* (1984) reported the duck-day egg production of 14.9 per cent under intensive system and 12.6 per cent in semi-intensive system of management with the diet containing 3.31 per cent calcium and 1.17 per cent total Phosphorus from 21 to 44 weeks of age. Whereas TianFwu *et al*. (1998) reported that the Tsaiya ducks fed diet with 3.0 per cent calcium showed higher egg production (85.56 per cent) than other treatment groups. Where in the duck house egg production were 71.43, 80.84, 83.84 and 74.64 per cent respectively in groups fed 2, 2.5, 3.5 and 4.0 per cent calcium levels.

The Ca, P levels and their interaction did not influence significantly the mean daily feed consumption (Table 3). Andrews *et al*. (1984) reported 191 g under the intensive system and 185g under the semi-intensive system with diet containing 3.31 per cent calcium and 1.17 per cent total Phosphorus during the period from 21 to 44 week of age. TianFwu *et al*. (1998) reported the mean daily feed consumption values of 194.89 and 193.49 g with 3.0 and 3.5 per cent calcium levels and were lower than that recorded at 2, 2.5, and 4 per cent calcium levels (203.87, 200.12 and 202.14 g) were widely differed from the present findings.

The better the FCR recorded with 4.0 per cent Ca and 0.6 per cent AP levels. The numerical values with other levels of Ca and AP were almost similar. TianFwu *et al*. (1998) reported comparatively higher the FCR/dozen eggs of 3.41 and 3.48 at 3.0 and 3.5 per cent calcium levels and these values were better than that recorded with 2.0, 2.5 and 4.0 per cent levels of calcium, wherein the mean values were 4.16, 3.61 and 3.98 respectively.

Avens *et al*.(1980) reported the 3.0 FCR /dozen eggs both in cage and floor rearing systems with 3.2 per cent Ca and 0.57 per cent AP level. Reddy *et al*. (1981) reported the 2.08 FCR/dozen eggs with 2.74 per cent calcium and 0.52 per cent available phosphorus during 21 to 52 weeks of age. Conversely, Andrews *et al*. (1984) reported the 19.5 FCR/dozen eggs in desi ducks in the intensive system and 22.7 in the semi intensive system by feeding 3.31 per cent calcium and 1.17 per cent total phosphorus in the diet.

Table 1. **Influence of dietary Ca level in indigenous layer ducks on production performance from 25 to 40 weeks of age**

Ca level	Body weight (g)		ASM days	Egg production		Feed consumption (g)	FCR	
	20 week	40 week		DHN	DHP		Per dozen egg	Per Kg Eggs
3.0	1418±9.01	1559±19.71	154	66.7[b]	59.4±1.94[b]	137.2±2.65	2.8±0.14	3.9±0.12
3.5	1427±18.98	1520±24.0	158	65.3[b]	58.0±1.90[b]	133.6±3.36	2.8±0.14	4.0±0.21
4.0	1448±21.46	1553±27.51	148	72.3[a]	64.6±1.92[a]	140.7±2.69	2.7±0.14	3.8±0.18
	1431±9.96	**1544±13.76**	**148**	**68.2**	**60.7±1.12**	**137.2±1.49**	**2.8±0.08**	**3.9±0.1**

Note: Mean values bearing same superscripts within the column did not differ significantly (P<0.05)

Table 2**.** **Influence of dietary available phosphorus level in indigenous layer ducks on production performance from 25 to 40 weeks of age**

P level	Body weight (g)		ASM days	Egg production		Feed consumption (g)	FCR	
	20 week	40 week		DHN	DHP		Per doz. egg	Per Kg eggs
0.4	1440±13.06	1529±26.98	161	69.0	61.5±1.97	136.1±2.66	2.7±0.12	3.8±0.18
0.5	1430±18.41	1549±17.88	154	67.4	60.0±1.63	139.4±2.43	2.8±0.10	3.9±0.08
0.6	1423±20.29	1553±26.71	148	68.1	60.6±2.21	136.1±2.70	2.8±0.19	4.0±0.23
	1431±9.96	**1544±13.76**	**148**	**68.2**	**60.7±1.12**	**137.2±1.49**	**2.8±0.08**	**3.9±0.10**

Note: Mean values bearing same superscripts within the column did not differ significantly (P<0.05)

Table 3.**Influence of dietary Ca and AP in indigenous layer ducks on production performance from 25 to 40 weeks of age**

Diet no.	Treatment		Body weight (g)		ASM days	Egg production		Feed consumption(g)	FCR	
	Ca %	AP %	20 week	40 week		DHN	DHP		Pe dozen egg	Per Kg eggs
1	3.0	0.4	1411±23.1	1552±42.8	163	72.7	64.6±3.4^{ab}	136.3±4.5	2.5±0.1	3.6±0.1
2	3.5	0.5	1438±7.5	1578±26.4	154	69.3	61.6±2.7^{abc}	145.0±4.4	2.8±0.2	4.0±0.1
3	4.0	0.6	1400±9.1	1546±37.6	155	58.6	52.0±3.5^{c}	130.3±4.4	3.1±0.3	4.1±0.3
4	3.0	0.4	1442±11.8	1473±18.1	161	64.4	57.5±2.7^{bc}	132.8±4.1	2.8±0.1	3.9±0.1
5	3.5	0.5	1436±51.9	1508±29.5	158	67.6	58.6±3.0^{bc}	133.8±4.0	2.7±0.1	3.8±0.1
6	4.0	0.6	1405±27.4	1579±58.3	175	64.8	57.9±4.2^{bc}	134.2±4.4	3.0±0.4	4.3±0.7
7	3.0	0.4	1465±29.3	1562±65.4	157	69.9	62.4±4.0^{abc}	139.1±5.3	2.8±0.3	4.0±0.5
8	3.5	0.5	1415±27.1	1563±33.4	158	66.9	59.4±2.9^{bc}	139.3±4.0	2.9±0.3	3.9±0.2
9	4.0	0.6	1465±53.2	1535±49.2	148	80.9	71.9±2.3^{a}	143.8±4.8	2.4±0.1	3.6±0.2
			1431±10.0	**1544±13.8**	**148**	**68.2**	**60.7±1.1**	**137.2±1.5**	**2.8±0.1**	**3.9±0.1**

Note: Mean values bearing same superscripts within the column did not differ significantly (P<0.05)

Conclusion

The study revealed that the dietary calcium and AP levels did not influence the mean daily feed consumption and FCR significantly. On the other hand, dietary AP levels influenced the mean egg weight. Though the mean egg weight of 60.1±0.566 g with 0.5 per cent AP was significantly higher, the significant interaction on egg number with the 0.6 per cent AP and 4.0 per cent calcium was found superior. Therefore it will be logical to set the requirements of AP at 0.6 per cent level. So it can be concluded that the 4.0 per cent calcium with 0.6 per cent AP with 18 per cent crude protein and 2650 kcal ME/kg was optimum for indigenous layer ducks under cage system of rearing.

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AZOLLA: A FEED SUPPLEMENT FOR LAYING DUCKS AT BACKYARD LEVEL IN A&N ISLAND

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Abstract:
Duck farming has long been adopted as livelihood option at backyard level in A&N Island and found to be highly adapted to this hot and humid climatic condition. Geographical isolation of these islands from mainland, the non availability of feed ingredients and higher price of commercial feed poses greater emphasis to identify the newer feed supplement to directly replace commercial feed to reduce the feed cost and to improve the efficiency of ducks. Nitrogen fixing aquatic fern, commonly found unconventional feed ingredient in tropics and subtropics, the *Azolla* can be cultivated with hardly any infrastructure. It was demonstrated that Azolla could be grown and cultivable under this island ecosystem and its nutritive value showed the feasibility of its utilization as a feed supplement for livestock and poultry. A trial for a period of 13 weeks was conducted in laying ducks. Layer ducks of 20 weeks old were divided into two groups with four replications. Group I: Azolla supplementation @200 gms /bird/day, Group II: without any azolla supplementation or control group. Production Parameters viz., Feed intake, Egg production and Feed cost benefit ratio were monitored. The Egg quality parameters viz., Egg weight. Yolk index, Albumen index and shell thickness were estimated. The results revealed that the egg production was not significantly differed between groupI (38.8%) and group II (39.9%). However, group I replaced 30%concentrate feed with azolla supplementation @200g/bird/day. The savings in feed cost was calculated as Rs. 1 per bird per day in groupI over control group. No adverse effect of Azolla feeding on egg qualities was observed. It was concluded that Azolla could be safely supplemented in the feed of laying ducks at backyard level with a significant savings in feed cost.

Key words: Fresh Azolla supplementation, ducks, Production performance, feed cost benefit

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Introduction

The verdant Andaman and Nicobar group of Islands popularly known as "Bay Islands," are situated in the Bay of Bengal spreading in an arch from North to South at a distance of about 1200 Km from the mainland India. Backyard duck rearing is an integral part of the various farming systems in these islands and local ducks are reared in very small numbers under free-range conditions. Of over 9-lakh poultry population, the duck population is over 70,000 of which only few hundred ducks are of improved varieties. Local andaman ducks are small in size and lay small sized 110 eggs per annum (Senani et al 2005). Introduced varieties include Chara-Chambelli, Pekin, Khaki cambell. Invariably duck constitutes as an one of the important component in pond based models existing in the islands. There is high demand for duck meat and egg in the market. Cost of duck for meat and egg is Rs. 180-200 per bird and Rs.5 per egg respectively. However there is substantial reduction in the production level and profitability of backyard duck farming which could be mainly due to shortage of feed and high cost involved in the procurement and transport of raw materials or readymade feed materials from mainland.

Thus a greater emphasis has been placed to identify the new feedstuff to directly replace the existing commercial feed thereby to reduce the feed cost, to improve performance of duck. The search for an alternative to concentrate feed led us to a wonderful aquatic fern Azolla. Azolla is fairly a good source of protein and contains about 24-30% crude protein (on dry weight basis) since it is capable of assimilating atmospheric nitrogen due to the presence of symbiotic blue green algae, Anabaena azollae in its leaves (Moore, 1969). Azolla inturn provides the carbon source and favourable environment for the growth and development of the algae. It is this unique symbiotic relationship that makes azolla a wonderful plant with high protein content. This aquatic fern was introduced in A&N islands as a nutritious and low cost feed to livestock feeding by Animal Science Division, Central Agricultural Research Institute, Port Blair. Hence considering the qualities of Azolla, a study was planned to evaluate Azolla as a direct feed supplement by replacing a portion of commercial feed in laying ducks.

Materials and Methods

An experiment was conducted for a period of 13 weeks to study the production performance and feed cost benefit with azolla supplementation in native local ducks. *Azolla pinnata* seed material received from Tamil Nadu Agricultural University, Coimbatore was used as inoculum and was cultivated in a 27 m^2-cemented tank in Animal Science division farm complex of the institute. Concrete tank contained a layer of soil and 10 cm of standing water supplemented with cow dung @ 1 kg and 30 gms of superphosphate per 10 litres of water for every 2 m^2 area with inoculums of 7 kg fresh Azolla. Azolla biomass doubled in a week. Azolla yielded approximately 700-800 gms/m^2. Fresh Azolla was harvested, washed four or five times thoroughly to remove the mud, sand, small roots and cow dung smell from the leaves. Fresh samples were sun dried immediately after collection and were analyzed for proximate principles as per the method of AOAC (1990).

Forty native local ducks of 20 weeks age were randomly housed in four pens with ten birds in each in a open sided house with a floor space of 4 sq ft per duck. They were divided into two groups with two replicates of each. Two replicates were assigned to each of the two dietary treatments in a completely randomized design. The two dietary treatments consisted of standard layer mash (control group) and commercial Layer mash + 200 gm fresh Azolla (Treatment /Azolla group). Fresh Azolla was offered to ducks in a separate container. Ducks were fed with commercial layer mash adlibidum from 20 to 33 weeks of age. The performance of ducks for the 13 weeks period was recorded. The chemical composition of commercial layer mash is shown in Table 1. The data on feed consumption, Hen day egg production percent, egg weight were collected. Two eggs from each replicate were collected on the last day of every week for assessing egg qualities. Feed consumption, percent feed and feed cost saved by azolla supplementation were assessed. The feed cost: benefit ratio in terms of feed cost saved over control group was calculated.

Results

Proximate composition of sundried Azolla

The proximate composition of *Azolla pinnata* is given in Table 2. It contained dry matter, crude protein ether extract, crude fibre, and the total ash 6.6, 21.17±0.57, 3.39±0.11, 14.6±0.54, 19.91±0.98 per cent respectively. The calcium content was generally high. The calcium, phosphorus ratio was 2:1.

Effect of feeding Azolla on the performance of ducks

Azolla was found to be highly palatable in ducks. The effect of Azolla supplementation on henday egg production percent, feed consumption and percent feed saved are tabulated in Table 3. The cumulative layer performance is given in the Table 4. The average daily intake of feed was 153g for ducks due to Azolla substitution and 219g for control group. Azolla feeing resulted in saving of feed at an amount of 30 per cent. The total number of eggs laid in the control group was 41 and 40 for Azolla group. Average hen day egg production percent of Azolla fed group (38.88 per cent) was comparable with control group (39.22 per cent). Egg weight and other quality parameters such as shape index, Albumen

index, and Yolk index and shell thickness were similar to control group. However, Roche fan colour score increased with Azolla supplementation in the diet. The eggs in the control group of ducks had a yolk colur score of 6.0 that increased to 7.4 with Azolla diet. By considering the average cost of the commercial feed as Rs.16 per kg feed, a 30 percent saving in the consumption of commercial feed due to Azolla supplementation resulted in feed cost savings of Rs.1 per duck per day.

Table 1: chemical composition of commercial layer feed (per cent - on dry matter basis)

Crude protein	18.0
ME (Kcal/kg)	2600
Calcium	2.75
Available phosphorus	0.50
Lysine	0.50
Methionine	0.25
Crude fibre	8.0
Salt	0.5

Table 2: Proximate analysis of Azolla (in percent on dry weight basis)

Moisture	6.62
Crude protein	21.17
Crude fiber	14.6
Ether extract	3.39
Total ash	19.91
Calcium	1.05
Phosphorus	0.52
Iron	0.49
Manganese	0.2

Table 3. Effect of Azolla supplementation on layer performance

Age in weeks	Henday Egg production percent		feed consumption (kg per bird per day)		per cent feed saved over control
	control	Azolla	control	Azolla	
20	12.86	12.50	0.214	0.150	30
21	28.57	26.79	0.214	0.152	29
22	32.86	39.29	0.214	0.154	28
23	31.43	71.43	0.214	0.150	30
24	35.71	57.14	0.214	0.152	29
25	37.14	55.36	0.214	0.154	28
26	55.71	30.36	0.214	0.146	32
27	58.57	62.50	0.214	0.141	34
28	62.86	50.00	0.224	0.150	33
29	57.14	50.00	0.214	0.152	29
30	44.29	38.43	0.214	0.148	31
31	28.57	24.57	0.240	0.163	32
32	32.86	22.29	0.233	0.165	29
33	25.71	18.57	0.231	0.157	32
	38.88	**39.94**	**0.219**	**0.153**	30.43

Table 4. Effect of Azolla supplementation on cumulative layer performance

Criteria	Control	Azolla
Number of eggs laid per duck	41	40
Hen day egg production per cent	39.94	38.88
Egg weight (g)	65.83±0.11	65.68±0.15
Shape Index	71.20±0.86	70.22±1.12
Albumen Index	0.094±0.0052	0.085±0.001
Yolk Index	0.42±0.0045	0.42±0.005
Yolk colour	6.22±0.14	7.41±0.16
Haugh Unit	78.20±5.11	80.41±6.11
Shell thickness(mm)	0.336±0.008	0.337±0.005
Total feed consumed per duck (kg)	21.5	15.00
Average feed consumed per duck per day (g)	219	153
Feed cost saved/duck/day (Rs)	1	

Feed cost: Rs.16/kg

Discussion

Proximate compositions of Azolla grown under island condition were similar to various authors. The dry matter content obtained on proximate analysis of sundried Azolla used in this study is similar to Subudhi and Singh (1978), Islam (1993) and Ali and Leeson (1994). The crude protein is similar to

Watanabe et al. (1977) and Querubin et al.,(1986). The same percent ether extract fraction of Azolla pinnata used for this study was obtained by Subudhi and Singh (1978) and Taklimi et al., (1993). Querubin et al.,(1986), Tamang and Samanta (1993) and Ali and Leeson (1994) has also reported the similar crude fibre content of Azolla utilised for this feeding trial. The similar average percent total ash of this study had been reported by Tamang and Samanta (1993) and Ali and Leeson (1994). The similar calcium values reported by Singh (1978), Querubin et al.,(1986) and Tamang and Samanta (1993).

The number of eggs laid and the hen day production did not vary much among the two Azolla supplementation and control groups. The variation noted in production performance is very small. Thus the results revealed that there was no significant difference in egg productivity between Azolla supplemented and control group. It indicates that Azolla supplementation in the feed of laying ducks did not affect egg production adversely. However, the feed consumption was considerably low with Azolla supplementation as against control group. More importantly significant amount of 30 per cent feed savings lead to reduced feed cost. Accordingly, Escobin (1978) recorded significantly improved production efficiency with azolla supplementation in duck ration. Khatunn et al., (1999) assessed Azolla for nutrient content and feeding value in laying hen diets. Azolla was included at a level of 50, 100, 150 and 200g kg^{-1} at the expense of sesame meal and was found that azolla meal could replace sesame meal on a digestible protein and digestible aminoacid basis up to 200g kg^{-1} diet for better egg mass out put and FCR at a level of inclusion of 200g kg^{-1}. The similar better productive performance has been obtained by Kannaiyan and Kumar (2005) in terms of higher egg yield and saved feed of 20 per cent and cost of 10.0 paise per day per bird with Azolla supplementation @ 100gm fresh per bird per day.

The egg quality parameters did not vary among the two groups, it indicates that fresh Azolla substitution used in this study was not lowering the production efficiency of ducks. On the other hand, the pigmenting ability of Azolla group was clearly demonstrated by its higher Roche fan clour score and this could be due to ability of Azolla to pigment the yolk as it is rich in beta carotein pigment. Similar influence on yolk colour due to inclusion of Azolla in layer ration was reported by Bastion (1987).

Results of the present study suggest that Azolla can be grown under island condition with minimum investment and considered as a potential alternative feed supplement in backyard/commercial duck rearing. A backyard duck farm having 50 ducks will require about 10kg fresh Azolla per day to replace 30 per cent of commercial feed. To meet out the daily need of fresh Azolla, the cultivation of Azolla in a shallow pond of 67 m^2 or 17 shallow tanks of each of 4m^2 with 30 cm depth is required. Thus approximately fifty rupees could be saved in a day towards feed cost.

Conclusion

Based on the results, it may be concluded that fresh Azolla could replace commercial feed up to a level of 30 percent with the savings in feed cost of Rs.1 per duck per day by supplementing fresh azolla in the feed of backyard ducks at the rate of 200g per duck per day. There was no significant difference in egg productivity and no adverse effect of Azolla feeding on egg qualities with Azolla supplementation. So, Azolla could be safely be supplemented in the feed of laying ducks. Azolla is considered as a promising suitable feed substitute for backyard duck farming and a boon to island farmers.

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INDIGENOUS FEEDING TECHNOLOGIES PREVALENT IN RURAL DUCK FARMING OF TAMILNADU

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Abstract

A field survey with direct contact method was carried out to document the indigenous feeding technologies followed by duck farmers in the North Eastern districts of Tamil Nadu. System of duck feeding is governed by the monsoon and paddy cultivation seasons. In rural areas especially semi-intensive / extensive system of management, the feeding system varies from place to place and mostly depends on pre-and post-harvested paddy fields, ponds, lakes, small water bodies, irrigation channels and canals. In this system, fallen paddy grains, insects, snails, earthworms, small fishes, fingerlings, tadpoles, water plants like alage etc. were the main sources of feeding for ducks. However feed resources are sufficiently available during sowing, harvest and monsoon seasons. The ducks farmers are also paying remuneration to the paddy field owners in the form of duck eggs and meat. The major disadvantage of this type of feeding is its seasonality in nature. In farmer's opinion, 100 ducks require 0.5 acre of paddy field per day for effective grazing. As the early growth of ducks up to 12 weeks is rapid than chicken, it is essential to give the sufficient nutrients to meet out the demands during this stage. But, the farmers did not give any specialized feeds or feed supplements to the ducks and they mostly doing active duck farming which coincides with two monsoon based paddy cultivation in Tamil Nadu. It clearly depicts that paddy cultivation and duck farming had been in symbiotic relationship over the decades. Here paddy fields were the excellent foraging basins for grazing ducks and duck droppings were good source of manure for paddy fields. During the lean months and absence of water resources, they were fed with low cost feed sources like paddy husk and low graded grains like broken rice, sorghum and copra palm pith or with low cost feed made up of locally available feed resources to improve or maintain their production status for the next laying cycle.

Key words: Duck feeding, indigenous feeding technologies

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Introduction

Scientific and historic evidences suggest that Asia is the homeland of domesticated ducks (*Anas platyrynchos*). As per FAO statistics 2004, the world duck population is 500 million of which 90 percent are concentrated in Asia-Pacific region. As per livestock census 2002, the duck population of India is 22.08 million constituting 7.19 percent of the total poultry population. The distribution and demographic dynamics of duck population revealed that they are concentrated in north east and southern regions of the country. Tamil Nadu state is located at the Southern part of the country with the area of 1, 30,044 sq.kms.

The climate of this state is tropical and temperature ranging from 18-43"C and the average rainfall is about 925 mm per annum. Rice is the staple food of this state and paddy is the food crop occupies major cropped area, provide conducive eco system for sustainable duck farming in this state.

As per the livestock census 2004, the duck population of this state was 5.12 million and it occupied the third rank after West Bengal and Assam in population. The distribution pattern revealed that 70 percent of the population concentrated in six districts namely, Kanchepuram, Thiruvallur, Villupuram, Cuddalore, Vellore and Tiruvennamalai, which comes under Northern agro climatic zone of Tamil Nadu. In Southern part, Tirunelveli district is having considerable population to the tune of 10.10 per cent of the total population. Here, it is note worthy to mention that Chengalpattu and Kanchepuram district alone is having 39 percent of the total population because of paddy based farming endowed with number of water bodies. Duck farming in Tamil Nadu is mostly a traditional business in the hands of marginal farmers and landless agricultural labours. Their high level of illiteracy and lack of financial sources made them to depend on the duck egg traders even for critical inputs like birds, marketing and credit facilities. A lender-debtor relationship exists between egg traders and duck farmers. The duck farmers borrows finance from duck egg traders for their farming inputs like, ducklings, feeding and for the maintenance of birds and repay the loan in the form of eggs and meat (excess male and spent ducks). This situation makes the duck farming as "Livelihood factor" for farmers.

The system of duck rearing in Tamil Nadu is characterized by low input –low output production system and it is traditionally a seasonal, extensive and nomadic type. In this system, farmers along with their flock of birds migrate to different areas (even to neighboring states) in search of foraging fields. The main foraging centers are pre and post harvested paddy fields, water bodies (tanks, ponds, reservoirs, canals, water channels etc). Duck farming in Tamil Nadu is also having a close symbiotic relationship with paddy cultivation. The duck population is more in paddy cultivation areas like Kancheepuram, Thiruvallur, Thiruvannamalai, Vellore, Villupuram, Tirunelvelli, Tanjore, Trichy and Tirunelveli districts. The flock size varies from 100-1000 and the average flock size is 300-400 maintained by three-member team consist of two males and one female. The breeding ratio in extensive duck farming is 1:12-15. Almost all the duck farmers are maintaining indigenous ducks only.

However from the perspective of feeds and feeding of ducks, anatomical and physiological differences between ducks and chicken, specially related to feeding and nutritional requirement are few but significant is several aspects. The first part of difference is the large flat bill of duck, which is efficient for foraging in mud at the bottom of the ponds but not taking feed effectively from the feed containers etc.Flat bill, causes ducks particularly young ones to push considerable quantities of feed out of the trough or feeder in to ground. Secondly like chick, ducklings have little or no capability to digest fibre but with increasing age, ducks gain good ability to digest fibre in the caecum to produce volatile fatty acids. Thirdly the higher water intake and requirement of ducks reflects the inherent characteristic of water fowl to shovel or filter when taking natural food in ponds and river and also the high proportion of water in the dropppings.Though intensive duck farming in the developed countries is depends on mash feeding, the way and source of feeding for indigenous ducks is foraging only. However scientific documentation of indigenous feeding practices of rural duck farmers is very limited. In this connection a field survey was designed to collect and document the indigenous feeding practices available with the farmers in the rural and extensive duck farming.

Materials and Methods:

A direct contact method survey was designed to document the indigenous feeding practices of rural duck farmers of Tamil Nadu. The survey was carried out with 20 traditional duck farmers in intensive duck farming areas of north eastern districts of Tamil Nadu. Data on feeding technologies during brooding, growing, laying and during lean periods were collected and recorded. Data on the relationship between paddy cultivation and duck farming, requirement of paddy fields for the ducks etc were recorded. Data collected from the farmers are systematically recorded and presented.

Results and Discussion:

Feeding of ducks in the rural duck farming of Tamil Nadu is cost effective, organic and sustainable. The different phases of feeding in the feeding of rural duck farming can be called as feeding during brooding, growing, laying and molting and non productive periods.

Feeding during Brooding:

Like in chicken brooding period is up to 8 weeks. Apart from regular brooding with artificial heat, farmers are practicing a technology called as " Tent Brooding" in which brooding is taking place in closed tent like structure to conserve the heat. During brooding period up to three weeks, they are feeding ducks 3-5 times a day with 10 minutes feeding period. This is a very critical period, in which balanced feeding is essential. To ensure the balanced feeding, most of the commercial duck farmers are feeding Commercial broiler starter feed (23 per cent protein and 2800-3000 kcal ME/ kg) combined with cooked rice in 50:50 proportion. This mixture feed will ensure the adequate supply of energy and protein as well necessary vitamins, minerals to the ducklings. After 4 weeks they are feeding 3 times a day with the feeding time of 10 minutes. Along with that broken rice, crushed snail, cooked rice and kitchen waste are also provided to the ducks. At all times water is made available because ducks should have access to water when it is taking feed. At the end of one week some farmers are allowing ducks to swim the shallow water bodies for some time. After 4 weeks the ducklings are housed in separate holding pen to raise it as grower.

Feeding during growing and laying:

In Tamil Nadu rural duck farming is characterized by extensive, nomadic and seasonal in nature. Active duck farming coincides with the monsoon and sowing seasons. The two clear monsoon seasons of Tamil Nadu are South West (June, July and August) and North East (September, October and November) monsoon. So the sowing seasons are also coincides with these monsoon. Seasonality of the monsoon, intern seasonality of the sowing decides the active duck farming. In the rural duck farming, feeding of growing and laying ducks depends of pre and post harvested paddy fields as their “Food baskets”, because paddy fields are excellence foraging centres for rural duck farming. In extensive system of rearing, the major feeding resources for ducks are pre and post harvested paddy fields, water bodies like ponds, lakes, reservoirs, canals and water channels of the rivers. The important feed materials are fallen paddy grains in the fields, snails, earth worms, insects, small fishes, fingerlings tadpole and water plants like algae etc., Feeds will be sufficiently available during sowing, harvest and monsoon seasons.

As per the opinion of the duck farmers, 5 acres of (20,000 sq.m) paddy field is required for 1000 ducks for a day grazing and it will be enough to support the active egg production and does not require any supplementation. During the peak production, the production potential of indigenous ducks goes up to 95 per cent duck day egg production and foraging on the paddy fields are able to supply the nutrient requirements of ducks during its very active production phase. So availability of pre and post harvested paddy fields are the deciding factors of the active duck farming in Tamil Nadu. The relationship between paddy cultivation and duck farming is quite interesting. Paddy cultivation and duck farming is having symbiotic relationship, in which paddy fields are acts as excellent foraging centres for ducks and the at the same time, herding and grazing of ducks in the paddy fields adds organic manuring the paddy fields, which helps in obtaining better yields in the paddy cultivation. The ducks farmers are also paying remuneration to the paddy field owners in the form of duck eggs and meat. The major disadvantage of this type of feeding is its seasonality in nature. When the sowing season is complete in one area, they are moving their ducks to another area for the search of fresh pre and post harvested paddy fields. This type of moving from one area to another for the search of paddy fields as foraging centres called as migratory route for the search of duck foraging. The distance of migration is short as 50 km to long as 400 km. For the longer distances they are using trucks to transport the ducks to the next foraging centres. So seasonality variation in the monsoon and sowing time with regard to paddy cultivation in different areas

of Tamil Nadu makes the duck farming seasonal and nomadic in various areas. The transport of duck from one area to another area for the search of foraging centres is one crucial cost factor in rural duck farming.

Feeding during summer / Lean season:

In summer season, due to the non availability of paddy fields, water channels etc they are supplementing or hand feeding these ducks with sorghum, paddy husk and copra palm pith. During the lean months, farmers feed their birds with low cost feed made up of locally available feed resources to improve or maintain their production status. One of the important feed technologies in feeding during leaner months is feeding of Paddy husk to the ducks. Paddy husk is one the high fibre ingredients available during processing of paddy and normally it will be used as litter material for poultry farms. How ever duck farmers are using as Paddy husk as one of the low cost feed ingredient to feed the ducks during leaner months of feeding and production. 5-7 kg of paddy husk is being used for 100 ducks which are not in laying season. At the same time they are not using paddy husk during laying season, because they feel it will affect the egg production. Apart during lean months some of the farmers are practicing or maintaining the ducks. However, most of the farmers are not willing to go for replacement; they are keeping the ducks for second production cycle.

Egg production:

Generally, indigenous ducks are known for its 2-3 years production cycle. Farmers are also keeping the flock for 2 years production, after the completion of one year they sell it to other farmer at a lesser price. The age at sexual maturity for these ducks ranges from 150-160 days based on the foraging resources. The average body weight at point of lay *ie* 20 weeks of age is 1500 g and1400 g for male and female. The scientific documentation about the egg production of indigenous ducks under farmer's field conditions is scanty. However, many farmers claimed that the flock average egg number is 150-160 eggs per production year. In egg production pattern, the indigenous ducks are having two peak periods, and in true sense it is producing 150-160 eggs in the period of 8-9 months with average of 60 percent duck day egg production. As per the farmer's reports and field surveys it is observed that, with good foraging resources these ducks are producing 80-90 percent duck day production for 20-30 days in each cycle. The first production period is for 70-80 days and second production period is for 80-120 days with break of molting period for 15-20 days. Though the indigenous ducks are having moderate egg production, their adaptability to climate, limited feed resources, system of rearing and hardiness to disease make it a suitable one for free range production system.

Conclusion:

The duck farming in Tamil Nadu is one of the livelihood propositions for small, marginal, landless agricultural labours of this state and it is characterized by nomadic and low input – low output production type. Despite of the fact that it is seasonal in nature, it is a sustainable farming system as long as opportunities of migration for feeding resources are available in this state. So any steps taken to address their problems will improve duck farmer's income level and livelihood substantially The first and foremost problem for the people involving in all segments of duck farming is the poor consumer acceptability for duck eggs. Apart from this, lack of availability of farming inputs (quality ducklings, feeding sources, vaccines etc), information about market prices and trends, access to micro credits from financial institutions and exploitation by middlemen and disease management are the major problems of the farmers. On the trader's side, long distance markets, scattered distribution of consumers, lack of cold storage and transport facilities and value added products are the challenges.

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FACTORS AFFECTING IN IMPROVE EGG SHELL QUALITY OF LAYING DUCKS

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Abstract

Poor egg shell quality is a huge hidden cost to the egg producer. Estimates are that more than 10% of eggs produced in the hen house are uncollectible or break before intended use. The first 2-5 percent is lost simply, due to form which may be shell less, cracked or broken to the extent that they are not suitable for collection. Another 3-8% is lost during collection, moving through the belts, cleaning, packing and transportation to the end user. The economic losses for the breeders will be even more due to reduced hatchability and chick livability. Therefore, every effort must be directed towards improving shell quality and reducing egg breakage. Ascorbic acid alleviates the ill affects of heat stress by reducing the plasma cortisone level in the bird. Ascorbic acxid is a factor in the absorption of Vitamin D to the active hormonal metabolite 'Calcitriol' $(OH)^2D^3$), which stimulates intestinal absorption of calcium and thus elevates plasma calcium to a level that supports normal mineralisation of bones. Supplementation of $NaHCO^3$ to laying hens at high temperatures is a means of improving eggshell quality as hens consume the additional bicarbonate during the period of active shell formation. Results indicate as much as 40% improvement in egg specific gravity and 2.2% improvement in feed conversion by the addition of 0.75% sodium aluminosilicate to layer diets. Shell quality increased in summer but not in winter. However, care must be undertaken while selecting composition and ion exchange capacity of silicates. Zinc, Manganese and copper are compounds involved in the metabolic process of eggshell formation. These trace minerals work as co-factors of enzymes involved with shell matrix formation. This article was conducted to evaluate the factors affecting in improve egg shell quality of laying ducks

Key words :- shell quality, factors, laying ducks, eggs.

Introduction

It is not desirable to bring ducks into egg production before 7 months of age because of problems with small egg size and low hatchability. Ducks hatched in April through July will reach sexual maturity at about 7 months of age because they are maturing during a decreasing day length. On the other hand, ducks hatched in September through January will mature 1 to 2 months early because they will be subjected to increasing lengths of natural day light. Scheduling your hatch season to coincide with the April through July time period will eliminate this problem.

Egg production will increase rapidly once sexual maturity is reached. Ducks can be brought into full production by giving them 14 hours of light daily once they reach sexual maturity. Artificial light can be added to the day by using a 40 to 60 watt light bulb in the holding pens or coop. The flock should be laying 90% or more within 5 to 6 weeks. Daily egg production should remain above 50 percent for about 5 months in meat type breeds. High producing egg type breeds will have a greater rate of persistency. Maximum efficiency for egg production can be achieved by feeding a commercial breeder diet. Increased nutrient requirements to support high rates of egg production make it essential to feed a special diet that is well balanced in the nutrients necessary to maintain reproductive performance.

Maintaining the proper number of males and females in the breeding flock is important to achieving high levels of fertility and hatchability. For best results, one male for each six females is recommended. A few extra males may be kept to replace mortality as it occurs. Levels of fertility and hatchability parallel egg production (i.e. fertility and hatchability increase as egg production increases). Fertility should increase rapidly during the first few settings of eggs, but will taper off toward the end of the egg production cycle. It is debatable as to the value of keeping breeding stock once the level of egg production drops below 50%. Some find it more economical to molt the birds for 8 to 10 weeks to

provide them a rest period for an additional lay period once they drop below 50% egg production. Most duck eggs are laid before 7 a.m., thus one might want to confine breeders to the laying house at night. It is advisable to gather the eggs early in the morning if artificial incubation is going to be used. Removing the eggs as soon as possible lessens the problems of dirty and cracked eggs. Clean and dry breeder houses are important for the production of clean, intact hatching eggs. Soiled eggs can be washed with care after collection using water warmer than the eggs. Temperatures of 110 - 115 degrees F. are adequate for washing the eggs. Cracked, misshapen or abnormally small eggs should not be incubated. Hatching eggs can be stored at a temperature of 55 degrees F. for up to two weeks without losing hatchability. Eggs should be stored small end down. For natural incubation, it is important to provide clean, dry nesting facilities. Ducks will make their own nest if straw or other litter material is provided. Wood shavings, peanut hulls and peat moss also make good litter materials. Nest boxes can also be provided. Nests should be 12 inches wide, 18 inches long and 12 inches deep and can be placed in a row along the walls of the breeder house. Feed and water should be in close proximity so the female can obtain her daily nutrient requirements without having to leave the nest for long periods.

Economic losses associated with the incidence of egg shell defects are important when evaluating the profitability of a layer operation (Bell, 1998; Gomez- Basauri, 1997; Roland, 1988; Hamilton et al., 1979). Worldwide estimates of reduced shell quality leading to egg breakage have been found to range from 6 to 8% (Anderson and Carter, 1976; Folkerts, 1976; Roland, 1977; Hamilton et al., 1979). In the USA alone this has been estimated to be around 8% (Roland, 1988).

Shell defects are not only of concern to producers and processors but to consumers as well. Recently, a study conducted to determine the quality of eggs at the retail level found that 45% of all cartons examined had at least one cracked egg (Bell et al., 1997). The results of this study would partially (or totally) justify the typical consumer behavior of opening the egg carton to check before purchasing. In addition, the presence of a cracked, or worse, a leaker egg would mean discarding the whole carton to avoid the risk of bacterial contamination, which translates into reduced profit for the supermarket, wholesaler, and ultimately the egg producer.

Considerable research has been done over the past four decades regarding egg shell quality that has helped the layer industry, and much continues to be done. Recently, dietary supplements that activate enzyme systems responsible for shell formation have caught the attention of the industry as a means of overcoming some of the losses associated with poor shell quality (Klecker et al., 1997; Gomez-Basauri, 1997). This chapter will review recent information on that topic.

STRUCTURE AND COMPOSITION

The egg shell is comprised of five layers: an inner egg shell membrane, an outer egg shell membrane, the mammillary layer, spongy layer and cuticle. The egg shell membranes are also called the 'organic matrix'; and their importance and effect on egg shell quality are often neglected. This matrix is comprised of a combination of proteins and mucopolysaccharides. Most of the protein is made up of keratin with a high concentration of sulfur (70- 75%) while about 10% of the protein is collagen. The amino acid ratio of matrix proteins changes as the hen ages and these changes are reflected in the quality of egg shell.

Changes in synthesis and secretion of egg shell membranes may have negative effects on shell formation and ultimately on quality. Adequate amounts of certain trace minerals, particularly manganese and zinc, are very important for the synthesis of these membranes, which form the basis of the calcified part of egg shell. Deficiencies in either mineral have negative effects on formation of membranes, egg shell morphology and egg production. These problems result very probably from the role that manganese plays in the process of synthesis of mucopolysaccharides. It seems that this glucoprotein structure influences calcification of egg shell. Moreover, zinc is indispensable for proper formation of keratin.

The mammillary layer is formed by cells of irregular conical shape forming irregular conical structures on the outer egg shell membrane. They form approximately one third of egg shell thickness. The so-called spongy layer is very firm; and its firmness increases in the direction of the egg shell surface. This layer forms approximately two thirds of egg shell thickness.
The cuticle is an organic layer on the egg shell surface that prevents penetration of microorganisms into the egg. It contains a high proportion of surface pigments.

From the chemical point of view, the egg shell consists of water (2%) and dry matter (98%). The dry matter is composed of 5% crude protein and 93% ash. Maintaining Egg Shell Quality

Poor egg shell quality is a huge hidden cost to the egg producer. Estimates are that more than 10% of eggs produced in the hen house are uncollectible or break before intended use. The first 2-5 percent is lost simply , due to form which may be shell less, cracked or broken to the extent that they are not suitable for collection. Another 3-8 percent is lost during collection, moving through the belts, cleaning, packing and transportation to the end user. Because the first 2-5% loss is due to uncollectible eggs, most egg producers often estimate their egg loss due to poor shell quality at only this percentage, which is most likely an underestimation. At Rs.1.50/ egg, even a 5 percent loss could be as much as Rs. 2.7 million/year for 100 thousand layer house. The economic losses for the breeders will be even more due to reduced hatchability and chick livability. Therefore, every effort must be directed towards improving shell quality and reducing egg breakage.

Egg: The fertile egg is highly complexed reproductive cell and is a tiny center of life, where initial development of embryo takes place. Most of the commercial eggs are infertile. The yolk is surrounded by albumen, having high water content, elasticity and shock absorbing capacity. This entire mass is surrounded by two membranes and an external covering called egg shell. The shell provides a proper shape to the egg and is meant for conserving the valuable nutrients within the egg.
Hen egg contains approximately 76% water, 12% protein, 10% lipids and rest vitamins, minerals and carbohydrates. Egg is a major source of human dietary protein with high biological value and excellent protein efficiency ratio.

Egg Shell: The outer cover of the egg, the shell comprises 10-11% of total egg weight. On an average the eggshell weighs 5-6g, with remarkable mechanical properties of breaking strength (>30N) and is 300-350 micrometer thick. This structure plays a crucial role in protecting the contents of the egg from the microbial and physical environment and in controlling the exchange of water and gases. The calcium content of the eggshell is approximately 1.7-2.5g. An average eggshell contains:

Calcium carbonate	:94-97%
Phosphorus	:0.3%
Magnesium	:0.2%
Sodium, Potassium, Manganese, Iron and Copper	:traces
Organic matter	:< 2%

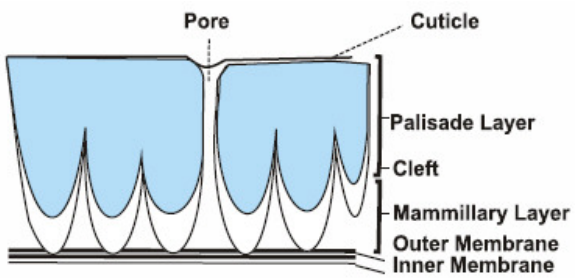

Fig. 1: Structure of the egg shell

The small amount of organic matter mostly consists of matrix proteins (mixture of proteins and polysaccharides rich in sulphated molecules) and shell pigment. The matrix proteins are critically important in determining the egg shell structure and serves as foundation for the deposition of calcium carbonate.

There are about 8000 microscopic pores on the shell. The outer surface of the shell itself consists of a mucous coating (cuticle) which is deposited on the egg just prior to the lay. This proteinous covering helps to protect the interior content of the egg from bacterial penetration through the shell.

Shell Quality: The aesthetic quality of the egg shell relates to the quality factors which one can observe; such as soundness of the shell, shape of the shell and colour of the shell. However, for commercial layer and breeder operations, shell quality means increased shell thickness and shell breaking strength to reduce number of cracked eggs, an increased number of saleable/ hatching eggs and a higher number of viable day old chicks.

Methods to Measure Shell Quality: On farm methods and sophisticated equipments are available for accessing shell quality parameters. The egg shell strength is the main, but not the only factor that determines shell quality. Egg shell quality can be measured as:

- Egg size and visual shell defects
- Specific gravity
- Shell colour
- Shell breaking strength
- Percentage shell (Shell weight X 100/Egg weight)
- Shell thickness (mm)
- Ultra structure of the shell

The specific gravity of an object equals the weight of its volume relative to the weight of an equal volume of water, when both are at the same temperature. The specific gravity of an egg is equal to the egg's density relative to water. The specific gravity of all four parts of the egg is different (shell: 2.325, Yolk: 1.032, albumen: 1.038, shell membranes: 1.075). Since the specific gravity of shell is more than two times higher than the other parts of the egg, the percentage of the shell has major influence on the specific gravity of whole egg. As the amount of shell increases, the specific gravity of the egg increases. Egg specific gravity, therefore, is a good indicator of percentage shell and shell quality. The incidence of breakage is above normal, if the specific gravity of a flock averages less than 1.080. Shell breaking strength can be measured through shell force gauge (static compressor) and is expressed in dynes/cm²(N). Maintaining egg size, proper and routine candling and measurement of specific gravity can be easily practiced at farm level.

FACTORS AFFECTING EGG SHELL QUALITY

Obtaining an egg with a smooth and strong egg shell is desirable. Shells from eggs collected immediately after lay as well as those of big eggs are more susceptible to cracking. The hen is able to deposit only a certain amount of calcium into the egg shell and this amount is influenced by genotype. This means that increasing the level of calcium in the diet will not necessarily improve the quality of egg shell (Ceylan and Scheideler, 1999). As hens age, egg size increases such that a constant amount of calcium is distributed over a larger surface. This means that changes in egg weight and the age of layers influence the quality of egg shell. Changes in temperature inside the laying house influence feed intake and therefore egg size. The fact that the egg shell is thick does not necessarily mean that it is also strong. Sometimes a thin egg shell may be stronger than a thick shell.

Numerous factors affect the functional quality of the egg shell such as fellow:-

Strain: Some strains of the birds may be able to deposit calcium for the egg shell at a faster rate than others, resulting in better deposition. It is observed that darker brown eggs have a higher shell quality than lighter brown eggs.

i. Diseases: Diseases like infectious bronchitis (IB), Newcastle disease (ND), avian influenza (AI) and egg drop syndrome (EDS) affect the shell quality. IB virus causes soft/rough shelled eggs, discolouration and wrinkling of the shell. EDS virus affects only the shell gland but with ND or IB, every portion of the reproductive tract can be affected.

ii. Management: Poor housing, high ambient temperature, rough handling of the eggs will affect the eggshell quality. Since large eggs are more prone to cracks, the egg size must be managed through proper nutritional and lighting management. Management: Poor housing, high ambient temperature, rough handling of the eggs will affect the eggshell quality. Since large eggs are more prone to cracks, the egg size must be managed through proper nutritional and lighting management. Eggs from hens in the 3L:1D (3 days light : 1 day dark) regimen had a significantly greater shell breaking strength than eggs from hens in the 16L: 8D (16 hours light : 8 hours dark) regimen.

iii. Moulting: The management practice of "forced" or "induced" moulting has shown to improve shell quality in all ageing flock. Following the moult, egg specific gravity, shell weight, shell thickness and percentage shell were either the same as they had been prior to the moult, or had improved, for all strains. Egg shell breaking strength improved in all strains as the result of the induced moulting.

iv. Age of Bird: As the hen ages, the thickness of the shell usually declines. Older flocks lay larger eggs, which break easily. The hen is genetically capable of placing only a finite amount of calcium in the shell. Secondly, hen looses some of her ability to mobilize calcium from the bone, and is less able to produce the needed calcium carbonate. The absorption and mobilization of calcium decreases to less than 50% of normal after 40 weeks of age.

v. Drugs: For example, sulfa drugs affect the eggshell quality whereas tetracyclines have some beneficial effects.

vi. Water Quality: Many studies showed that saline drinking water, including tap water containing sodium chloride supplied to mature laying hens at concentrations similar to those found in underground bore water, has an adverse effect on eggshell quality while having little effect on feed intake, egg production or egg weight. In contrast some reports indicate that there were no visible shell defects and specific gravity was also not adversely affected.

vii. Stress: While a genetic predisposition for egg and eggshell quality exists, good genes can be upset by environmental stresses. The shell is formed by the activity of cells lying the oviduct and uterus. Under stress the secretions of these cells become acidic and the cells can be damaged or destroyed. In extreme cases, stress induced effects can result in eggshells that have excess deposits of calcium - a sort of powdery "bloom" on the surface and result in misshapen eggs. Relocation stress is known to have effects on the visual appearance of eggs produced; increasing the incidence of calcium coated and checked (misshapen) eggs. Major types of relocations, such as movement from one type of housing to a completely new housing environment, can produce severe visual defects of the egg.

viii. Environmental Temperature: One of the factors contributing to poorer eggshell quality in hot weather is inadequate feed intake. Eggshell quality is somewhat compromised during summer months. During exposure to warm environmental temperature, the hen reacts by increasing its rate of breathing (panting) in order to cool itself. This causes the lowering of CO^2 in the blood and produces a condition termed "respiratory alkalosis". The pH of the blood becomes alkaline and the availability of calcium for the eggshell is reduced. This disturbance in acid-base balance causes an increase in soft-shelled eggs during summer.

Temporary thinning of the egg shell may occur during periods of high ambient temperature (above 25ºC) since feed intake is reduced. The shells quickly regain normal thickness when temperatures are reduced and feed intake increases. Respiratory alkalosis also causes increased carbonate loss through the kidney resulting in competition between kidney and uterus for carbonate ion, consequently resulting in poor

eggshell thickness. During heat stress calcium intake is reduced as a direct consequence of reduced feed intake and this stimulate bone resorption resulting in hyperphosphatemia. This inhibits the formation of calcium carbonate in the shell gland. Also heat stress reduces carbonic anhydrase (Zinc dependent enzyme) activity in the uterus. Under heat stress more blood is shunted to the peripheral tissues with concomitant reduction in flow of blood to the oviduct resulting in poor shell quality. Lastly the ability of layers to convert vitamin D^3 to its active form is reduced during heat stress.

ix. Nutrition: There is a complex relationship between calcium, phosphorus, vitamin D^3 and the hormonal system of the layer in calcium metabolism during lay. Calcium and phosphorus balance is critical for proper egg production and eggshell quality. Layer ration should be formulated with correct amount of calcium and phosphorus (usually 3.5 - 4.0% calcium, 0.35-0.40% phosphorus)

Calcium and the egg shell

It is obvious that in order to maintain good egg shell quality it is necessary to assure adequate nutrition. Hens producing approximately 300 eggs per year must deposit 24 times more calcium into egg shells than the amount contained in their bones. For that reason, the requirements for calcium supply in the diet are enormous. During the 20 hr period in which the egg shell is formed, the hen must deposit 25 mg of calcium on the egg surface every 15 minutes.

As the hen can only obtain 30-50% of total dietary calcium (depending on its source, size of particles, health condition of birds, etc.), the amount of dietary calcium that must be supplied daily ranges from 3.2 to 4.5 g (depending on production level, daily feed intake, environmental temperature and other factors).

Availability of calcium from various sources differs. Ground shells of marine animals are the best source of calcium followed by egg shells. These organic sources are followed by aragonite and then by common limestone. The most sensitive response to calcium deficiency can be observed in hens at the age of 150-180 days. Toward the end of the laying period, the utilization of calcium generally decreases. This can be partly improved by a change of calcium source.

Important also is the particle size in which calcium is supplied to hens. The coarser the particles, the longer the residence time in the upper gastrointestinal tract. The release of calcium from coarser particles is slower; and this fact may be important given that shell formation is continuous and proceeds during the non-daylight hours when layers do not eat. This is demonstrated by the fact that shells of eggs laid in the afternoon are usually thicker. The presence of adequate amounts of vitamin D3 in relation to calcium is obviously also important. However, increased doses of this vitamin do not affect the quality of egg shell.

Zinc and the egg shell

Along with calcium, carbonate ions are needed in formation of calcium carbonate. However, they are usually neglected as a potential cause of problems associated with egg shell quality. Carbon dioxide, which is present in the oviduct as a common product of cell metabolism or as a gaseous compound in blood, is the main source of carbonate ions. The carbonic anhydrase enzyme requires the presence of zinc and catalyses formation of carbonic acid from water and carbon dioxide. In non-laying hens, activity of carbonic anhydrase is lower than in laying hens. Ceylan and Scheideler (1999) demonstrated that organic zinc was associated with higher activity of carbonic anhydrase and in turn with improved shell quality. The fact that zinc is a co-factor of this enzyme makes both activity and proper function of this enzyme potentially sensitive to trace elements, their interactions and availability. The dietary concentration of zinc needed to meet daily zinc requirements ranges from 40 to 60 mg/kg of feed dry matter. Zinc oxide and zinc sulfate have been the most commonly-used sources of zinc.

Manganese and the egg shell

The presence of manganese (Mn) has an activating effect on alkaline phosphatase; explaining the importance of this element in proper formation of bone tissue and egg shell. Ochrimenko et al. (1992) noted a positive effect of manganese supplements on calcification and egg shell strength. In experiments carried out by Sazzad et al. (1994), no effects of increased amounts of manganese in the diet on production and weight of eggs were observed. However, egg shell thickness increased significantly. These authors recommended that laying hens receive 105 mg/kg Mn in the diet. Manganese deficiency decreases egg shell weight; which may support the hypothesis regarding the importance of manganese as a enzyme co-factor in controlling synthesis of mucopolysaccharides.

Phosphorus and the egg shell

A surplus of phosphorus in the diet has a negative effect on egg shell quality. For that reason it is important to maintain an optimum ratio of phosphorus and calcium, which widens as the hen ages. If calcium is supplied in powder form, the optimum phosphorus/calcium ratios from week 19 to 50 and after week 50 of age are 1:9-10 and 1:11-12, respectively. However, if calcium is supplied in the form of coarse particles (65%, 2-4 mm), the optimum phosphorus/calcium ratios are 1:10-11 and 1:12-13 for weeks 19-50 and after week 50 of age, respectively. The phosphorus requirement of hens increases in a hot environment.

Magnesium and the egg shell

Magnesium deficiency reduces egg production, calcium deposition and formation of egg shell. In practice, however, it is not necessary to supplement diets with special amounts of magnesium because its content in vegetablebased feed ingredients and common (dolomitic) sources of limestone is sufficient.

Diet formulation:

Shell breaking strength was greater for the sorghum diet than wheat or barley based diet and less for maize-soya diet. High levels of calcium and phytate in the diet of laying hen reduce the availability of trace minerals, especially manganese and zinc. Addition of non starch polysaccharides breaking and phytase enzymes to the feed tends to improve eggshell quality.

No deleterious effects on egg and eggshell quality were observed when levels of chloride and magnesium were upto three times higher than recommended levels. Excess dietary chlorine, however, decreases blood bicarbonate concentration, which plays a pivotal role in eggshell calcification. Low dietary cationic-anionic balance, presence of non starch polysaccharides, mycotoxins and contaminants results in poor shell quality

How to Improve Shell Quality

a. Vitamnin C (Ascorbic Acid): Ascorbic acid is essential for synthesis of organic matrix (tropocollagen) of eggshell. Ascorbic acid alleviates the ill affects of heat stress by reducing the plasma cortisone level in the bird. Ascorbic acxid is a factor in the absorption of Vitamin D to the active hormonal metabolite 'Calcitriol' $(OH)^2D^3$), which stimulates intestinal absorption of calcium and thus elevates plasma calscium to a level that supports normal mineralisation of bones.

   A dietary level of 250 mg ascorbic acid/kg diet of moulted hen improves the egg production and eggshell quality by enhancing intestinal calcium absorption or by resorption of bone Ca mediated through 1,25 $(OH)^2D^3$) production.

b. Sodium bicarbonate ($NaHCO^3$):Hens aged 30 weeks fed with 1% dietary $NaHCO^3$ and housed at 32ºC either in conventional or intermittent lighting programme had improved eggshell breaking strength. The improvement in eggshell quality was more in the group with intermittent lighting programme. Supplementation of $NaHCO^3$ to laying hens at high temperatures is a means of improving eggshell quality as hens consume the additional bicarbonate during the period of active shell formation. The addition of sodium bicarbonate or

purified sodium sesquicarbonate, has shown to elevate the dietary electrolyte balance, improved acid-base balance and has a positive effect on eggshell quality.

c. Aluminosilicates: Results indicate as much as 40% improvement in egg specific gravity and 2.2% improvement in feed conversion by the addition of 0.75% sodium aluminosilicate to layer diets. Shell quality increased in summer but not in winter. However, care must be undertaken while selecting composition and ion exchange capacity of silicates.
d. Minerals: Zinc, Manganese and copper are compounds involved in the metabolic process of eggshell formation. These trace minerals work as co-factors of enzymes involved with shell matrix formation. Carbonic anhydrase, which is zinc dependant, stimulates calcium carbonate deposition for eggshell formation. Polymerase enzyme, which is dependent on manganese, forms the shell glycoprotein matrix or foundation. Supplementing the diet with highly bioavailable minerals like mineral-amino acid complexes increases the eggshell weight and eggshell thickness. Copper affects the synthesis of shell membrane by activity of copper containing enzyme lysyl oxidase.
Dietary supplementation of zinc methionine improved the shell breaking strength. There was no improvement in shell quality where zinc sulphate was supplemented to approximate zinc concentration of zinc methionine.
e. Calcium: Provide extra calcium to the older hens @1g/bird in the form of oyster shell over and above normal requirement in summer months. Maintain the desired particle size of calcium source at the time of shell formation. The minimum size of calcium source to improve gizzard retention is about 1 mm. Solubility and absorption of calcium source must be major criteria. Magnesium content of calcium source must be as low as possible. Organic calcium is also a good option.
f. Chemicals: Injection of Indomethacin 4hr or 16hr post-entrance of egg into uterus delays oviposition and prevents premature expulsion of some soft shelled and shell less eggs. Chemotherapeutic agents like salicylic acid, aspirin reduce body temperature of laying hens during heat stress thereby alleviates its ill effects.
g. Management: Reducing egg breakage at farms requires constant attention to management details and proper equipment maintenance. Some methods to reduce the percentage of broken eggs are:
    i. Provide cushioning of some type at the front of egg collection area of the cages. This will soften the impact of eggs rolling on to the collection wires and reduce the incidences of hairline cracks. Be sure that cushioning is positioned correctly to receive the eggs from the cages.
    ii. Collect the eggs at least twice a day and more often if possible. Eggs rolling down the cage floor have an increased chance of being broken if there are several eggs already in the collection area.
    iii. Maintain egg collection wires/trays in good condition. Examine them regularly for sharp edges, any foreign objects and for excessive wear and tear of the wire mesh/trays.
    iv. Ensure that eggs do not pile up; dead birds protruding from the cage often block the egg flow to the collection area and causes spilling of the egg on the floor.
    v. Routinely check the quality and condition of the egg trays in which the eggs are collected from the cages.
    vi. Train egg collection workers for carefully picking the eggs from the cage area and gently placing them in the collection trays without slowing down the collection process.
    vii. Be sure that ventilation is well maintained and fans, if any are working properly during hot weathers. Try to provide constant ambient temperature as far as possible.
    viii. Reduce sound, activity and movement of workers inside the layer houses as much as possible to reduce disturbances to the birds.

ix. Procure good quality feed ingredients devoid of contaminants, adulterants and mycotoxins and provide wholesome water at all times to the birds.
x. Reduce flies, and rats causing annoyance to the birds.
xi. Check size, specific gravity, shell thickness routinely and if any change is observed, try to correct it by various means.

Conclusion :

Maintaining eggshell quality is a complex activity. it is impossible, even with current knowledge, to correct all eggshell quality problems. We can, however, make significant reductions in the number of eggs lost due to poor shell quality. This can be accomplished if one realises that no single factor is usually responsible for egg breakage. Many factors are known to be related with eggshell quality including, flock health problems, management practices, environmental conditions, breeding and adequacy of nutrition.

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USE OF AZOLLA (*AZOLLA PINNATA*) AS A PROTEIN SUPPLEMENT IN THE DIET OF SEMI-SCAVENGING KHAKI CAMBELL LAYER DUCKS

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Abstract

An experiment was conducted for a period of 170 days at farmers house to investigate the effect of feeding Azolla (*Azolla pinnata*) that replaced conventional protein supplement mustard oil cake (MOC) in the diets for Khaki Cambell ducks. The experiment included a total of 60 laying ducks with four treatments; T_1 (control diet without Azolla meal), T_2 (diet with 5 % Azolla meal), T_3 (diet with 10% Azolla meal) and T_4 (diet with 15% Azolla meal) and three replicates having five ducks per replicate. The diets were based on rice by products where soybean meal and mustard oil cake as protein source. The birds were raised under extensive system and feeds were supplied two times daily. The replacement of MOC by 10% Azolla meal significantly improved live weight gain (P>0.05), egg weight (P>0.05) and feed conversion efficiency (P>0.05). There was significantly increased egg production (P<0.01) Body weight gain and egg productivity showed a linear increasing trend as the proportion of Azolla meal in the diet was increased. Considering growth performance and productivity it may be recommended to replace MOC by Azolla meal up to 10% level in the diet of laying duck.

Introduction

Ducks occupy an important position next to chicken farming in India. They form about 10% of the total poultry population and contribute about 6-7% of total eggs produced in the country. Ducks are mostly concentrated in the Eastern and Southern States of the country mainly coastal region with non-descriptive indigenous stocks, which however are poor layers.

The use unconventional feed to the diet formulation reduce the production cost for duck. Among the fed proteins plant originates are less costly than animal protein. The water fern Azolla (*Azolla pinnata*) is an unconventional feed ingredient. Azolla is a free floating fresh water fern belonging to the family Azollaceae and order Pteridophyta. Azolla is reach in protein, total protein is 25-30%. Other constituents in Azolla are minerals, chlorophyll, carotinoids, amino acids, vitamins etc. It is also a potential source of nitrogen and a potential feed ingredient for livestock (Pannerker, 1988). In addition Maurice *et al*. (1984) started that inclusion of aquatic plants at low levels in poultry diets had shown better performance, specially when they supply part of the total protein or when they are included as a source of pigment for egg and broiler skin. With those considerations, the experiment was under taken with the following objectives: i) To investigate the performance of duck fed Azolla at different dietary levels. ii) To compare the production cost of duck provided with diets containing different levels of Azolla in the diet.

Materials and Methods

The experiment was conducted at Zonal agriculture Research Station, Jagdalpur (Chhattisgarh) to study Azolla meal (*Azollapinnata*) as a feed ingredient in duck ration. The experiment was started with 7 days old Khaki Cambell ducklings and continued up to 170 days. Azolla was collected from a few ponds located at Agriculture and fish farm farm. It was then dried in the sun. After sun drying, it was ground and stored in the plastic bags until used for feeding.

Duck chicks were equally and randomly divided and distributed in four dietary treatments groups (T_1, T_2, T_3 and T_4) having three replications in each. Each dietary treatment group consists of 15 ducklings distributed in three replicated pens (R_1, R_2 and R_3) with 5 ducks in each. Four-duck starter, grower and layer diets were replacing MOC by Azolla meal. However, to adjust the nutrient level of the

diets proportion of soybean meal and DORB was little changed. The composition of the experimental diets have been shown in Table 2 and Table 3.

The experimental birds were managed properly including housing environment, providing floor space, feeder and waterer space. During the managemental period, body weight, feed consumption etc. were recorded and egg weight and egg production were also recorded.

Chemical composition of the Azolla: The diets and Azolla meal was analyzed for proximate principles (AOAC,1990) and presented in the Table 4. All the recorded and calculated data were analyzed for ANOVA (Steel and Terrie, 1980) using a Completely Randomized Block Design (CRD) with the help of computer packaged program MSTAT.

Result and Discussion

Azolla meal contain dry matter 90.8 %, crude protein 25.38%, crude fiber 15.65%, ether extract 2.28%, nitrogen free extract 30.05% and total ash 15.68%. The result are almost similar with earlier observation of Ali and Leeson (1995). The crude protein level of Azolla was found 25.78 percent. The result was close to crude protein level found by the Sreemannaryana *et al*. (1993). Singh (1990) also reported that the crude protein might vary from 25-37.36 percent. Ether extract content of Azolla was 3.47 percent. Though the composition may vary but similar result was reported by Sreemannaryana *et al*. (1993). But variation in ether extract value was reported by Ali and Lesson (1995). They found 1.58 and 2.63 percent of ether extract. On the other hand, Buckingham *et al*. (1978) reported 5.1 and 4.4 percent ether extract. Crude fibre level in Azolla meal was 15.71 percent. The results are similar with the earlier observation of Querubin *et al*. (1986b) for *Azolla pinnata*. On the other species of Azolla (*Azolla microphylla*) they found 15.02 percent crude fibre. Nitrogen free extract (NFE) content of Azolla sample was 30.08 percent. The result is similar with the observation of Ali and Leeson (1995) and Querubin *et al*. (1986a). Ash content of Azolla was 15.76 percent. The results are consistent with Buckingham *et al*. (1978) who reported 15.50 percent of ash in *Azolla pinnata*.

Body weight: The body weights of ducks were shown in Table 3. The body weight differed significantly at 5 and 6 weeks of age. In both the weeks almost similar trend in body weight were obtained. In this experiment, the diet containing of 10% level of Azolla meal was best in respect of body weight while T_2 diet was second the best in 6 weeks of age. The result is similar with the earlier observation of Subudhi and Singh (1977). In this experiment sesame meal was replaced by Azolla meal. The digestible protein percent in MOC was 89.9 percent (NRC, 1994) but in Azolla meal it was 56.6 percent (Tamany *et al*., 1992). Cambel (1984) found better result using 10% and 15% Azolla meal in broiler chicken.
The higher level of Azolla (T4) meal resulted poor growth than control, T2 and T3 treatments. This might be due to higher level of NDF in Azolla meal is the main limiting factor for efficient utilization in monogastic animals (Buckingham *et al*., 1978). Tamany *et al*. (1992) reported higher lignin i.e. 17.48% might cause poorer growth as against the diet containing 15 percent Azolla meal.

Feed consumption: Feed consumption was almost similar in different dietary treatments and the differences were non significant at all ages of the experimental period (Table 3). The results are similar with the earlier observation of Bhuyan *et al*. (1998). They found that the inclusion of Azolla in broiler diet did not affect feed consumption upto 15%. Similar result also found by Sreemannryana *et al*. (1993). But Bested and Morento (1985) stated that Azolla affected the palatability of the feed and reduced feed consumption.

Feed Conversion Ratio (FCR): Feed conversion ratios obtained in different treatments are shown in Table 3. Feed conversion ratios obtained by the treatments by the T_3 and T_2 were highest during 2-6 weeks of age which were very close to the standard (1.87:1) The feed conversion ratios differ

significantly among the treatment during 5-6 weeks and 2-6 weeks periods. Poorest feed conversion ratio was obtained in treatment T4 .These might be due to higher fibre content of Azolla. Feed conversion ratios decreased significantly at 15% Azolla meal in the diet. Similar results are reported by Querubin *et al*. (1986a). Higher level of fibre and tannin in aquatic plant may be responsible for decreased the nutrient utilization and ultimately decreased FCR (Muzlar *et al*., 1978). Buckingham *et al*. (1978) reported the high level of NDF in Azolla affected the utilization of feed or feed efficiency in monogastic animals.

Egg weight and egg production

Individual egg production of almost an egg a day for 170 days has been recorded and flock averages in excess of 165 per duck are not uncommon (Table 4). Khaki Campbell ducks weigh about 2.2 to 2.4 Kg. Egg size varies from 65 to 75 g. The higher egg weight and egg production were recorded in T3 where 15% Azolla meal was incorporated in the diet.

Conclusion: From the above discussion it may be concluded that: i) Azolla is a good source of protein and may be used upto 10% level in the duck diet for better performance. ii) Azolla meal had no deleterious effect on palatability of the diets iii) Azolla meal is an unconventional feed ingredients at low price and may be used as a duck feed to reduce feed cost.

Table1 Ingredient composition of diet

Ingredients (%)	Treatments			
	T_1	T_2	T_3	T_4
Starter				
Wheat	45	45	45	45
Yellow Maize	-	-	-	-
D.O.R.B.	14	14	14	14
Soyabean Meal	10	10	10	10
MOC	15	10	5	-
Azolla meal	-	5	10	15
Fish Meal	10	10	10	10
Lucern Leaf Meal	2	2	2	2
Mineral Mixture	2.5	2.5	2.5	2.5
Shell Grit	-	-	-	-
D.C.P	1.0	1.0	1.0	1.0
Vitamin Mixture	0.5	0.5	0.5	0.5
Grower				
Wheat	48	48	48	48
Yellow Maize	-	-	-	-
D.O.R.B.	25.5	25.5	25.5	25.5
Soyabean Meal	-	-	-	-
MOC	15	10	5	-
Azolla meal	-	5	10	15
Fish Meal	6	6	6	6
Lucern Leaf Meal	2	2	2	2
Mineral Mixture	2.5	2.5	2.5	2.5
Shell Grit	-	-	-	-
D.C.P	0.5	0.5	0.5	0.5
Vitamin Mixture	0.5	0.5	0.5	0.5
Layer				
Wheat	42	42	42	42
Yellow Maize	10	10	10	10
D.O.R.B.	6.5	6.5	6.5	6.5
Soyabean Meal	5	5	5	5
MOC	15	10	5	-
Azolla meal	-	5	10	15
Fish Meal	10	10	10	10
Lucern Leaf Meal	2	2	2	2
Mineral Mixture	2.5	2.5	2.5	2.5
Shell Grit	5.5	5.5	5.5	5.5
D.C.P	1.0	1.0	1.0	1.0
Vitamin Mixture	0.5	0.5	0.5	0.5

Table 2 Chemical composition of diet (%)

Particular	Treatments			
	T_1	T_2	T_3	T_4
Starter				
Moisture	10.50	11.00	11.00	10.50
Crude Protein	20.15	20.00	19.95	19.91
Crude fibre	7.05	7.15	7.50	7.65
Acid insoluble ash	4.05	4.10	4.25	4.50
Salt	0.60	0.60	0.60	0.60
Calcium	1.00	1.00	1.00	1.00
Phosphorous (Available)	0.50	0.50	0.50	0.50
Metabolizable Energy (Kcal/kg)	2600	2590	2585	2578
Grower				
Moisture	10.50	11.05	10.05	11.00
Crude Protein	16.85	16.55	16.50	16.00
Crude fibre	8.05	8.15	8.45	8.75
Acid insoluble ash	4.00	4.20	4.55	4.85
Salt	0.60	0.60	0.60	0.60
Calcium	1.00	1.00	1.00	1.00
Phosphorous (Available)	0.50	0.50	0.50	0.50
Metabolizable Energy (Kcal/kg)	2550	2530	2525	2500
Layer				
Moisture	10.50	11.05	10.50	11.00
Crude Protein	18.25	18.15	18.05	18.00
Crude fibre	8.10	8.50	8.70	8.80
Acid insoluble ash	4.00	0.60	4.00	4.00
Salt	0.60	0.60	0.60	0.60
Calcium	3.00	3.00	3.00	3.00
Phosphorous (Available)	0.50	0.50	0.50	0.50
Metabolizable Energy (Kcal/kg)	2595	2590	2575	2565

Table 3 Growth rate, feed intake and feed efficiency of ducks in various groups

Particulars	Age (weeks)	Treatments			
		T_1	T_2	T_3	T_4
Cumulative feed intake (kg)	1.	0.21±0.00	0.20±0.01	0.19±0.02	0.19±0.01
	2.	0.97±0.01	0.98±0.01	0.97±0.00	0.95±0.02
	3.	2.25±0.05	2.25±0.03	2.24±0.01	2.24±0.01
	4.	3.79±0.08	3.80±0.09	3.78±0.02	3.76±0.05
	5.	5.42±0.11	5.41±0.08	5.42±0.02	5.40±0.04
	6.	7.17±0.25	7.15±0.04	7.16±0.05	7.15±0.15
Body weight (kg)	1.	0.19±0.01	0.20±0.00	0.19±0.00	0.17±0.02
	*2.	0.60±0.00	0.77±0.01	0.83±0.01	0.57±0.02
	*3.	1.11±0.02	1.28±0.01	1.32±0.01	1.05±0.01
	*4.	1.68±0.04	1.73±0.02	1.80±0.01	1.55±0.02
	*5.	2.18±0.08	2.25±0.03	2.32±0.02	2.05±0.04
	*6	2.58±0.03	2.61±0.03	2.72±0.05	2.48±0.03
Feed/gain	1.	1.11±0.00	1.00±0.00	1.00±0.01	1.12±0.05
	*2.	1.61±0.02	1.27±0.02	1.17±0.03	1.67±0.01
	*3.	2.03±0.05	1.76±0.04	1.70±0.05	2.13±0.02
	*4.	2.26±0.01	2.20±0.03	2.10±0.05	2.42±0.05
	*5.	2.49±0.01	2.40±0.02	2.34±0.04	2.63±0.04
	*6	2.78±0.05	2.74±0.05	2.63±0.02	2.88±0.02

* indicate significance at ($p<0.05$).

Table 4 Egg weight and egg production at different dietary treatments

Age (weeks)	Treatments			
	T_1	T_2	T_3	T_4
Egg weight (g)	65±0.25	66±0.42	69±0.35	62±0.65
Egg production**	135±5.45	145±4.25	167±3.45	129±4.65

** indicate significance at ($p<0.01$).

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EFFECTS OF DIETARY XYLANASE AND ENERGY DENSITY ON PERFORMANCE AND DIGESTIVE TRACT OF DUCK

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Abstract
A trial was conducted to study the effects of xylanase added in the different-energy-density diets on the growth performance, digestive tract of duck. A 2×4 factorial design was conducted with two dietary xylanase level (0 or 1860 u/kg) and four dietary ME levels (A:12.13 & 10.92 MJ/kg; B: 11.76 & 10.59 MJ/kg; C: 11.38 & 10.25 MJ/kg; D:11.00 & 9.92 MJ/kg for 0 t 14 d & 15 t 42 d respectively). The four basal diets were corn-soybean meal-rapeseed meal-wheat bran diet with the same ratio of ME to CP or amino acids, and fed in mash. Total 576 1-day-old male Cherry Valley ducks were randomly assigned to the 8 treatments with 6 replicates of 12 birds. Ducks were fed in cage and free access to feed and water. Results showed that with the addition of xylanase, the average body weight (ABW) or average body gain (APG) ($P<0.01$), and the feed to gain ratio (F/G) ($P<0.05$) during 1□42d were improved significantly. With the lower ME level, the ABW ($P<0.01$) and APG ($P<0.01$) were decreased significantly but average feed intake ($P<0.05$) and F/G ($P<0.01$) increased. There were no significant interactions between ME level and xylanase for duck growth performance ($P>0.05$), while the growth performance with the lower ME diet with xylanase was improved and reached to that with the higher ME diet without xylanase. Also the lower ME diet decreased the cecum digesta pH on day 7 ($P<0.01$), while xylanase not ($P>0.05$). The relative length of 37d jejunum was decreased by xylanase addition ($P<0.05$), but increased with lower ME level ($P<0.05$). Both xylanase addition and ME level did not affect the digesta viscosity of jejunum and ileum, the relative weight of pancreas and gizzard, the relative length of each segments of small intestinal except the 37d jejunum, the digesta pH in cecum at13d and 37d, and the relative proportion of Lactobacillus and Escherichia coli in ileum($P>0.05$). There were no significant interaction effects on digestive tracts between the ME level and xylanase ($P>0.05$). In conclusion, the duck growth performance could be improved with the addition of xylanase in different ME diets. With the addition of xylanase, the dietary ME could be lower.

Key Words: Duck, Growth Performance, Xylanase, Energy density, Digestive Tract

Introduction

Although corn is the predominant source of energy for poultry diets in China, it is difficult to maintain diet formulation to use corn as the main cereal in poultry feeding because of the cost. The using of by-products appropriately in feed not only can decrease the cost, but also can relieve the problem of inadequate feedstuff. But even the by-products usually contain the higher concentrations of CP, minerals and vitamin B than the parent grain (Slominski et al., 2004), but also contain a lot of non-starch polysaccharides (**NSP**) that reduces the utilization of nutrients. Xylan is one of the most important NSP□Barrera et al., 2004□. The digestive organs were the important organs for animals to digest and /or absorb nutrients, so its function closely relates to the performance of animals. Adding xylanase in diet hydrolyzed xylan and decreased the digesta viscosity (Danicke et al., 2007; Gao et al., 2008), digestive-

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organs compensatory hyperplasia (Jaroni et al., 1999; García et al., 2008) and microorganism fermentation (Hock et al, 1997); thus xylanase could depress the adverse effect of xylan to improve the

health and performance in poultry. At present, the research of adding xylanase in broiler diets was more but less in duck diets (Bedford and Morgan, 1996). And the results of the previous researches showed that the more the dietary energy reduced to a certain extent, the greater the effect of enzyme additive was (Kocher et al., 2003; Zhou et al., 2009).

Therefore, the aim of the present experiment was to study the effects of xylanase added in the different-energy-density diets on the growth performance, digestive tract of duck.

Materials and Methods

Animals and Diets

The experiment was conducted by using a total of 576 1-d-old Cherry Valley male ducks. Birds were randomly assigned to 8 treatments with 6 replicates cages of 12 birds per cage in a completely randomized design involving a 2×4 factorial design with two dietary xylanase level (0 or 1860 u/kg) and four dietary ME levels (A:12.13 & 10.92 MJ/kg; B: 11.76 & 10.59 MJ/kg; C: 11.38 & 10.25 MJ/kg; D:11.00 & 9.92 MJ/kg for 0 t 14 d & 15 t 42 d respectively). Birds were house in electrically heated thermostatically controlled cages with fiberglass feeders and a 24-h constant light schedule. The birds were allowed ad libitum access to the experimental diets and tap water. The birds were managed according to the conventional management. The experimental protocols used in this study were approved by the Institutional Animal Care and Use Committee of Sichuan Agricultural University.

The basal diet (A, Table 1) was formulated to the nutrient level of NRC recommendation. And all the other lower ME diets were kept the same ratio of ME to CP or amino acids.

Sample Collection

On day 7, 13 and 37, 1 bird per replicate was randomly selected (not fast), weighted individually, and sacrificed. The gastrointestinal tract and organs were carefully excised. The contents of caeca were collected. The content of jejunum (from the pancreatic loop to Meckel's diverticulum) and ileum (from Meckel's diverticulum to ileocaecal junction) was collected only on day 13 and 37, and stored in box with ice bag until the chyme viscosity was determined. The length of the duodenum (pancreatic loop), jejunum, and ileum, the weights of the empty gizzard, the pancreas and liver (removing gall bladder) were recorded only on day 13 and 37.

On day 13, another bird was selected per replicate (not fast), weighted individually, sacrificed, and then ducks were soaked in 5% benzalkonium bromide to sterilize. Later a ligates of 5□10 cm ileum from ileocaecal junction to foregut. The contents of the ligated segment of ileum were collected and stored at -70□ until bacteria analyses were carried out.

Sample Preparation and Measurement

The Digesta pH-Value of Caecum. The Digesta pH-Value of Caecum was determined by pH-Star Pistol (model pHS-3C, Shanghai Instrument Co., Shanghai, China).

The Digesta Relative Viscosity of Jejunum and Ileum. The chyme of jejunum and ileum were weighed, transferred into a sterile 10-ml tube containing 5 ml of distilled water, and *misced* by vortexer (XW-80 A, Shanghai Qingpu west instrument factory, Shanghai, China). Then the liquor was centrifuged at 12,000 ×g for 20 min to get supernatant for the viscosity determination. 4 ml of supernatant was sucked into viscometer (Φ 0.5□0.6 mm)which was preheated at 30□1□ in thermostat-controlled water-bath, and was preheated for 5 min. Then, the effusing time was recorded as S_1. Each sample did two times. The effusing time of distilled water was using the same method to determine, recorded as S_2. The viscosity of sample was expressed the relative to the viscosity of distilled water and the relative viscosity of each sample was calculated as follow formula:

The Relative Viscosity of Sample = $(8\ S_{1)} / (3\ S_{2)} - 5/3$

The Relative Proportion of Lactobacillus and Escherichia coli in Ileum Digesta. The contents from ileum (0.5 g) were inverted into a sterile 2-ml tube containing 1ml of sterile PBS (pH=7.4), and homogenized by vortexing for about 2□3 min. The homogenate was centrifuged (200×g for 3min at 4 □), and the supernatant was carefully inverted into a new sterile tube. Then, 1 ml PBS was added to the pellet again, and homogenized by vortexing for about 2□3 min. The homogenate was centrifuged (150×g for 3 min at 4 □), and the supernatant was collected. Finally, 1 ml PBS was added to the pellet again, and homogenized by vortexing for about 2□3 min. The homogenate was centrifuged (100 ×g for 3 min at 4 □), and the supernatant was collected. The supernatant of the three times was mixed together and centrifuged (6000 rpm for 5 min at 4 □), and the pellet was collected. The pellet was washed three times with acetone (6000 rpm for 5 min at 4 □), pre-chilled at -20 □, and the pellet was collected. The pellet was washed three times again with PBS. The bacterial genomic DNA was isolated with TIANamp Bacteria DNA Kit (TIANGEN BIOTECH (BEJING) CO., LTD.). Finally, the extracted DNA was dissolved in 50 uL TE, and the concentration and purity was checked spectrophotometrically.

The primers for universal, Lactobacillus and Escherichia coli were designed (Table 2), all using the 16S rDNA region, according to Amit-Romach et al. (2004). The universal primers set were used for determining the total microflora bacteria population. The relative proportion of Lactobacillus and Escherichia coli in ileum was determined as described by Amit-Romach et al. (2004). For PCR amplification of the bacterial targets form ileum contents, 5 uL of DNA extract was added to 15 uL of PCR mixture containing 10 uL of 2 × Master Mix (TIANGEN BIOTECH (BEJING) CO., LTD.), 2 uL of each primer (10 uM), 1 uL of ddH_2O. The PCR was conducted in a DNA Thermal Cycler (Mastercycler Gradient, Eppendorf, Germany). The amplification conditions were: 1 cycle of 94 □ for 3 min, 35 cycles of 94 □ for 30 s, 60 □ for 1 min, 68 □ for 2 min, and finally 68 □ for 7 min. The PCR products (10 uL of each) were visualized by electrophoresis in agarose gel (2 %) containing GreenView (0.05 ul/ml). Back groups subtraction of gel images was performed and densitometric evaluation of the different bands was done with Quantity One 4.62. To evaluate the relative proportion of Lactobacillus and E.coli, all products were expressed relative to the content of the universal primer product and proportions of each bacterial group were presented where the universal primer product was set at 100%.

The Digestive Organs Index. The digestive organs Index was calculated by the following formula:

The Relative Weight of Digestive Organs = The Weight of Digestive Organ (g)/BW (kg)

The Relative Length of Small Intestinal Each Segments = The Length of Small Intestinal Each Segment (cm)/ BW (kg)

Statistical analyses

Data were analyzed by 2-way ANOVA using the GLM procedure (SAS Inst. Inc., Cary, NC). The model included the main effects of energy content, xylanase, and their interaction. Cage was the experimental unit. A logarithmic transformation was applied to the data on the on the relative proportion of Lactobacillus and Escherichia coli in ileum. Results are given as least square means with pooled standard error (**SEM.**). Differences among means were tested by the Duncan's method and $P<0.05$ was considered to be statistically significant.

Results

Performance

Xylanase improved the ABW, APG, and F/G with significant effects on 42 d ABW, 15□35 d and 1□42 d APG, 15□35 d F/G ($P<0.05$) and 35 d ABW ($P<0.01$) (Table 3, 4). Supplementation of xylanase in diet had no significant ($P\geq0.226$) effects on APFI of birds 1□14 d, 15□35 d, 36□42 d and 1□42 d (Table 4).

The ABW and APG were decreased with the decrease of the ME content in diet, while the APFI and F/G increased. The level of dietary ME content had significant effect on the 35 d , 42 d ABW, 15□35 d and 1□42 d APG, 15□35 d, 36□42 d and 1□42 d APFI, and 1□14 d, 15□35 d, 1□42 d F/G ($P<0.05$ or

0.01) (Table 3, 4) that showed that the depressed of the performance with the decrease of the ME content in diet (Table 3, 4).

Table 1 Composition and nutrient levels of basal diets (%)

Items	0□14 d				15□35 d			
	A	B	C	D	A	B	C	D
Ingredients								
Corn	51.83	53.90	55.97	58.04	61.72	57.92	54.12	50.32
Soybean meal	26.75	24.45	22.14	19.84	9.10	6.57	4.03	1.50
Rapeseed meal	5.00	5.00	5.00	5.00	10.00	10.00	10.00	10.00
Wheat bran	7.20	8.97	10.73	12.50	14.55	20.84	27.14	33.43
Soybean oil	4.76	3.21	1.65	0.10	0.00	0.00	0.00	0.00
CaCO3	1.26	1.28	1.31	1.33	1.36	1.39	1.41	1.44
CaHPO4	1.61	1.59	1.58	1.56	1.50	1.46	1.43	1.39
Lys.HCl	0.14	0.16	0.18	0.20	0.26	0.29	0.31	0.34
DL-Met	0.22	0.21	0.21	0.20	0.28	0.28	0.29	0.29
L-Thr	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.06
Choline chloride	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
NaHCO3	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vitamin premix	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Mineral premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total□	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient levels								
ME□MJ/kg□	12.13	11.76	11.38	11.00	10.92	10.59	10.25	9.92
CP	19.00	18.41	17.82	17.23	15.00	14.54	14.08	13.62
Ca	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TP	0.61	0.61	0.61	0.61	0.76	0.76	0.76	0.76
AP	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
TLys	0.976	0.946	0.915	0.885	0.750	0.727	0.704	0.681
TMet	0.495	0.480	0.464	0.449	0.359	0.348	0.337	0.326
TSAA	0.810	0.785	0.760	0.735	0.761	0.738	0.714	0.691
TThr	0.668	0.647	0.627	0.606	0.528	0.512	0.496	0.479

Per kilogram of complete diet provides□VA 15 000 IU, VD_3 3000 IU, VE 7.5 IU, VK_3 1.5 mg, VB_{11} 0 mg, VB_2 4.8 mg, VB_6 1.8 mg, VB_{12} 18 mg, nicotinic acid 10.5 mg, calcium pantothenate 7.5 mg, folic acid 150 ug, Cu 8 mg, Fe 80 mg, Mn 80 mg, Zn 60 mg, Se 0.2 mg ,I 0.4 mg.

Table 2 Primers used for Lactobacillus, Escherichia coli and Universal (form E.Amit et al.,2004)

Bacterial group	Primer sequences □5'□3'□	Length (bp)
Lactobacillus	F□CATCCAGTGCAAACCTAAGAG R□GATCCGCTTGCCTTCGCA	286
Escherichia coli	F□GACCTCGGTTTAGTTCACAGA R□CACACGCTGACGCTGACCA	585
Universal	F□CGTGCCAGCCGCGGTAATACG R□GGGTTGCGCTCGTTGCGGGACTTAACCCAACAT	611

Table 3 The effect of xylanase supplementation to diets with different ME contents on ABW and APG for ducks

ME levels	Xylanase (u/kg)	ABW (g/bird)			APG (g/bird)		
		1 d	14 d	42 d	1□14	15□42 d	1□42 d
A	0	53.91	485.57□237:.2;^{CBcb}	237:.2;^{CBcb}	633.63	3890.:0$^{A@a}$	2326.72^{CBcb}
	3862	73.;7	701,03	267:.65^{Aa}	444.:3	3977.73^{Cc}	2626.:0^{Aa}□
B	2	73.;3	676.89	2636.37^{Ccb}	623.37	3963.:7^{Ca}	23:2.:0$^{Aa`}$
	3862	73.:9	699,18	267;.70^{Aa}□445,41	445,41	39:0.07^{Aa}	2426.22^{Aa}
C	0	56.00	475.83	2377.9:$^{ABa`}$	622.30	1;02.33^{ABa}	0323.32$^{ABa`}$
	3860	53.;7	4;0.84	2425.97^{Acb}	436.31	3935.67^{ABa}	2353.30$^{Ca`}$
D	0	56.24	467.86	2229.02^{Bc}	413.47	1760.73^{Bb}	2175.60^{Bc}
	1860	53.92	482.13	2342.54^{ABb}	428.17	1860.60^{ABab}	2289.70^{ABb}
SEM			13.90	55.15	13.92	40.65	39.03
ME levels	A		493.30	2428.37^{Aa}	439.13	1935.27^{Aa}	2374.75^{Aa}
	B		487.04	2457.94^{Aa}	433.30	1970.97^{Aa}	2404.50^{Aa}
	C		483.08	2391.96^{Aa}	429.22	1908.90^{ABa}	2337.30^{ABa}
	D		474.99	2285.79^{Bb}	420.82	1810.67^{Bb}	2232.65^{Bb}
Xylanase (u/kg)	0		476.04	2355.42^{b}	422.04	1879.38	2301.60^{b}
	1860		493.17	2426.61^{a}	439.19	1933.52	2373.00^{a}
P-Value	ME		0.614	<0.001	0.612	0.002	<0.001
	Xyl.		0.089	0.014	0.089	0.067	0.013
	ME×Xyl.		0.981	0.632	0.981	0.617	0.631

In the same column, values with different small letter superscripts mean significant difference (P<0.05), different capital letter superscripts mean significant difference (P<0.01). The same as below.

Table 4 The effect of xylanase supplementation to diets with different ME contents on APFI and F/G for ducks

ME levels	Xylanase (u/kg)	APFI (g/bird)			F/G		
		1□14	15□42 d	1□42 d	1□14 d	15□42 d	1□42 d
A	0	737.35	5574.38^{ABbc}	6133.39^{ABbc}	1.709^{ABb}	2.951^{ABbc}	2.642^{BCbc}
	1860	755.75	5441.24^{Bc}	6073.56^{Bc}	1.690^{Bb}	2.758^{Bc}	2.509^{Cc}
B	0	738.79	5872.66^{ABab}	6460.95^{ABab}	1.757^{ABab}	2.998^{ABbc}	2.715^{ABCb}
	1860	776.93	5802.96^{ABab}	6432.69^{ABab}	1.745^{ABb}	2.934^{ABbc}	2.655^{BCbc}
C	0	759.67	6001.99^{Aa}	6609.91^{Aa}	1.800^{ABab}	3.160^{ABab}	2.847^{ABab}
	1860	764.83	5953.02^{Aab}	6556.44^{ABa}	1.753^{ABab}	3.126^{ABab}	2.798^{ABab}
D	0	770.58	5809.62^{ABab}	6413.82^{ABab}	1.884^{Aa}	3.316^{Aa}	2.954^{Aa}
	1860	762.10	5878.85^{ABab}	6465.70^{ABab}	1.798^{ABab}	3.164^{ABab}	2.825^{ABab}
SEM		15.30	117.51	159.48	0.042	0.097	0.093
ME levels	A	746.55	5507.81^{Bb}	6103.47^{Ba}	1.700^{Bb}	2.855^{Cc}	2.576^{Cb}
	B	757.86	5837.81^{Aa}	6446.82^{Ab}	1.751^{ABb}	2.966^{BCbc}	2.685^{BCb}
	C	762.25	5977.51^{Aa}	6583.17^{Ab}	1.777^{ABab}	3.143^{ABab}	2.822^{ABa}
	D	766.34	5844.24^{Aa}	6439.76^{Ab}	1.841^{Aa}	3.240^{Aa}	2.889^{Aa}
Xylanase (u/kg)	0	751.60	5814.66	6404.52	1.788	3.106	2.789
	1860	764.90	5769.02	6382.10	1.747	2.995	2.696
P-Value	ME	0.605	0.02	0.001	0.014	0.01	<0,001□
	X{l,	2.224	2.784	2.780	2.170	0.112	0.053
	ME×Xyl.	0.479	0.855	0.957	0.807	0.829	0.877

Table 5 The Effect of Xylanase Supplementation to Diets with Different ME Contents on The Characteristics of Intestinal Tract for Ducks

ME levels	Xylanase (u/kg)	The Digesta Relative Viscosity of Jejunum and Ileum		The Digesta pH-Value of Caecum			The 13 d Relative Proportion of Measured Bacteria in Ileum	
		13 d	37 d	7 d	13 d	37 d	Lac. (%)	E. coli (%)
A	0	2.04	1.52	5.62^{Aa}	5.42	5.61	13.62	8.86
	1860	1.93	1.36	5.54^{Aab}	5.16	5.50	11.58	12.24
B	0	1.97	1.52	5.26^{ABabc}	5.39	5.77	9.49	8.66
	1860	1.69	1.35	5.23^{ABabc}	5.37	5.42	12.22	10.90
C	0	1.75	1.54	5.24^{ABabc}	5.61	5.63	13.06	10.02
	1860	1.68	1.44	5.18^{ABbc}	5.4	5.51	13.91	20.86
D	0	1.94	1.57	5.25^{ABabc}	5.46	5.53	13.90	6.47
	1860	1.78	1.46	4.94^{Bc}	5.37	5.52	17.31	6.45
SEM		0.16	0.11	0.13	0.15	0.18	3.79	4.43
ME levels	A	1.99	1.44	5.58^{Aa}	5.29	5.56	12.60	10.55
	B	1.83	1.44	5.25^{ABb}	5.38	5.60	10.86	9.78
	C	1.72	1.49	5.21^{Bb}	5.48	5.57	13.49	15.44
	D	1.86	1.51	5.10^{Bb}	5.41	5.53	15.61	6.46
Xylanase (u/kg)	0	1.93	1.54	5.34	5.47	5.64	12.52	8.50
	1860	1.77	1.40	5.22	5.31	5.49	13.76	12.61
P-Value	ME	0.411	0.848	0.004	0.691	0.984	0.660	0.316
	Xyl.	0.176	0.069	0.196	0.150	0.267	0.650	0.223
	ME×Xyl.	0.928	0.987	0.703	0.821	0.819	0.890	0.666

Table 6 The Effect of Xylanase Supplementation to Dievs"wkth Fiffgrgnt ME Convent"ol Chcrccveristkcq of Dkggsvive Orgcnq for Fuckq

OE"lgvglq	Zynanase (u/kg)	Vhe Renavive Wgight of Dkggsvive"orgcnq *g/kg)						Vhe Renavive Lgngth of Soanl Intgsvinal Gach Sggoents *cm/kg)					
		33"d			37 d			33"d				37 d	
		Pcncrgaq	Niver	Gizzcrd	Pancrecs	Lkver	Gkzzard	duodenum	jejunum	duodenum	duodenum	jejunum	duodenum
A	0	8.62	47.35ab	57.33	3.86	39.06	34.94a`	61.62	341.92	146.33	17.62	38.56ABab	40.16
	1860	8.32	45.50b	57.36	3.76	36.07	34.04ab	58.25	131.83	135.81	15.62	34.69Bb	37.33
B	0	7.93	46.89ab	59.60	3.91	39.94	33.54b	54.64	128.57	129.22	16.31	40.20ABa	41.95
	1860	7.82	48.45ab	52.53	3.93	38.73	34.75ab	61.02	127.99	130.80	17.96	40.11ABa	41.16
C	0	8.08	50.36ab	57.84	3.98	41.26	36.84a	64.04	133.26	137.74	18.19	42.80Aa	42.93
	1860	8.15	49.26ab	58.13	3.84	38.38	35.67ab	55.73	132.39	135.54	17.31	39.67ABa	41.73
D	0	7.76	48.57ab	54.69	4.02	39.17	33.88ab	57.20	132.81	138.79	17.51	40.45ABa	41.46
	1860	7.38	51.51a	54.78	4.32	40.08	35.81ab	59.16	132.02	134.60	16.82	39.12ABa	41.39
SEM		0.51	1.76	2.56	0.18	1.74	0.97	3.60	5.30	6.40	1.01	1.46	1.74
ME levels	A	8.47	46.42	57.35	3.81	37.57	34.49	59.93	136.88	141.07	16.62	36.63Ab	38.74
	B	7.87	47.67	56.06	3.92	39.33	34.14	57.83	128.28	130.01	17.14	40.15ABa	41.55
	C	8.11	49.81	57.99	3.91	39.82	36.25	59.89	132.83	136.64	17.75	41.24Ba	42.33
	D	7.57	50.04	54.73	4.17	39.62	34.85	59.00	130.11	136.70	17.16	39.78ABa	41.42
X{lcncse *u/kg)	0	8.10	48.29	57.36	3.94	39.85	34.80	59.37	134.14	138.02	17.41	40.50a	41.63
	3860	7.92	68.68	55.70	3.;6	3:.32	37.07	58.95	129.91	134.19	16.93	38.40`	60.40
R-Value	ME	0.351	0.136	0.597	0.224	0.557	0.161	0.929	0.405	0.396	0.744	0.019	0.199
	Xyl.	0.620	0.759	0.364	0.874	0.219	0.696	0.869	0.265	0.402	0.505	0.048	0.325
	ME×Xyl	0.973	0.494	0.408	0.603	0.652	0.304	0.179	0.784	0.817	0.342	0.562	0.878

The interaction of ME and xylanase in diet had no significant effects on all index of ducks (P>0.05). But the performance with the low-ME-diet groups with xylanase was improved and reached to that with the high-ME diet without xylanase.

The Characteristics of Intestinal Tract

Xylanase had the tendency to decrease the digesta relative viscosity of the jejunum and ileum on day 13 and 37, the digesta pH-value of cecum on day 7, 13 and 37, and increased the relative proportion of Lactobacillus and Escherichia coli bacteria in ileum on day 13(P> 0.05, Table 5).

The dietary ME level had no significant effect on the digesta relative viscosity of jejunum and ileum on day 13 and 37, the digesta pH-value of cecum on day 13 and 37, and the relative proportion of Lactobacillus and Escherichia coli bacteria in ileum on day 13 of ducks (P> 0.05) (Table 5). Decreased the dietary ME significantly decreased the 7 d digesta pH-value of cecum (P<0.01). The 7 d digesta pH-value of cecum of the diet A was significantly higher than that of the diet B (P<0.05), C (P<0.01) and D (P<0.01), and there were no significantly difference among the other groups (Table 5).

The interaction between the ME content and xylanase supplementation in diet had no significant effects on the three indicators of the characteristics of intestinal tract for ducks (P>0.05) (Table 5). But adding xylanase to diets with different ME content decreased the digesta relative viscosity and digesta pH-value of cecum in various degrees.

The Index of Digestive Organs

Xylanase had the tendency to decrease the relative length of each intestinal segments on day 13 and 37, and in which the P-value of 37d duodenum relative length was lower than 0.05 (Table 6). While xylanase had no significantly effect on the relative weight of pancreas, liver, and gizzard on day 13, 37 (P>0.05) (Table 6).

With the decreasing dietary ME content, the 37d duodenum relative length significantly increased ($P<0.05$), while no significant effects on the other digestive organs index. The 37d duodenum relative length in diet A was significantly lower than that in diet B ($P<0.05$), C ($P<0.01$) and D ($P<0.05$), and there were no significantly difference among the other groups (Table 6). In generally, decreased the ME content in diet had the tendency to increased the relative weight of liver, pancreas, gizzard and the relative length of each intestinal segments on day 37.

The interaction between the ME content and xylanase supplementation in diet had no significant effects on the indexes of digestive organs for ducks ($P>0.05$) (Table 5). Adding xylanase to diets with different ME content had different effects on different digestive organs indexes.

Discussion

Effects of Supplementation Xylanase on the Performance, Characteristics of Intestinal Tract and Index of Digestive Organs

The Performance. Xylan is the main anti-nutritive factor in corn-soybean meal-rapeseed meal-wheat bran diet. In the present experiment, xylanase supplementation improved ABW, APG, F/G, and had no effect on APFI. This is in agreement with our earlier findings (Tang et al., 2008) and the results of other authors (Adeola et al., 2004; Gao et al., 2008; J´ozefiak et al., 2003 and 2007).

The Characteristics of Intestinal Tract. With regard to the effects of NSP enzymes on intestinal digesta viscosity, the reports had no consistent results. Jaroni et al. (1999) reported that supplementation NSP enzymes to hens' diets had no effect on the intestinal digesta viscosity; Kiarie et al. (1999) showed the similar result in pigs. Danicke et al. (2007) and Gao et al. (2008) et al. reported that supplementation NSP enzymes significantly decreased the digesta viscosity. In the current study, 13 d and 37 d digesta relative viscosity of jejunum and ileum with the addition of enzyme was decreased respectively by 8.29 % ($P>0.05$) and 9.09 % ($P>0.05$) compared with the control without enzyme. The effects of enzyme preparation on intestinal viscosity were related to dietary formula (Kiarie et al., 2007). Xylan is divided into groups. One linked in the cell wall to cellulose through hydrogen bonding and physical entanglements which was insoluble, and one was not belonged to ingredient of cell wall which was soluble (Chanliaud et al., 1995). The Xylan in wheat-bran was mainly the former. So it would not significantly increased intestinal viscosity compared with soluble Xylan. The research of Adeola et al. (2004) and Jozefiak et al. (2007) confirmed to this; adding xylanase in low-viscosity diets or not had no significances difference for digesta viscosity, but in high-viscosity diets significantly decreased digesta viscosity. That was why the results of enzymes affecting intestinal digesta viscosity were not consistent.

Xylan would decrease the digestibility of nutrients (Adeola et al., 2004) and had the capacity of liquid-binding power no matter soluble or insoluble Xylan (Jelaca and Hlynca, 1971; Kim and Appolonia, 1977), which drastically changes the microbial profile in the gut and providing a relatively suitable environment where fermentative microflora can multiply (Wagner and Thomas, 1978). Therefore, a corresponding greater production of volatile fatty acids leading to a lowering pH value (Hume et al., 1992; Ricke et al., 1982). Xylanase supplementation can relieve the symptoms. Gao et al. (2008) reported that xylanase inclusion in wheat-based diets reduced the digesta pH of the caecum at 21-day-old ($P>0.05$) and 49-day-old ($P<0.05$) broiler chickens, Similar to Choct et al. (1996 and 1999). But J´ozefiak et al. (2003 and 2007) reported that xylanase supplementation did not result in marked differences in caecal organic acid concentrations. In the present study, the digesta pH in the caecum of 7 d ,13 d and 37 d ducks with enzyme was respectively decreased by 2.25 % ($P>0.05$), 2.93 % ($P>0.05$) and 2.66 % ($P>0.05$) compared with the no enzyme control groups. And this conformed that the supplementation of xylanase to low-viscosity diet have no marked effects on pH (Adeola et al, 2004; Choct et al, 1996 and 1999). Hock et al (1997) reported that supplementation xylanase to diets significantly decreased the counts bacteria in gastrointestinal tract. However, the present study found there was no significant difference in the relative proportion of Lactobacillus and Escherichia coli bacteria in ileum for 13 d ducks

between the diets with or no xylanase. These results were consistent with the results of Engberg et al. (2004) and Gao et al. (2008).

The Index of Digestive Organs. Increased the viscosity of the intestinal contents decreased the rate of diffusion of substrates and digestive enzymes, and hinders their effective interaction, leading to significant modifications of the structure and function of the digestive organs (Edwards et al., 1988; Ikegami et al., 1990).To adapt to these changes, the activities of the intestinal secretory mechanisms may be enhanced possibly leading to the hypertrophy of the digestive organs. This increased size of the digestive organs could be an adaptive response to an increased need for enzymes (Ikegami et al, 1990; Brenes et al, 1993). When xylanase is supplemented to diet, part of the NSP may be hydrolyzed, which might attenuate the secretory function of the responding organs, and then the organ sizes may decrease. In addition, xylanase can reduce the digesta viscosity, presumably by cleaving the large molecules into smaller fragments. Since only high-molecular weight soluble arabinoxylans are responsible for increased digesta viscosity (Bedford and Classen, 1992), it was concluded that the released fragments had low molecular weights.

The present study showed that the addition of xylanase decreased the relative length of 13 d and 37 d each intestinal segments and the relative length of 37 d ileum with significant difference ($P<0.05$), according to the previous results (Jaroni et al., 1999; García et al., 2008). Brenes et al. (1993) reported that enzyme supplementation to barley-based diet (higher viscosity) significantly decreased the relative length of duodenum, jejunum, ileum and colon for broiler, while to wheat-based diet (lower viscosity) had no significant difference comparing with no enzyme supplementation. Iji et al. (2003) found the effectiveness of enzyme supplementation to corn-soybean based diet (low viscosity) on the weight of digestive organs was limited. These results were in disagreement with the conclusion that adding enzyme in the diets of high viscosity more obviously improve digestive organic growth. The diets in present study were low viscosity that may be the reason of no significant difference in the relative weight of pancreas, gizzard and liver with the control with the adding of xylanase in the present study.

Effects of ME Levels in Diets on the Performance, Characteristics of Intestinal Tract and Index of Digestive Organs

The Performance. In the present study, decreasing dietary ME had adverse effect on ducks performance (decreasing ABW, APG and increasing APFI, F/ G), according with the previous results (Nahashon et al., 2005; Dozier et al., 2007; Plumstead et al., 2007). Dietary energy content is the important factor of affecting feed intake. Poultry have the capability to accommodate feed intake to the need for autochthonous energy, and the capability of ducks is extraordinary strong (Dean et al., 1978). Decreasing dietary ME induce the increasing the content of crude fiber in diet and the decreased nutrient availability with the result of the performance of ducks depressed.

The decreasing dietary ME content depressed the ducks performance (except F/G) of 15□42 d significantly, but not significantly during1□14 d. This was in agreement with Lv et al. (2002). It maybe relates to the dietary ME content. In the present study, the ME content of 1□14 d & 15□42 d diets was 11.00□12.13 & 9.92□10.92 MJ/kg respectively. Comparing to the 1□14 d & 15□42 d ME requirement of ducks (NRC,1994; 12.13 & 12.55 MJ/kg respectively), the degree of the decrease of dietary ME at the final phases was obviously greater than that of earlier phases.

There was no significant difference between the dietary ME content of diet A and diet B, in agreement with the earlier findings (Tang et al, 2008), while significant between the diet C and diet D. These results showed that the more the dietary ME content decreased, the more the ducks performance was depressed with agreement to Lv et al. (2002) (the performance in dietary ME 12.54 MJ/kg group was significantly different with the dietary ME 11.08 MJ/kg group but not with dietary ME 11.70MJ/kg group). Even the ducks can increase feed intake to redeem the decreasing ME content within some range of dietary ME, the ducks increased the feed intake, but still can not ingest sufficient nutrient when the diet decreased too

many ME. In this case, the performance would become worse. The APFI in the diet D was lower than the diet C in the present study conformed this.

The Characteristics of Intestinal Tract. The fiber concentration in diets increased with the ME content decreased. Researches had documented that the high viscosity of digesta was mainly produced by soluble NSP (**NSPs**). In present study, decreased the ME concentration in diets was down by decreasing the dosage of corn, and soybean oil, and increasing the dosage of wheat-bran, while the NSP in wheat-bran was mainly xylan and insoluble. By calculating the NSPs content of each diet according to the NSPs content of Corn, Soybean meal, Rapeseed meal, Wheat bran and each portion in diets, these figures can be gained as follow: in the 0□14 d diets, the NSPs content in diet A, B, C and D was respectively 2.42 %, 2.34 %, 2.25 %, 2.17 %; in the 15□42 d diets, the NSPs content in diet A, B, C and D was respectively 1.72 %, 1.63 %, 1.54 %, 1.46 %. In present study, the digesta relative viscosity of jejunum and ileum was increased on day 13 and decreased on day 37 with the decreased ME content confirmed to the theoretical values. These results were consistent to that of Farrell and Martin (1998). In the present study, the digesta relative viscosity on day 37 was lower than that on day13 due to soybean meal having more NSPs (6%) comparing with corn, rapeseed meal and wheat bran and the dosage of soybean meal in 15□42 d diet being less than 1□14 d diet.

The intestinal microbiota, living in mutual beneficial symbiosis with the host organism, is an important regulator of energy uptake and storage (George, 2006). One of the reasons was that decreased ME content, the fiber content increased leading to the digestibility of diets decreasing and more residues in hindgut. Therefore, this lead to that fermentative microflora can multiply and greater production of volatile fatty acids was accompanied resulting to a lowering pH value. The present study showed that the 7 d pH value of cecum was significantly decreased with decreased ME content ($P<0.05$), confirming to it. The 13 d and 37 d pH value of cecum had the tendency to decreased with decreased ME content ($P>0.05$). Because the digestive power will enhance with animals growing and the effectiveness would deflate. In addition, the present study found that the ME content had no effects on the relative proportion of Lactobacillus and Escherichia coli bacteria in ileum for 13 d ducks, coinciding with our obtained viscosity, pH.

The Index of Digestive Organs. When decreased ME content, the density of diet decreases and bulk enlarges; the content of fiber and viscous polysaccharides in diet increased which resulted in the increasing endogenous loss of water, protein, dielectric, and so on, and feed intake was increased. To adapt to these changes, the size of digestive organs would generate an adaptive response to enlarge. The researched documented that the level of nutrition can have a profound effect on the mass of the most metabolically active organs (Koong et al., 1985; Ortigues and Doreau, 1995). The present study showed that decreased the ME content had the tendency to increase the index of digestive organs on day 37, confirming to it; while had no effects on 13 d index of digestive organs. One reason may be that the capacity to ducks modulating feed intake was limited owing to the digestive system being developing, in earlier phases. The results of decreased ME content slightly increasing the earlier APFI but significantly increasing the final APFI supported the view in the present study. Another reason may be accumulation.

Effects of The Interaction Between The ME Content and Xylanase Supplementation in Diet on The Performance, Characteristics of Intestinal Tract and Index of Digestive Organs for Ducks

Feed nutrition level is a important factor which influence effect of enzyme. Generally, the lower the dietary nutrition level was to a certain extent, the greater the effect of enzyme additive was (Kocher et al., 2003; Zhou et al., 2009). Turkeys experiment made by Virginia University showed that adding enzyme preparation (containing protease, diastase and xylanase) could improve growth performance of turkeys significantly. However, it didn't reach the performance of 28% high crude protein level feed. To add the same enzyme into 28% high crude protein level feed had no effect. Wan (2004) and Liu (2006) had the similar reports. Li□2006□[117] reported that adding phytase into middle energy level group had the best effect on broilers F/G, DM and Ca digestibility. Qiao (2006) had the similar report. Luo (2006) reported that energy (12.5 and 13.0 MJ/kg) and complex enzyme (0 and 0.075 %) had no significant effect on pig performance and nutrient digestibility interaction. The different results might have relationship with

nutrition level and amount of enzyme. Proper enzyme and substrate percentage could make good results. Because of low energy level, anti-nutrition factors increased and more enzyme was needed(Ni and Zhang, 2001). Qiao (2006) reported that adding 0.05 % xylanase into high level energy (3.35 and 3.33 MC/kg) and middle level energy (3.25 and 3.23 MC/kg) groups had better effect on pig performance and digestibility, but worse effect in low level energy group. To add 0.1 % xylanase had better effect in low level energy group than high and middle lever energy groups, and adverse effect occurred in high level energy group. Ni (2001) had a similar report. Zheng (2006) reported that the interaction between feed energy and complex NSP enzyme had no significant effect on broilers ADG, blood glucose and significant effect on F/G, digestibility, triglyceride, VLDL. It showed that the interaction between nutrition level and enzyme had different influence on different indicators. The experiment results showed that the interaction between energy level and xylanase had no significant effect on performance, characteristics of intestinal tract and index of digestive organs for ducks. Adding xylanase in 4 ME content diets showed similar effect to improve performance; and the growth performance in the lower ME diet groups with xylanase could reach to the degree of the higher ME but without xylanase diet. These results showed that adding xylanase could reduce dietary energy level properly.

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DISTRIBUTION OF ISLETS OF LANGERHANS IN THE PANCREATIC LOBES IN KUTTANAD DUCKS

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Running Title: Islets of Langerhans in Kuttanad ducks

Abstract

Distribution of islets of Langerhans among the lobes of pancreas in Kuttanad ducks was studied using six birds of 24 weeks of age. The pancreas was seen as a long narrow strip of glandular tissue, pale pink in colour, enclosed between the ascending and descending limbs of the duodenal loop within the pancreatico-duodenal ligament. Duodenal loop extended well beyond the caudal end of pancreas. Pancreas contributed 0.44 percent to the body weight at this age and consisted of large dorsal and ventral lobes, and a small and narrow splenic lobe associated with the dorsal lobe. The dorsal lobe presented cranial and caudal segments demarcated by a thinner junctional area in the middle. The individual contributions of the lobes to the body weight were 0.28 and 0.14 percent respectively, by the dorsal lobe along with the splenic lobe and ventral lobe. With haematoxylin and eosin staining, the islets were seen as light-stained aggregates of cells among the darker staining pancreatic acini. The islets lay in the interacinar connective tissue, arranged as anastomosing cords with blood vessels in between. Islets were arranged along the central axis in the ventral lobe. In the dorsal lobe, the clusters of islets were more near the ventral surface and also near the junction of its cranial and caudal segments. The average size of the islets was found be more in the dorsal and ventral lobes ranging between 195x 325 and 130 x 260μm in cross sectional diameters. But the splenic lobe presented smaller and narrower islets ranging from a size of 26 x 26μm to a larger size of 130 x 210μm.

Keywords: Islets, Kuttanad duck, Langerhans, pancreas

Introduction

The pancreas is a compound racemose gland, analogous in its structure to the salivary glands, though softer and less compactly arranged than those organs. Ninety nine percent of its tissue is made up by the exocrine portion and one percent by its endocrine part. Its secretion, the pancreatic juice, carried by the pancreatic duct to the duodenum, is an important digestive fluid. In addition, the pancreas has an important internal secretion, elaborated by the cells of Langerhans, which is taken up by the blood stream and is concerned with carbohydrate metabolism.

In birds, the pancreas is a long narrow pale pink gland located in the mesentery connecting the two arms of duodenal loop. Pancreas extends from the apex of duodenal loop to the point where the pancreatic ducts enter the distal duodenum. It has two main lobes, dorsal and ventral with a small splenic lobe extending from the head of the pancreas to the spleen. Functionally, the pancreatic juice is secreted by the exocrine portion and the hormones, by the endocrine part. The islets of Langerhans, is scattered among the acinar connective tissue and made up chiefly of A (alpha), B (beta) and D(delta) cells, which vary in their distribution among different lobes. These cells produce glucagon, insulin and somatostatin respectively, playing important roles in the metabolic activities of the bird. Eventhough pancreas of fowl has been extensively studied (Sturkie, 1965; Hodges, 1974; Mc Lelland, 1975), only very little research

has been done to describe the islets of Langerhans in the duck. The present study was directed primarily towards the pattern of distribution of the islets among the pancreatic lobes of Kuttanad duck, a native breed of Kerala, which will be of help in assessing the blood level of pancreatic hormones after subtotal pancreatectomy and ensuing diabetics.

Materials and Methods

Six apparently healthy adult ducks of 24 weeks age were used for the study. Birds were selected randomly from a single hatch and reared under intensive system of management. They were grown under similar environmental and nutritional conditions. After recording the live body weight, the birds were euthanized and the thoraco-abdominal cavity was opened to expose the pancreas. The topography of the pancreas was noted, and it was separated from the duodenum, dissected out and biometric observations like total and individual weights and lengths of dorsal, ventral and splenic lobes were recorded. The materials were fixed in 10% neutral buffered formalin. Standard procedures were adopted for processing, tissues were embedded in high-melting paraffin (58-60^{0}C), and sections of 5 µm thick were made and stained by routine staining methods. Relative distribution of the islets was noted and the micrometrical data were recorded using an ocular micrometer.

Results

Pancreas was seen as a long and narrow glandular tissue enclosed between the descending and ascending limbs of duodenum within the pancreatico-duodenal ligament. It was pale pink in colour in fresh state. Pancreas consisted of two main- dorsal and ventral- lobes, with a small splenic lobe extending from the dorsal lobe upto the spleen. Dorsal lobe presented cranial and caudal segments demarcated by a thinner junctional area in the middle (Fig. 1).

Fig. 1

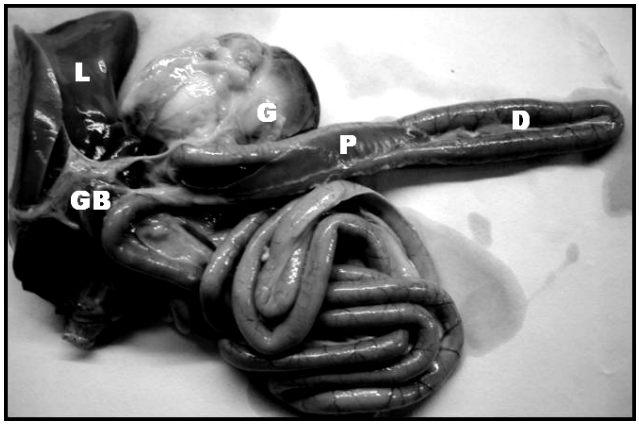


Fig. 2

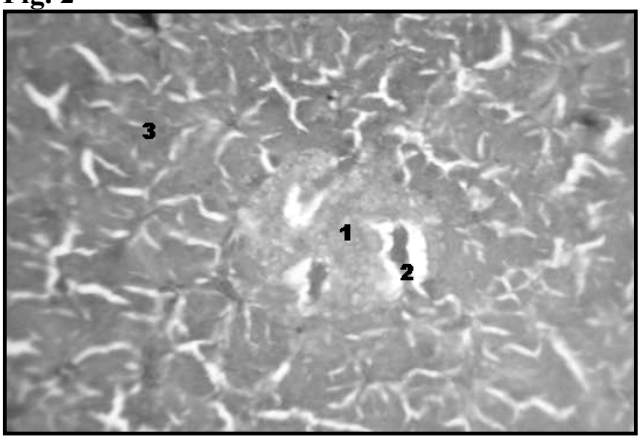


Fig. 3

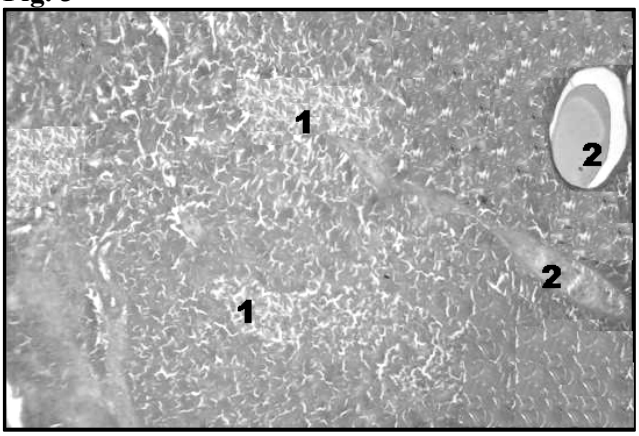


Fig. 4

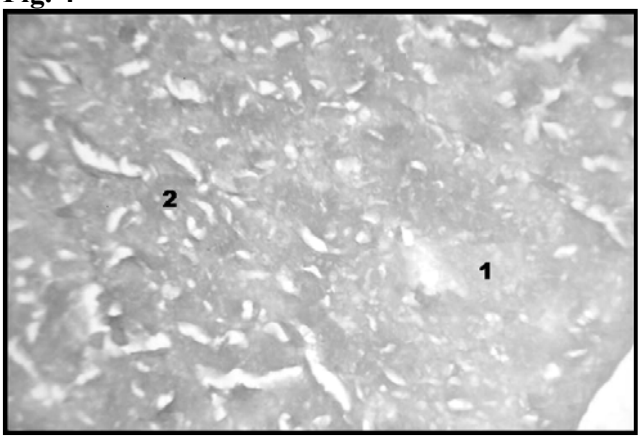


Fig. 5

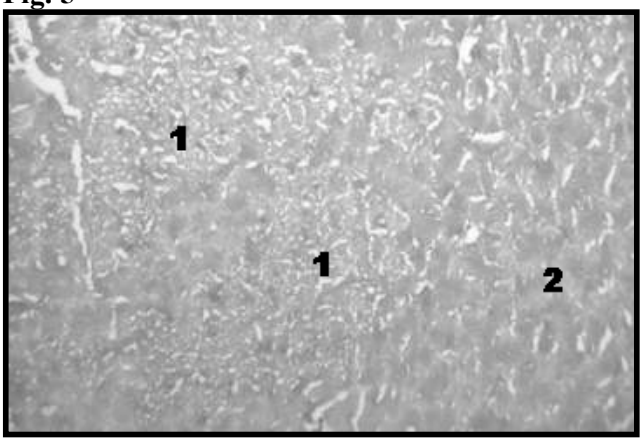
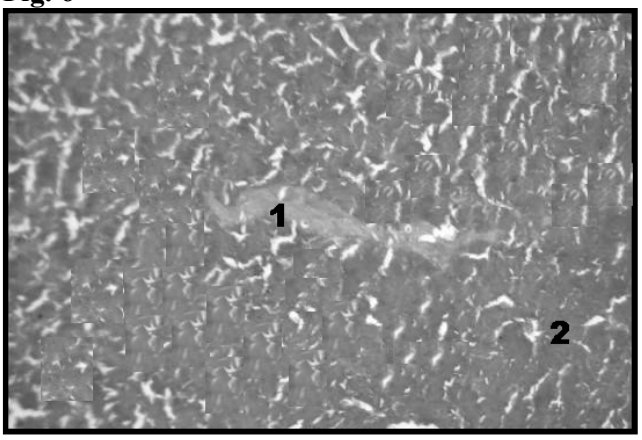


Fig. 6



LEGENDS TO FIGURES

Fig. 1 Location of pancreas at 24 weeks of age. Ventral view.
P- Ventral lobe of pancreas D- Duodenum G- Gizzard
L- Liver GB- Gall bladder
Fig. 2 Ventral lobe of the pancreas at 24 weeks. H & E x 400
1. Islets 2. Blood Vessels 3. Exocrine acini
Fig. 3 Ventral lobe at 24 weeks. H & E x 100
1. Islets 2. Blood Vessels
Fig. 4 Dorsal lobe at 24 weeks. H & E x 400
1. Islets 2. Exocrine acini
Fig. 5 Dorsal lobe at 24 weeks. H & E x 100
1. Islets 2. Exocrine acini
Fig. 6 Splenic lobe at 24 weeks. H & E x 100
1. Islets 2. Exocrine acini

Pancreas had an average weight and length of 6.28g and 9.80 cm respectively and contributed 0.44 percent to the body weight. The dorsal lobe had a weight of 4.20g with a length of 6.60cm. The respective values for the ventral lobe were 2.08g and 7.00cm. The average contributions of the lobes to the body weight were 0.28% and 0.14% respectively by the dorsal lobe along with splenic lobe and ventral lobe.

With haematoxylin and eosin staining, the islets of Langerhans appeared pale in contrast with surrounding exocrine acini. Islets were arranged in irregular disseminating clusters with a network of blood vessels (Fig. 2). Nuclei did not show any particular arrangement. Occasionally they formed roughly spherical islands of cells scattered among acinar connective tissue. The connective tissue components surrounding the islets showed PAS positive reaction. Islets were of two types: dark and light. Dark ones represented A cells and light ones indicated B cells.

Neither light nor dark islets were distributed through out either lobe. They were arranged along the central axis of ventral lobe (Fig. 3). In the dorsal lobe, the clusters were more near the ventral surface and also near the junction of cranial and caudal segments (Fig. 4). The average size of the islets were more in the dorsal and ventral lobes ranging between 195 x 325 and 130 x 260 µm in cross sectional diameters (Fig. 5). But the splenic lobe presented more number of smaller and narrower islets (Fig. 6) ranging from a size of 26 x 26 µm to a larger size of 130 x 210 µm.

Discussion

The lobation of pancreas agreed with the observations of Mc Lelland (1975) in chicken and that of. Nickel *et al.* (1977) and Indu *et al*. (2001) in duck.

The islets were scattered as pale staining clusters of cells as per the earlier reports of Hodges (1974) in domestic fowl. The distribution of islets was more in the splenic lobe even though the individual size of the islets was less. This was in accordance with the findings of Qakberg (1949) who could also find the largest number of islets in the splenic lobe of White Leghorn chicken. PAS positive

reaction of the connective tissue components surrounding the islets might be due to the presence of collagen and reticular fibres.

Studied by by Sitbon and Mialhe (1980), concluded that when the total pancreactectomy induced a fatal hypoglyceamia associated with the disappearance of circulating glucagon, and an impaired glucose tolerance ascribed to the lack of insulin, the subtotal pancreactectomy provoked a diabetes characterized by a basal hyperglyceamia and an impaired glucose tolerance, which pointed out the importance of the pancreas in birds.

Conclusion

Pancreas is considered both as the largest exocrine gland and the smallest endocrine gland. The endocrine part of pancreas plays a major role in the carbohydrate metabolism of the body. Interaction between insulin, glucagon and pancreatic hormone-plasma metabolite feedback mechanisms are the main regulators of these secretions. An increased knowledge about the endocrine system not only results in a better understanding of the fundamental aspects of development but also may lead to new practical applications.

Acknowledgements

The authors are grateful to Dr. E. Nanu, Dean of the Faculty and the Staff members of Department of Veterinary Anatomy and Histology, College of Veterinary and Animal Sciences, Mannuthy, for their timely help and valuable guidance.

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POSTNATAL HISTOLOGY OF THE TRACHEA AND SYRINX IN KUTTANAD DUCKS (*Anas platyrynchos domesticus*)

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Running Title: Trachea and Syrinx in Kuttanad Ducks

Abstract

This study was carried out to elucidate the age-related histological changes in lower trachea, syrinx and primary bronchi of Kuttanad ducks (*Anas platyrynchos domesticus*) using 72 ducks of various ages upto 22 weeks. Trachea was lined by mucociliary pseudostratified columnar epithelium with simple acinar mucous glands. Basal cells of epithelium had round or irregular nuclei, while the more superficial ciliated cells had oval or elongated nuclei. Cells of mucous glands were typical mucous-secreting cells with large round, basal nuclei and a foamy cytoplasm, filled with numerous round clear vacuoles. In the mucosa lining the most posterior portion of trachea and that lining syrinx, these glands were replaced by goblet cells. Lamina propria consisted of dense irregular connective tissue containing blood vessels. It was continuous with a dense submucosa with many elastic fibres, which was again continuous with the perichondrium of rings of cartilage. The whole duct was bounded by a layer of adventitial connective tissue. Striated muscles associated with trachea, formed bands of flattened layers and spread about two-thirds of the way around each side. Trachea presented osseous metaplastic cartilage with bone marrow between cancellous trabeculae from 21 weeks of age onwards. Syringeal structures were covered by a respiratory epithelium, with local modifications in cellular height and numbers of ciliated and goblet cells. Smooth muscle cells occurred in the wall from the lateral parts of the inter-bronchial ligament to the medial line and cranially to the inner tympaniform membranes, may play a role in sound generation by influencing the tension of the medial tympaniform membranes. Central, thin portion of the external tympanic membrane presented internally the mucosa with a layer of cuboidal or flattened cells with very few mucous goblet cells and cilicated cells. Beneath this was a layer of coarse elastic fibres and then a layer of loose, fine collagen and elastic fibres, with blood vessels and scattered smooth muscle cells. An outer layer consisted of coarse collagen fibres interspersed with elastic fibres, bounded by squamous epithelium. Passing towards anterior and posterior edges of the membrane, the mucosal cell layer gradually became pseudo-stratified, with taller cells and more frequent cilia and goblet cells. Different parts of the syrinx were connected by thick bands of elastic fibrous tissue. Epithelium in primary bronchi became progressively lower and less pseudostratified, with lesser aggregation of mucous cells. Cartilaginous rings of each bronchus were C- shaped with membranous medial wall

Introduction

Syrinx, trachea and bronchi form important constituent parts of the upper respiratory tract of the duck. The syrinx is located in the throat, at the bottom of the trachea near the junction of the bronchial tubes. Calls are produced as air passes over the membranes of the syrinx, causing them to vibrate. The shape of the syrinx and the muscles that control membrane tension dictate the different calls within and between species. This study was aimed at observing normal histological characteristics of the lower trachea, syrinx and the primary bronchi of the Kuttanad ducks (*Anas platyrynchos domesticus*) using 72 ducks of various ages.

Materials and Methods

Six birds each were collected at fortnightly intervals up to 22 weeks of age. The birds were anaesthetised by chloroform, euthanized by bleeding and the neck region was dissected exposing the larynx and trachea with the muscles attached on either side. The sternum was also split open in the midline. The collected specimens were fixed in 10 percent neutral buffered formalin for 48 hours, processed by routine histological techniques and embedded in high-melting paraffin. Five to six-micron sections were stained with haematoxylin and eosin.

Results

Trachea was lined by mucociliary pseudostratified columnar epithelium with simple acinar mucous glands (Fig. 1). Basal cells of the epithelium had round or irregular nuclei, while the more superficial ciliated cells had oval or elongated nuclei. Cells of the mucous glands were typical mucous-secreting cells with large round, basal nuclei and a foamy cytoplasm, filled with numerous round clear vacuoles. In the mucosa lining the most posterior portion of trachea and that lining syrinx, these glands were replaced by goblet cells.

Lamina propria consisted of dense irregular connective tissue containing blood vessels. It was continuous with a dense submucosa with many elastic fibres, which was in turn continuous with the perichondrium of rings of cartilage. The whole duct was bounded by a layer of adventitial connective tissue. Striated muscles associated with trachea, formed bands of flattened layers and spread about two-thirds of the way around each side. Trachea presented osseous metaplastic cartilage with bone marrow between cancellous trabeculae from 21 weeks of age onwards (Fig. 2).

Syringeal structures were covered by a respiratory epithelium, with local modifications in cellular height and numbers of ciliated and goblet cells. Central, thin portion of the external tympanic membrane presented internally the mucosa with a layer of cuboidal or flattened cells with very few mucous goblet cells and ciliated cells. Beneath this was a layer of coarse elastic fibres and then a layer of loose, fine collagen and elastic fibres, with blood vessels and scattered smooth muscle cells (Fig. 3). Smooth muscle cells occurred in the wall from the lateral parts of the inter-bronchial ligament to the medial line and cranially to the inner tympaniform membranes. An outer layer was found consisting of coarse collagen fibres interspersed with elastic fibres, bounded by squamous epithelium. Passing towards anterior and posterior edges of the membrane, the mucosal cell layer gradually became pseudo-stratified, with taller cells and more frequent cilia and goblet cells. Different parts of the syrinx were connected by thick bands of elastic fibrous tissue. Epithelium in primary bronchi became progressively lower and less pseudostratified, with lesser aggregation of mucous cells. Cartilaginous rings of each bronchus were C-shaped with membranous medial wall (Fig. 4)

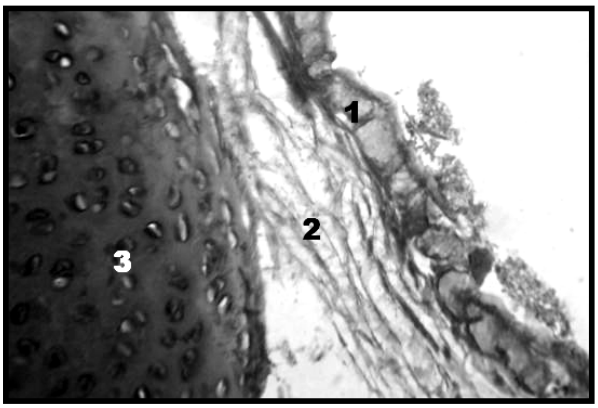

Fig. 1 C. S. of trachea at 16 weeks of age. H & E x 400
1. Mucous glands 2. Lamina propria 3. Tracheal cartilage

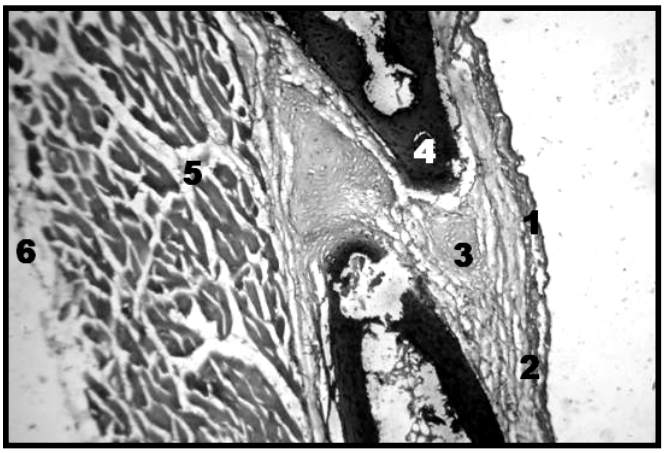

Fig. 2 C. S. of trachea at 22 weeks of age. H & E x 400
1. Epithelium 2. Lamina propria 3. Submucosa 4. Ossifying tracheal cartilage
5. Striated muscle 6. Adventitia

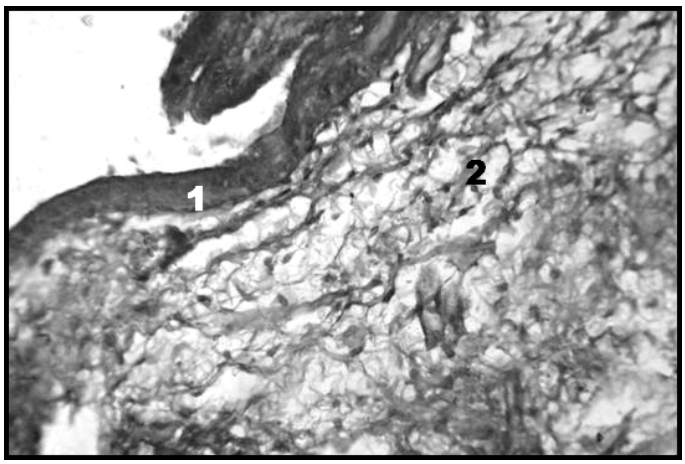

Fig. 3 C. S. of syrinx at 22 weeks of age. H & E x 400
1. Epithelium 2. Connective tissue layer

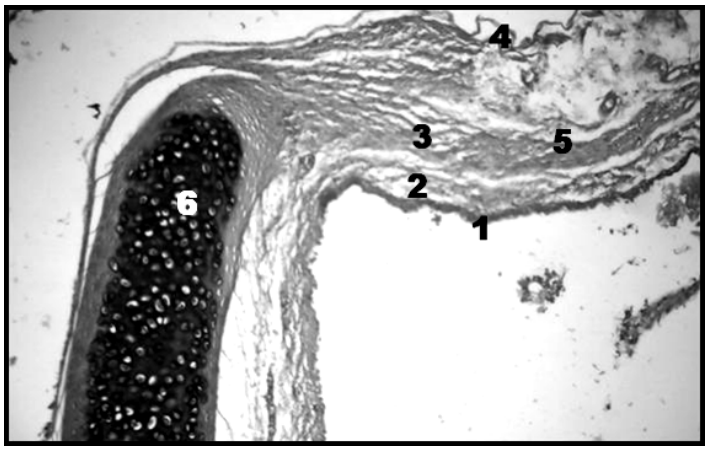

Fig. 4 C. S. of bronchi at 16 weeks of age. H & E x 100

1. Epithelium 2. Lamina propria 3. Submucosa
4. Adventitia 5. Membranous wall 6. C- shaped cartilage

Discussion

Trachea was lined by mucociliary pseudostratified columnar epithelium with simple acinar mucous glands in accordance with the observations of Smith *et al* (1986) in budgerigar (*Melopsittacus undulatus*). The glands were replaced by goblet cells in the mucosa lining the most posterior portion of trachea and that lining syrinx, agreeing with the findings of Jeffery (1978), who during the comparative study of structure and function of mucus-secreting cells of cat and goose airway epithelium, stated that both goblet cells and sub mucosal glands were abundant in the trachea of cat where as that of goose had abundant goblet cells which formed the intra epithelial glands. The secretion contained mucins with a predominance of sulphate esters. A surface mucosubstance was also demonstrated. This surface layer may be sloughed in response to an inhaled irritant such as ammonia and thereby contribute to the respiratory tract mucus recovered experimentally.

Lamina propria contained dense irregular connective tissue containing blood vessels and was continuous with submucosa with many elastic fibres, which was in turn continuous with the perichondrium of rings of cartilage. There was an external layer of adventitial connective tissue. Ossification of tracheal cartilages was observed from 21 weeks of age onwards. Garrod (1875) opined that a "slight fusiform dilatation" in the anterior syringeal region and such mid-tracheal swellings were found only in Mergini and Aythyini, which was extremely rare in the genus *Anas*.

Local modifications were observed in the syringeal respiratory epithelium, which agreed with those of Demirkan *et al* (2007), who found that in Japanese quail only the inlet of the larynx was covered by olfactory epithelium where as the rest was covered by respiratory epithelium. In mallard ducks, the syrinx showed sexual dimorphism in duck where male syrinx was large and laterally asymmetric. In their study they found that left half in male was larger than right and in females it was small and bilaterally symmetric (Takahashi and Noumura, 1993; Pierko, 2007), which was true in this study also.

Central portion of the external tympanic membrane presented internally the mucosa with a layer of cuboidal or flattened cells with very few mucous goblet cells and ciliated cells. Smooth muscle cells, which occurred in the wall from the lateral parts of the inter-bronchial ligament to the medial line and cranially to the inner tympaniform membranes, may play a role in sound generation by influencing the tension of the medial tympaniform membranes.

Cartilaginous rings of each bronchus were C- shaped with membranous medial wall and this finding was in accordance with Frank *et al.* (2006) in duck (*Anas platyrinchos*).

Conclusion

In duck, the trachea was lined by mucociliary pseudostratified columnar epithelium with simple acinar mucous glands; epithelium in primary bronchi became progressively lower and less pseudostratified, with lesser aggregation of mucous cells. The wall structure showed a parallel simplification; tracheal elements were comprised of osseous metaplastic cartilage with bone marrow between cancellous trabeculae. Local modifications were observed in the syringeal respiratory epithelium. Although the tracheal muscle bands do help in the production of voice, none of them comes into direct contact with the tympanic membranes.

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POSTNATAL DEVELOPMENT OF CAECA IN KUTTANAD DUCK (*Anas platyrhynchos domesticus*)

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Abbreviated title: Caecal development in Kuttanad duck

Abstract

Caecum, the largest part of duck's intestine has an important role in liquid absorption, cellulose digestion and defensive mechanism. Age related changes in the histomorphology of the caeca in Kuttanad ducks were studied in 72 birds from day-old to adult at fortnight intervals. After recording the biometry and gross features, the material was fixed in neutral buffered formalin and standard procedures were adopted for histological and histochemical studies. The paired caeca extended cranially from the ileo-colic junction. Each caecum showed three regions, viz., the base, middle part and an apex. The caeca lay parallel to the ileum to which they were attached by ileo-caecal ligaments. The apical portion was caudally directed and free. In day-old birds, the caecum had a uniform diameter (1 mm). Mean length of caecum increased from 4.00 ± 0.42 cm in day-old birds to 13.69 ± 2.45 cm in the adults. The adult length was attained by eight weeks of age. Average diameters of the basal, middle and apical portions of fully developed caecum were 0.28 cm, 0.38 cm and 0.57 cm, respectively. Histologically, ileo-caecal-colic junction showed a papilla-like protrusion made up of circular smooth muscle layer. Large nerve bundles were found in the inner circular layer of tunica muscularis in this region. Mucosa of the caecum carried tooth shaped villi, which were more prominent and longer in the basal part. Their height reduced towards the middle portion and again increased in the apex in the non-distended caecum. In day-old birds, histological picture was same as in the adult except in that there was no lymphatic tissue in the lamina propria. Longitudinal mucosal folds were noticed in the middle and apical regions as age advanced. Lamina epithelialis was formed of simple columnar epithelium with goblet cells, the number of which decreased towards apex. Lamina propria showed tubular intestinal crypts of Lieberkuhn and diffuse lymphatic tissue. A typical caecal tonsil could not be located unlike in the domestic fowl. Lymphatic tissue decreased towards the apex. Lamina propria was separated from the submucosa by a thin muscularis mucosa. Tunica muscularis showed a very thick inner circular and a thin outer longitudinal smooth muscle layers. At the basal region, tunica muscularis was extremely thick forming the caecal sphincter. Tunica muscularis showed bundles of nerve fibres. Thickness of the muscular coat decreased towards the apex. Externally there was a serosa.

Key words: Kuttanad duck; postnatal development; caeca

Introduction

The hindgut in duck is comparable to that of other birds although there are many unique aspects to consider. Caecum, the largest part of duck's intestine, has an important role in liquid absorption, cellulose digestion and defensive mechanism. Literature on postnatal development of caeca in duck is scanty. Hence this work was undertaken to study the age related changes in the caecum of Kuttanad ducks. This will form a basis for correlating the possible functions of the caeca particularly to that of defensive action in different age groups.

Materials and methods

This study was conducted on apparently healthy 72 Kuttanad ducks of various age groups. The birds were selected randomly from a single hatch and reared under semi- intensive system of management. After recording the body weight of birds, caeca were collected at two weeks interval

ranging from day-old to adult. Body cavity was opened and topography of the caecum was noted. The caeca were then dissected out and examined for gross appearance, colour and shape. After recording the biometry and topography, the material was fixed in neural buffered formalin and standard procedures were adopted for histological and histochemical studies. The sections were stained using Ehrlich's haematoxylin and eosin method, Van Gieson's method for collagen and Gomori's one step trichrome method (Luna, 1968). Measurements were taken using ocular micrometer. The data on these physical parameters were analysed statistically (Snedecor and Cochran, 1985).

Results

Morphology

The paired caeca extended cranially from the ileo-colic junction. Each caecum showed three regions, viz., the base, middle part and an apex. Caecum lay parallel to the ileum and was connected to it by means of short ileo-caecal ligaments (Fig. 1). Gross and histological features of the caecum showed marked variation with the advancement of age. Measurements of caecum at various stages of development are given in table 1.

Length of the caecum increased from 4.00 ± 0.42 cm to 13.69 ± 2.45 cm from day-old to adult. Caecum attained its adult length by eight weeks of age. Mean length showed an increasing trend upto 18 weeks of age and gradually its length decreased. Diameter of all the three regions of the day-old caecum was uniform, i.e., 0.10 cm. But in fully developed caecum, the apex showed maximum diameter. Diameters of fully developed caecum at basal, middle and apical regions were 0.28cm, 0.38cm and 0.57cm, respectively suggesting that lumen has expanded especially in the free apical portion.

Table 1. Gross parameters of the caecum in Kuttanad ducks

Age	Mean length of caecum (cm)	Mean diameter of caecum (cm)		
		Base	Middle	Apex
Day-old	4.00±0.42	0.10±0.00	0.10±0.00	0.10±0.00
2 wk	10.75±0.10	0.22±0.02	0.28±0.00	0.22±0.02
4 wk	13.30±0.25	0.25±0.01	0.27±0.02	0.29±0.02
6 wk	13.43±0.60	0.28±0.09	0.38±0.02	0.37±0.04
8 wk	13.60±0.94	0.34±0.03	0.38±0.00	0.40±0.04
10 wk	14.40±0.70	0.30±0.00	0.42±0.04	0.37±0.06
12 wk	15.40±0.94	0.30±0.00	0.36±0.00	0.39±0.05
14 wk	15.16±1.90	0.25±0.02	0.35±0.02	0.42±0.03
16 wk	14.30±1.48	0.27±0.00	0.29±0.00	0.34±0.02
18 wk	18.66±0.60	0.26±0.01	0.28±0.02	0.37±0.05
20 wk	16.16±1.42	0.25±0.02	0.26±0.01	0.34±0.03
22 wk	13.69±2.45	0.28±0.00	0.38±0.02	0.57±0.05

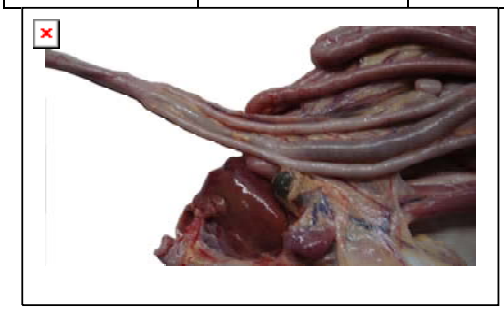

Fig.1

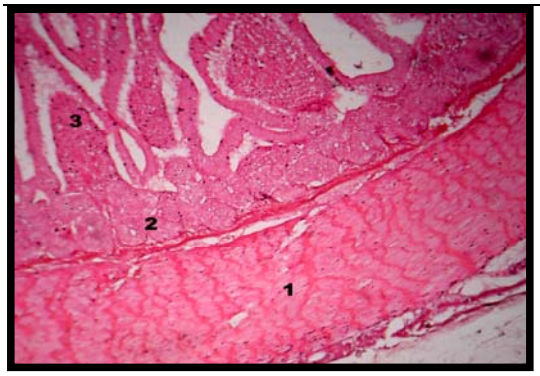

Fig.2

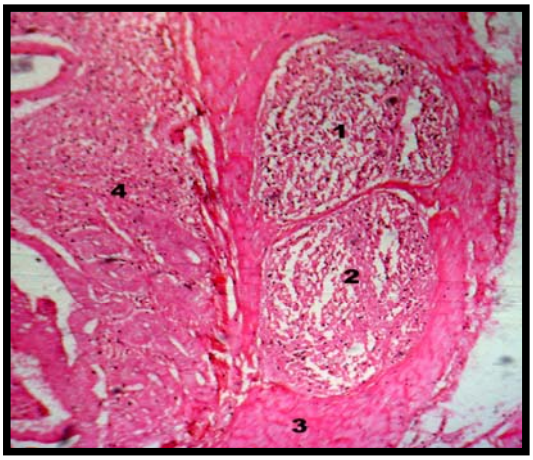

Fig.3

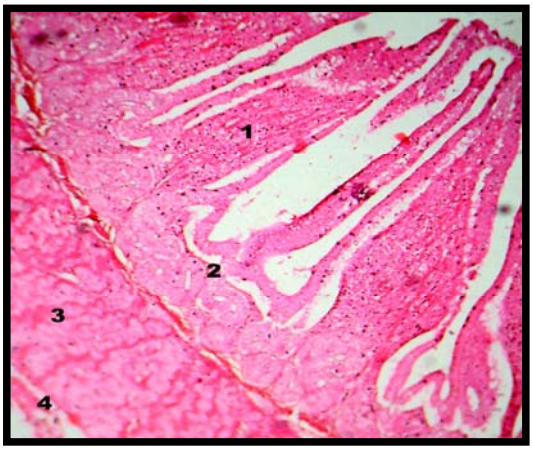

Fig.4

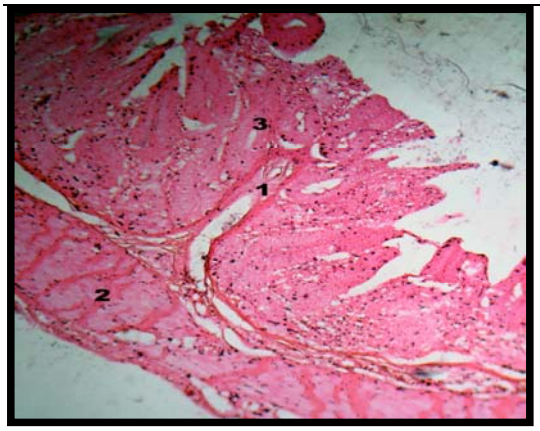

Fig.5

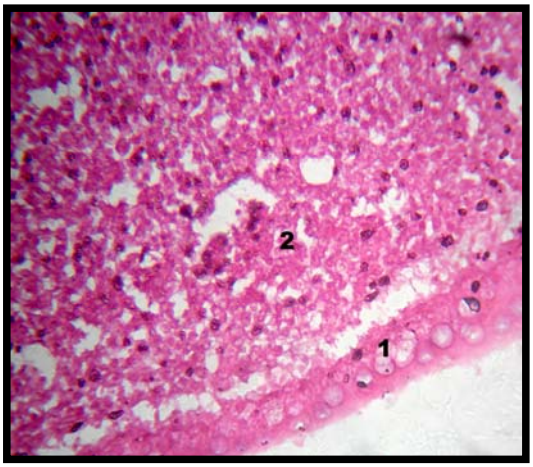

Fig.6

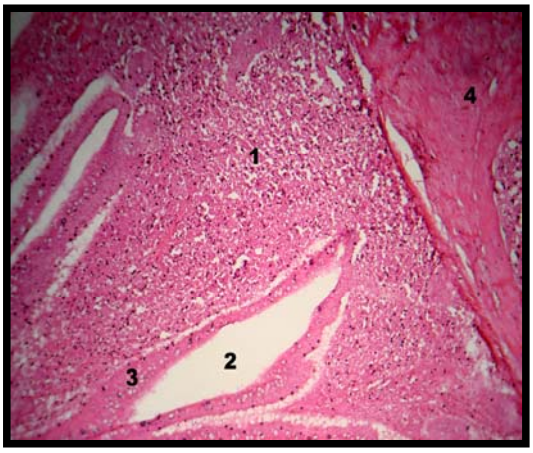

Fig.7

Fig.1 Caecum attached to ileum by ileo-caecal ligaments
Fig.2 1-circular smooth muscles 2-Lamina propria 3- Villus
Fig.3 1, 2- Nerve bundles 3- Tunica muscularis 4- Lamina propria
Fig.4 1- Tooth-shaped villi 2- Lamina propria 3- Tunica muscularis 4- Serosa
Fig.5 Longitudinal mucosal fold 2- Tunica muscularis 3- villus
Fig.6 Goblet cell 2- Lamina propria
Fig.7 1-Lymphatic tissue 2- Inter-villus space 3-simple columnar epithelium 4- Tunica muscularis

Histology

Histologically, ileo-caeco-colic junction showed a papilla-like protrusion made up of circular smooth muscle layer (Fig. 2). Large nerve bundles were found in the inner circular layer of tunica muscularis in this region (Fig. 3). The mucosa of the caecum carried tooth-shaped villi, which were more prominent and longer in the basal part (Fig. 4). Micrometric parameters of caecal villi revealed that the mean height of the villi increased from 206.67±13.33 µm in day-old to 886.67±24.7 µm in the adult at the base, 61.33±1.33 µm to 308.0±35.23 µm in the middle portion and 70.0±5.77 µm to 366.37±29.06 µm at the apex. Their height reduced towards the middle portion and again increased in the apex in the non-distended caecum.

In the day-old birds, histological picture was the same as in the adult except in that there was no lymphatic tissue in the lamina propria. Longitudinal mucosal folds were noticed in the middle and apical region as the age advanced (Fig. 5). Lamina epithelialis was formed of simple columnar epithelium with goblet cells, the number of which decreased towards the apex (Fig. 6). Lamina propria showed tubular intestinal crypts of Lieberkuhn and diffused lymphatic tissue (Fig.7). A typical caecal tonsil could not be located unlike in domestic fowl. Lymphatic tissue decreased towards the apex. Lamina propria was separated from the submucosa by a thin muscularis mucosa. Tunica muscularis showed a very thick inner circular and a thin outer longitudinal smooth muscle layers. At the basal region, tunica muscularis was extremely thick forming the caecal sphincter. Tunica muscularis showed bundles of nerve fibres. Thickness of muscular coat decreased towards the apex. Externally there was a serosa.

Discussion

Histomorphological age related changes were studied in duck caecum from day- old to adult. Changes in caecal length, diameter, presence of villi and lymphatic tissue were studied.

The paired caeca extended cranially from the ileo-colic junction and lay parallel to the ileum and was connected to it by means of short ileo-caecal ligaments as reported by McLelland (1975) in domestic fowl. Length showed marked increase with the advancement of age. Nickel *et al.* (1977) reported that the length of caeca in domestic duck ranged from 10 to 20 cm. In the present study, the length of caecum in the case of adult was found to be in the same range. Diameter in day-old birds was uniform but in fully developed caecum, apex attained maximum diameter.

The mucosa of the caecum carried tooth-shaped villi, which were more prominent and longer in the basal part. According to Hodges (1974) villi in duck caeca were tooth shaped and shorter than in the small intestine. In the non-distended caecum height of villi reduced towards the middle portion and again increased in the apex.

In the day-old birds, histological picture was the same as in the adult except in that there was no lymphatic tissue in the lamina propria. This may be due the minimum exposure to antigen at this age. Longitudinal mucosal folds were noticed in the middle and apical region as the age advanced. Hodges (1974) reported the presence of longitudinal mucosal folds in the caecum of fowl. Lamina epithelialis was formed of simple columnar epithelium with goblet cells, the number of which decreased towards the apex. Lamina propria showed tubular intestinal crypts of Lieberkuhn and diffused lymphatic tissue.

Lamina propria was separated from the submucosa by a thin muscularis mucosa. According to Hodges (1974), in case of domestic fowl, muscularis mucosae were very poorly developed and consisted of only a few bundles of circular muscle fibres. In the case of domestic fowl such bundles of circular muscle fibres were found to be absent in many places in the apical region of caecum as proved by Looper and Looper (1929). Tunica muscularis showed a very thick inner circular and a thin outer longitudinal smooth muscle layers. At the basal region, tunica muscularis was extremely thick forming the caecal sphincter as reported by Mc Lelland (1975) in domestic fowl. Tunica muscularis showed bundles of nerve fibres. Mahdi and McLelland (1998) observed that the majority of nerve bundles were found in the circular muscle layer and consisted of axons with small granular vesicles, axons with small agranular vesicles and axons with many large granular vesicles.

In the case of fowl, Looper and Looper (1929) proved that in the distal 2/3rd of the caeca showed abundant lymphoid tissue. In contradiction, Das and Biswall (1967) described that lymphocytic aggregation and lymphocytic follicles with germinal centers were absent in duck. In the present study however, characteristic finding was the presence of diffused lymphatic tissue in lamina propria in growing and adult birds unlike in the case of day-old. A typical caecal tonsil could not be located unlike in domestic fowl (Hodges, 1974).

The occurrence of diffused lymphatic tissue in the lamina propria throughout the caecal wall in growing and adult birds highlights the immunological surveillance against the caecal luminal contents and thus helps in maintaining the caecal microenvironment.

Conclusion

Caecum attained its adult length by eight weeks of age. Mean length showed an increasing trend upto 18 weeks of age and gradually its length decreased. Diameter of all the three regions of the day-old caecum was uniform. In fully developed caecum, the apex showed maximum diameter. The mucosa of the caecum carried tooth-shaped villi, which were more prominent and longer in the basal part. Their height reduced towards the middle portion and again increased in the apex in the non-distended caecum. Longitudinal mucosal folds were noticed in the middle and apical region as the age advanced. In the day-old birds, histological picture was the same as in the adult except in that there was no lymphatic tissue in the lamina propria. Lymphatic tissue decreased towards the apex. A typical caecal tonsil could not be located unlike in domestic fowl. At the basal region, tunica muscularis was extremely thick forming the caecal sphincter. Tunica muscularis showed bundles of nerve fibres.

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POSTNATAL DEVELOPMENT OF LYMPH NODES IN KUTTANAD DUCK (*Anas platyrhynchos domesticus)*

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Abreviated title: Lymph node development in Kuttanad duck

Abstract

Morphological and histological parameters of lymph nodes were studied in 72 Kuttanad ducks from day-old to 22nd week of age at fortnight intervals in 12 batches. A pair of cervico-thoracic and a pair of lumbar lymph nodes were identified. Cervico-thoracic lymph nodes were situated close to the jugular vein caudal to the thyroid and parathyroid glands in the cranial region of the body cavity, i.e., at the level of confluence of jugular vein with cranial vena cava. They were elongated and spindle shaped. Lumbar lymph nodes were slightly longer than the cervico-thoracic lymph nodes and were situated immediately ventral to vertebral column on either side of lumbar aorta in medial plane near the origin of external iliac arteries. The material was fixed in neutral buffered formalin and processed using routine histological techniques. Microscopically, both the cervico-thoracic and the lumbar lymph nodes showed the same structure. The capsule was very thin and made up of collagen fibres. The thickness increased from 14 µm in day-old to 28 µm in the adult birds. The lymph node was characterized by thin lympho-reticular cords and the absence of trabeculae. Central sinus was irregular in shape and was surrounded by central zone of lymphocyte accumulations, the zone of cortex. The medullary tissue occupied the peripheral region unlike in the case of most mammalian species and was made up of loosely arranged lymphatic tissue. The lymphatic nodules could be identified in the central cortical dense zone. They were either round or ellipsoidal in shape. The diameter of lymphatic nodule was found to be increased from 140 µm in day-old to 210 µm in the adult birds. Numerous endothelium-lined intermediate sinuses were also found, which were connected to the central sinus. Presence of these lymph nodes in water birds is considered as a unique feature when compared to other avian species, substantiating the high immunological status of these birds.

Key words: Lymph node; postnatal development; Kuttanad duck

Introduction

The immune system of birds is very similar to that of mammals, although major differences do exist in the distribution and organization of lymphoid tissue (Rose, 1979). Lindner (1961) reported that whenever lymph nodes were present they occurred as two pairs viz., cervico thoracic and lumbar. Rautenfeld and Budras (1983) studied the general topography, ultrastructure and phagocytic capacity of avian lymph nodes. Literature on postnatal development of lymph nodes in duck is scanty. Hence this work was undertaken to study the age related changes in the lymph nodes of Kuttanad ducks. This will form a basis for correlating the functions of the lymph nodes, particularly to that of immunological status in different age groups.

Materials and methods

This study was conducted on apparently healthy 72 Kuttanad ducks of various age groups. Selection of birds was done randomly from a single hatch and they were reared under semi-intensive system of management. After recording the body weight of birds, the body cavity was opened and

topography of the cervico-thoracic and lumbar lymph nodes was noted. Lymph nodes were collected from day–old to adult. The lymph nodes were then dissected out and examined for gross appearance, colour and shape. After recording the biometry, the material was fixed in neural buffered formalin and standard procedures were adopted for histological. The sections were stained using Ehrlich's haematoxylin and eosin method, Van Gieson's method for collagen and Gomori's one step trichrome method (Luna, 1968). Measurements were taken using ocular micrometer.

Results

Morphology

Cervico-thoracic lymph nodes were situated close to the jugular vein caudal to the thyroid and parathyroid glands in the cranial region of the body cavity, i.e., at the level of confluence of jugular vein with cranial vena cava. They were elongated and spindle shaped (Fig.1). Lumbar lymph nodes were slightly longer (mean length of 1.2cm) than the cervico-thoracic lymph nodes (mean length of 0.8cm) in adult birds. Lumbar lymph nodes were situated immediately ventral to vertebral column on either side of lumbar aorta in medial plane near the origin of external iliac arteries (Fig.2). They were related ventro-laterally to the kidneys. In the adult birds, the lumbar lymph nodes weighed 0.095g and contributed 0.005% to the total body weight, whereas, the cervico-thoracic lymph nodes weighed about 0.04g and contributed 0.002% to the total body weight.

Fig.1

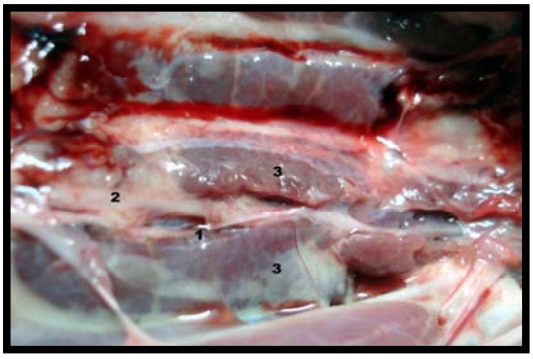

Fig.2

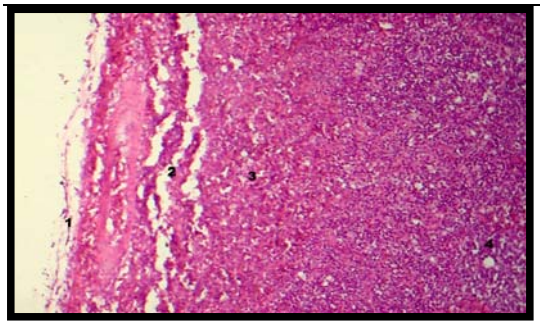

Fig.3

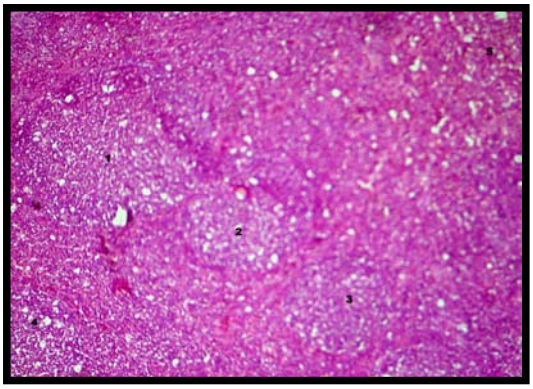

Fig.4

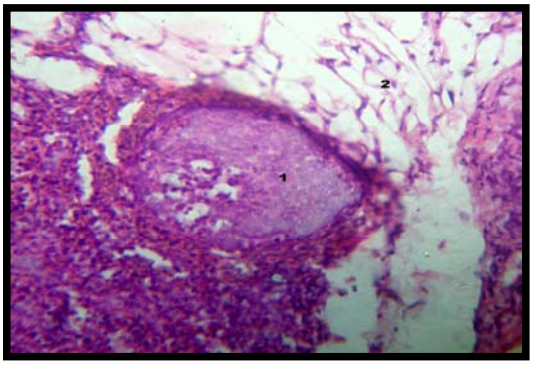

Fig.5

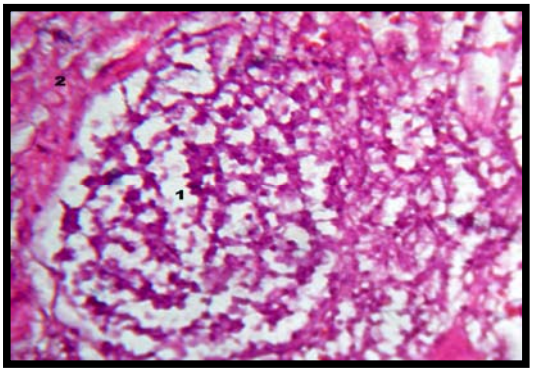

Fig.6

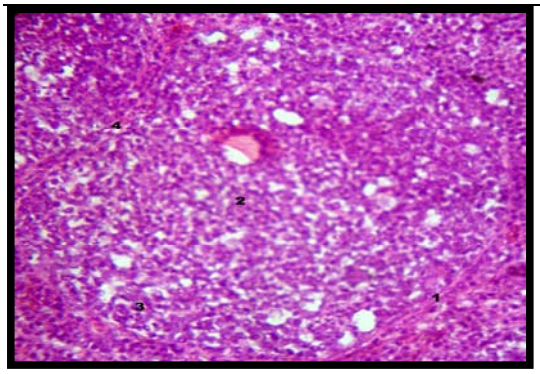

Fig.7

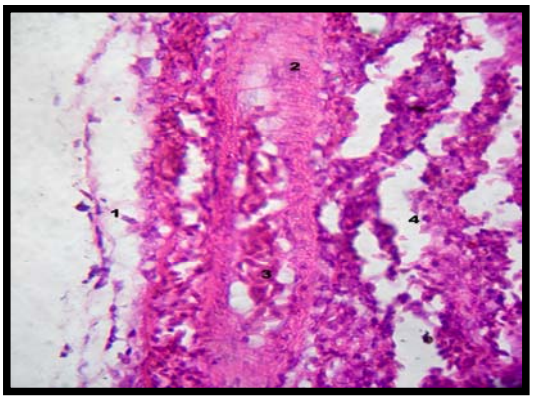

Fig.8

Fig.1 1- Cervical lymph node
Fig.2 1- Lumbar lymph node 2- Dorsal aorta 3- kidney lobes
Fig.3 1- Capsule 2-peripheral sinuses 3- Loosely arranged medulla 4- Cortex
Fig.4 1, 2, 3, 4- Lymphatic nodule 5- Medulla
Fig.5 Peripheral lymphatic nodule showing germinal centre
1- Adipose tissue around the lymph node
Fig.6 Lymphatic nodule of day-old showing loosely arranged lymphocytes
Fig.7 1-Capsule 2- germinal centre 3- Periphery of lymphatic nodule 4- Capsules of adjacent lymphatic nodules
Fig.8 1- Capsule 2-arteriole 3- RBCs inside arteriole 4- Peripheral sinuses

Histology

Microscopically, both the cervico-thoracic and the lumbar lymph nodes showed the same structure. The capsule was very thin and made up of collagen fibres (Fig.3) the thickness of which increased from 14 µm in day-old to 28 µm in the adult birds. The lymph node was characterized by thin lympho-reticular cords. There were no trabeculae extending from the capsule to the interior unlike in the mammalian lymph nodes. Central sinus was irregular in shape and was surrounded by central zone of lymphocyte accumulations, the zone of cortex. The lympho-reticular cords were the medullary tissue that occupied the peripheral region of the lymph node unlike in the case of most mammalian species. It was made up of loosely arranged lymphatic tissue arranged towards the periphery (Fig.3) and lymphatic nodules occupied the centre. In other words, the lymphatic nodules could be identified in the central cortical dense zone (Fig.4). Lymphatic nodule occurred very rarely in peripheral medullary zone (Fig.5). They were either round or ellipsoidal in shape. The diameter of lymphatic nodule was found to be increased from 140 µm in day-old to 210 µm in the adult birds. In the case of day-old birds, these nodules showed more loosely arranged cellular architecture (Fig.6). In the case of day-old birds, four to five nodules could be identified where as in the adults there were 25-30 nodules in a single longitudinal

plane of section. Each lymphatic nodule was found to be surrounded by a very thin connective tissue capsule (Fig.7). A central sinus surrounded by few lymphatic nodules was more developed in the day-old birds. Numerous endothelium-lined intermediate sinuses were also found, which were connected to the central sinus. As the age advanced, the central sinus was found to be absent and the endothelium-lined intermediate sinuses could be detected towards the periphery of the lymph node in the sub-capsular region (Fig.8).

Discussion

In Kuttanad ducks, two pairs of lymph nodes were identified, namely cervico-thoracic and lumbar lymph nodes. The cervico-thoracic lymph nodes were situated close to the jugular vein caudal to the thyroid and parathyroid glands in the cranial region of the body cavity, i.e., at the level of confluence of jugular vein with cranial vena cava. The above statement was in accordance with findings made by Hodges (1974) and King (1975).

The lumbar lymph nodes were slightly longer than the cervico-thoracic lymph nodes and were situated immediately ventral to vertebral column on either side of lumbar aorta in medial plane near the origin of external iliac arteries. According to Wakenell (2000), lumbar lymph nodes were in close association of kidney lobes medially, as was observed during the present study.

Microscopically, both the cervico-thoracic and the lumbar lymph nodes showed the same structure. The capsule was very thin and made up of collagen fibres. In the Kuttanad ducks, presence of this very thin membranous capsule with absence of trabecular network in the substance of lymph node was evident both in adult as well as in day-old. Similar findings were made by Rautenfeld and Budras (1983) in their study on the general topography, ultrastructure and phagocytic capacity of avian lymph nodes. Contrary to this, Hodges (1974) and Tizard (2002) stated the absence of any recognizable capsular element enclosing the avian lymph node.

The lymph node was characterized by thin lympho-reticular cords. Rautenfeld and Budras (1983) reported the presence of the lympho-reticular cords in the avian lymph nodes where they were able to locate avian germinal centers. The medullary tissue thus formed by thin lympho-reticular cords occupied the peripheral region unlike in the case of most mammalian species and was made up of loosely arranged lymphatic tissue.

A central sinus surrounded by few lymphatic nodules was more developed in the day-old birds. Numerous endothelium-lined intermediate sinuses were also found, which were connected to the central sinus. As the age advanced, the central sinus was found to be absent and the endothelium-lined intermediate sinuses could be detected only towards the periphery of the lymph node in the sub-capsular region.

The lymphatic nodules could be identified in the central cortical dense zone. Lymphatic nodule occurred very rarely in peripheral medullary zone. They were either round or ellipsoidal in shape. In the case of day-old birds, these nodules showed more loosely arranged cellular architecture.

Each lymphatic nodule was found to be surrounded by a very thin connective tissue capsule. Similar findings were made by Hodges (1974).

As the age advanced, the number of lymphatic nodules as well as the diameter of lymphatic nodule increased, indicating the increased immunological activity of lymph nodes in adult stage.

Hashimoto and Sugimura (1980) stated that, in case of duck, anti-body forming cells were predominantly found in the peripheral areas of the lymphatic nodules and lymphatic cords of lymph nodes. Bando and Higgins (1996) described the role of duck lymph nodes specifically, in the extra bursal development of B-cells and considered these to be the sites containing precursor cells of B-cells. Further studies are required to establish the physiological role of duck lymph nodes in immunological responses and its evolution especially in case of far migrating species of ducks and other members of order Anseriformes.

Conclusion

In duck, lumbar lymph nodes were slightly longer than the cervico-thoracic lymph nodes. The lymph node was characterized by thin lympho-reticular cords. Each lymphatic nodule was found to be surrounded by a very thin connective tissue capsule. As the age advanced, the central sinus was found to be absent and the endothelium-lined intermediate sinuses could be detected only towards the periphery of the lymph node in the sub-capsular region. With the advancement of age, the number of lymphatic nodules as well as the diameter of lymphatic nodule increased, indicating the increased immunological activity of lymph nodes in adult stage.

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PHISTOMORPHOLOGICAL STUDIES ON THE HARDERIAN GLAND OF KUTTANAD DUCKS (*Anas Platyrhynchos domesticus*)

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Running title: Harderian gland development in Kuttanad ducks

Abstract

A study on the histomorphological changes in harderian gland at different stages of growth was undertaken in the specimens collected from 72 female birds from day-old to 22 weeks at fortnightly intervals. The gland was located in the orbit .It was pale brownish in colour and hemispherical with a small dorsal lobe and a large ventral lobe. From its anterior extremity emerged a duct, which opened into the medial angle of the nictitating membrane. The average dimensions of the dorsal and ventral lobes of the gland and its mean weight increased from day old to 22 weeks of age. The histological structure of the harderian gland in day old and adult birds were similar except for variation in size of the lobules, the lining epithelium of the acini and tubules and number of lymphocytes and plasma cells in them. The gland was surrounded by a thin connective tissue capsule and septa divided it into unequal-sized lobules. The parenchyma of the Harderian gland consisted of numerous compound tubulo-acinar type of structure, lined by a simple columnar epithelium. Its secretory surface was increased by intratubular folds. The number and size of the intratubular folds in the tubules and acini increased with age. In each lobule the acini were located at the periphery. From it emerged small tertiary

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collecting tubules which drained into secondary tubules. The secondary tubules lead to a single main collecting tubule which emerged as the duct which carried the secretion of the nictitating membrane. From the capsule and septa strands of fibers penetrated between the acini and tubules. The acini were lined by bipolar columnar epithelial cell with a large apical and a smaller basal accumulation of vesicles. Numerous capillaries formed a network around the acini and tubules. Between the secondary collecting tubules towards the centre of the gland varying numbers of plasma cells could be identified. The number of plasma cells and lymphocytes increased with age. Results of the present study indicated that the gland was important in lubricating the surface of the eye with its secretions and also provided local immunity to eye and upper respiratory tract by protecting and maintaining its integrity against microbial invasion from the environment.

Key words: harderian gland; postnatal development; morphology; histology

Introduction

Harderian glands occur in the orbit of most vertebrates except fish and completely aquatic amphibians. Their usual function is to lubricate the surface of the eyeball and serve as a site of immune response. But in water fowl they are so modified as to be primarily associated with osmoregulatory functions also (Wight *et.al*,971). Hence any alterations and impairment in the structure and function of harderian gland has a profound effect on the performance of the bird. There have been some studies of mammalian harderian glands but there is little literature relating to those of birds (Payne, 1994).

The present investigation is primarily concerned with the posthatching changes in the morphology and histology of the gland in Kuttanad ducks.

Materials and methods

Harderian glands were examined in ducks at different stages of growth from the specimens collected from 72 female birds from day-old to 24 weeks at fortnightly intervals. The glands were dissected from the orbit. During its removal, the general location, shape and major blood and nerve supply were noted. The maximum length, breadth, thickness and weight of the gland were also recorded. The general histology of the gland was studied after fixing specimens in 10 percent neutral buffered formalin. Paraffin sections of 5um thickness were stained with Haematoxylin and Eosin and examined (Luna, 1968).

Results

The gland was located in the orbit, ventral and postero-medial to the eyeball. It was pale brownish in colour, hemispherical and arrow shaped with a small dorsal and a large ventral lobe(Fig-1). From its anterior extremity emerged a duct, which opened into the medial angle of the fornix of the nictitating membrane. The surface of the gland adjacent to the periorbital fascia was convex and that facing the eyeball was concave. The average dimensions of the dorsal and ventral lobes of the gland increased from 0.1cm. and 0.3cm respectively at day old to 0.82cm and 1.38cm respectively at 18 weeks of age. There after its dimensions didnot vary much up to 22 weeks of age. The mean weight of the gland in day old birds was 0.002g which increased to 0.52g in adult birds. The major blood supply was from the ophthalmotemporal branch of the external ophthalmic artery and drainage was via the ophthalmic vein. The inferior branch of the oculomotor nerve gave off small branches to the gland as it passed over it to the inferior oblique muscle.

The histological structure of the harderian gland in day old and adult birds were similar except for variation in size of the lobules, the lining epithelium of the acini and tubules and number of lymphocytes and plasma cells in them. The gland was surrounded by a thin connective tissue capsule and septa divided it into unequal-sized polygonal shaped lobules. In the capsule and septa blood vessels and nerves were present. The parenchyma of the Harderian gland consisted of numerous compound tubulo-acinar type of structure, lined by a simple columnar epithelium. Its secretory surface was increased by intratubular folds. In each lobule the acini were located at the periphery. From it emerged very small tertiary collecting tubules which drained into the secondary tubules (Fig-2).The secondary tubules lead to a single main collecting tubule which passed through the centre of the gland from its posterior to its anterior extremity and emerged as the duct which carried the secretion of the nictitating membrane. The secondary tubules were longer in the lobules located at the periphery and smaller in the central lobules. The number and size of the tubules and acini were smaller in day old birds (Fig.2 & 4) and increased with age. From the capsule and septa thin streaks of interstitial connective tissue consisting of collagenous and reticular fibres penetrated between the acini and tubules. The acini were lined by bipolar columnar epithelial cell. Within the cytoplasm of the epithelial cells secretory granules were observed with a large apical and a smaller basal accumulation of vesicles. Between these vesicles was the oval nucleus with a basophilic nucleolus. The epithelium showed considerable variation in height depending on their functional state. The secretion was merocrine. There was no evidence of mitotic activity. Numerous capillaries formed a network around the acini and tubules. Between the secondary collecting tubules towards the centre of the gland varying numbers of plasma cells could be identified. The number of plasma cells increased with age. Relatively few plasma cells and lymphocytes were recorded in the interstitial tissue and beneath the epithelium lining the tubules of the gland in newly hatched birds but these progressively increased until large numbers were present in adult birds (Fig.3). The interstitial tissue was sparse but large aggregates of lymphoid tissue were noticed in it in birds after about 16 weeks of age.

Figures

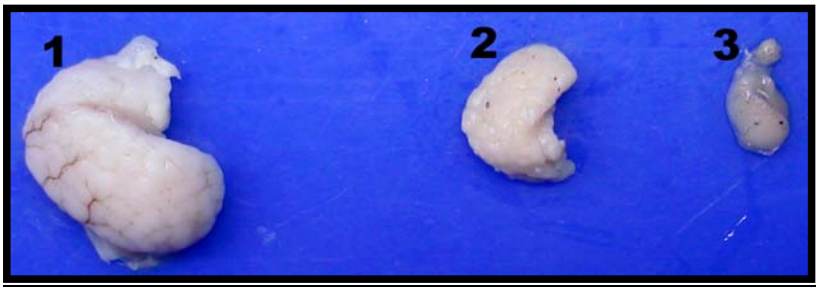

Fig.1.

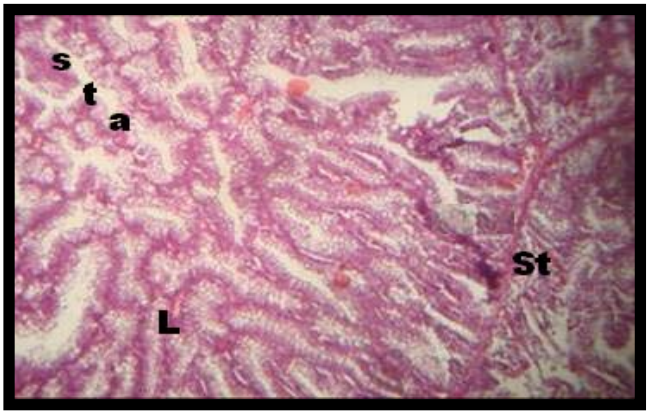

Fig.2.

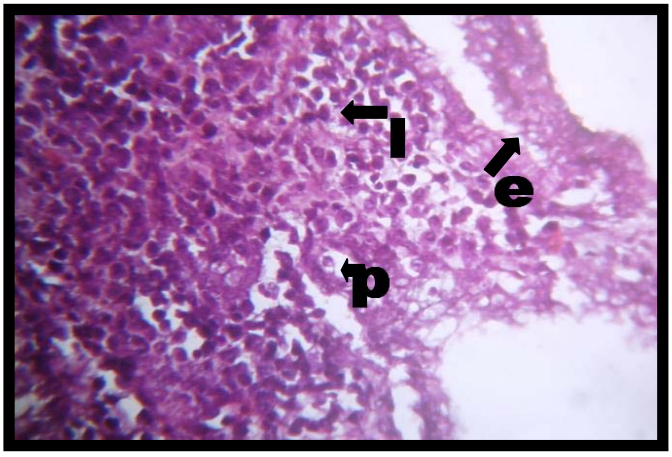

Fig.3.

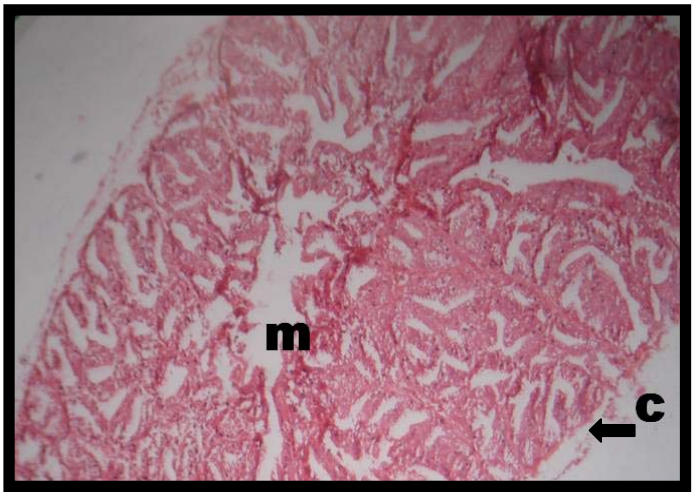

Fig.4.

Legends to figures

Fig.1. The harderian gland of Kuttanad ducks.
1. 22-weeks 2. 10 weeks 3. Day-old

Fig.2. Photomicrograph of harderian gland of 18 week old ducks. H&E X 100
L- Lobule; St- Septa; s- secondary tubule; t- tertiary tubule; a - acini

Fig.3. Photomicrograph of harderian gland of 22 week old ducks. H& E X 400
e- epithelium; p- plasma cell; l- lymphocytes

Fig.4. Photomicrograph of harderian gland of day- old ducks. H& E X 100
m- main collecting duct; c- capsule

Discussion

Macroscopically the gland closely resembled Slonaker's (1918) description of that of the sparrow with convex and concave surfaces following the respective curvatures of the wall of the orbital cavity and the eyeball. Although there was an hour-glass narrowing in the middle, the harderian gland of Kuttanad ducks was arrow- shaped with a small dorsal lobe and a large ventral lobe instead of the lingual shape observed in ducks by MacLeod (1880) . The blood supply and innervation were identical to that described by Burns(1974) in avian harderian gland.

Maxwell *et.al* (1986) described the histology of the turkey Harderian gland as a lobulated,compound tubulo-acinar Type 1 gland with a predominantly merocrine secretion. The gland was surrounded by a thin connective tissue capsule and septa divided it into unequal-sized polygonal shaped lobules. In each lobule the peripheral acini , very small tertiary collecting tubules, wider secondary tubules and a single main central collecting tubule were similar to the reports made in domestic fowl by Wight *et.al*(1971b).The secretory epithelial cells in the Harderian gland of the ducks appeared to be bipolar in nature, composed of apical and basal accumulation of vesicles. There was no indication of apocrine or holocrine secretions since debris was not recognised in tubule lumina. This mucoid secretion was characteristic of birds, in contrast to mammals where the secretion was lipoidal (Paule & Hayes,1958).

From the capsule and septa thin streaks of interstitial connective tissue consisting of collagenous and reticular fibres penetrated between the acini and tubules. Relatively few plasma cells and lymphocytes were recorded in the interstitial tissue and beneath the epithelium lining the tubules of the

gland in newly hatched birds but these progressively increased until large numbers were present in adult birds. The present study supports this description of harderian gland in turkey by Maxwell *et.al.(*1986). Large aggregates of lymphoid tissue were noticed in ducks after about 16 weeks of age. In the absence of a well developed lymphatic system in avian species, presence of such lymphatic tissues was considered to be normal for performing the function of lymph nodes of mammals .

. The interstitial tissue was sparse but large aggregates of lymphoid tissue were noticed in it. Bang & Bang (1968) have reported the occurrence of large numbers of plasma cells in the Harderian gland of the fowl and other species of birds. The importance of these cells in antibody formation suggested the role of this gland in immunological mechanisms of the fowl which was confirmed earlier in fowl by Mueller *et.al*. (1971).

Conclusion

Results of the present study indicated that the harderian gland attained its maximum development in by about 18 weeks of age. The histological studies confirmed the role of the gland in lubricating the surface of the eye with its secretions. The immunological functions of the gland were depicted by the presence of plasma cells and lymphocytes in it.

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AGE RELATED CHANGES IN THE HISTOMORPHOLOGY OF THYROID GLAND IN KUTTANAD DUCKS (*Anas platyrhynchos domesticus*)

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Abbreviated title: Thyroid gland development in Kuttanad duck

Abstract

Postnatal development of thyroid gland in Kuttanad ducks was studied using 72 female birds from day-old to adult at fortnight intervals. After recording the biometry and topography, the material was fixed in neutral buffered formalin and standard procedures were adopted for histological and histochemical studies. The thyroid glands were located on either side of the trachea close to the vascular angle formed by the subclavian artery and common carotid artery. They were reddish brown in colour and elliptical in outline. The length and breadth of the gland increased from 1.00 mm and 0.90 mm at day-old to 8.10 mm and 5.00 mm, respectively at 22 weeks of age. Absolute weight of the gland increased from 0.02 g (day-old) to 0.90 g (22 weeks) and contributed to 0.052 % and 0.045 % of the body weight, respectively. The capsule was made up of collagen fibres predominantly. Parenchyma was composed of follicles which were separated from each other by interfollicular connective tissue made up of collagen and reticular fibres and fibroblasts. Each follicle was lined by a single layer of cells, the height of which varied according to the stage of activity. These cells rested on a distinct basement membrane. In day-old birds, the follicles were spherical and lined by cuboidal epithelium. The presence of taller cells, highest relative weight and basophilic colloid in the follicle in these birds indicated greater activity of the thyroid at hatch. In young growing birds (6 to 8 weeks of age), the active follicles were lined by low columnar cells with centrally placed, large, vesicular nuclei and granular cytoplasm, inferring the role of thyroid during active growth. Follicles of different sizes and shapes were noticed as age advanced. Deeper zone of the gland showed larger follicles than the periphery. Interfollicular spaces showed lightly stained eosinophilic parafollicular cells, numerous blood vessels and nerves. In three to four months-old birds, the follicles were swollen, inactive and lined by squamous epithelium and were filled with large amount of acidophilic colloid indicating inactive follicles with the colloid that is not being utilized. In layers (20 to 22 weeks-old birds), the epithelium became columnar and the follicles were filled with basophilic vacuolated colloid indicating regular production and consumption of the hormone, substantiating the higher thyroid activity during egg production.

Key words: Histomorphology; thyroid; Kuttanad ducks

Introduction

The endocrine system of birds is comparable to that of mammals although there are many unique aspects to consider. Avian thyroid is a unique endocrine gland which plays an important role in carbohydrate, protein and lipo-regulatory mechanisms. Literature on the histomorphology of thyroid gland in duck is scanty. Hence this work was undertaken to study the age-related changes in the histomorphology of thyroid gland of Kuttanad ducks. This will form a basis for correlating the possible functions of the thyroid gland in relation to growth and production of layer chicks and diagnosis of deficiency syndrome.

Materials and methods

This study was conducted on apparently healthy 72 female Kuttanad ducks of various age groups. The birds were selected randomly from a single hatch and reared under semi-intensive system of management. After recording the body weight of the birds, thyroid glands were collected at two weeks

interval ranging from day-old to adult. Body cavity was opened and the topography of thyroid gland was noted. The gland was then dissected out and examined for gross appearance, colour and shape. After recording the biometry and weight, the material was fixed in neutral buffered formalin and standard procedures were adopted for histological and histochemical studies. The sections were stained using Ehrlich's haematoxylin and eosin method, van Gieson's method for collagen and Gomori's one step trichrome method (Luna, 1968). Measurements were taken using an ocular micrometer.

Results

Morphology

The thyroid glands were located on either side of the trachea close to the vascular angle formed by the subclavian artery and common carotid artery (Fig. 1). They were reddish brown in colour and elliptical in outline. Both the glands were situated asymmetrically with regard to each other. The right one was more cranially and ventrally placed than the left one.

The length and breadth of the gland increased from 1.00 mm and 0.90 mm at day-old to 8.10 mm and 5.00 mm, respectively at 22 weeks of age. Absolute weight of the gland increased from 0.02 g (day-old) to 0.90 g (22 weeks) and contributed to 0.052 % and 0.045 % of the body weight, respectively. The thyroid and parathyroid glands were seen as a cluster embedded in the adipose tissue. Thyroid was related to common carotid artery, oesophagus, jugular vein and vagus nerve.

Figures

Fig. 1

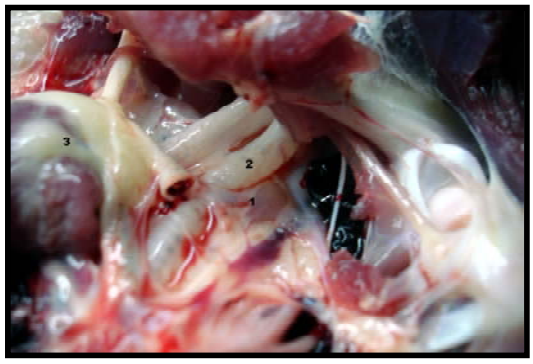


Fig. 2

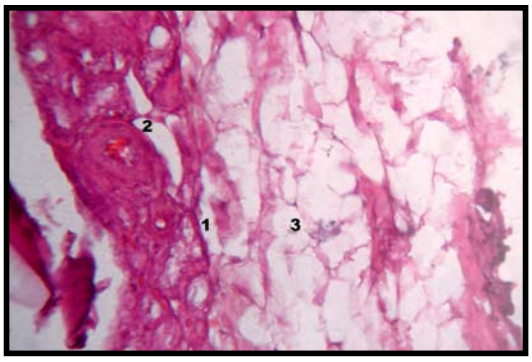


Fig. 3

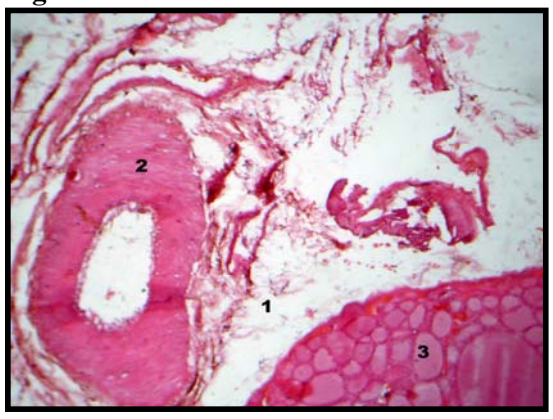


Fig. 4

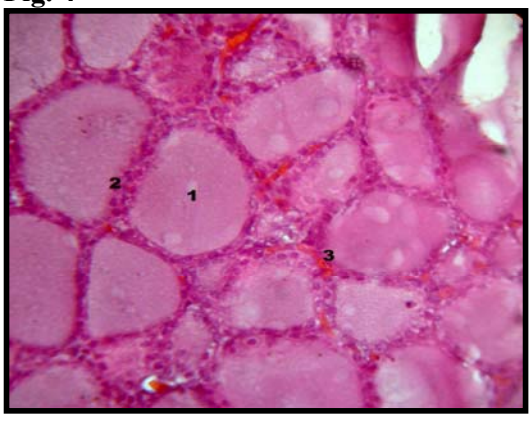


Fig. 5

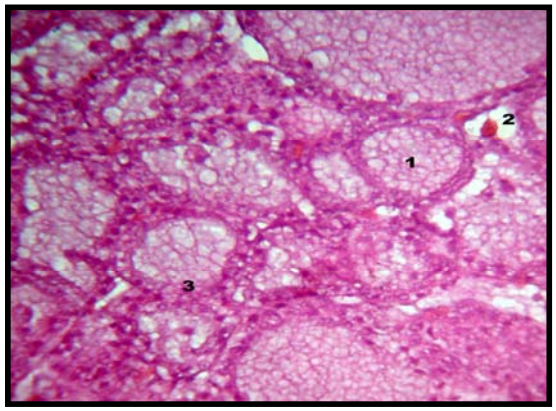


Fig. 6

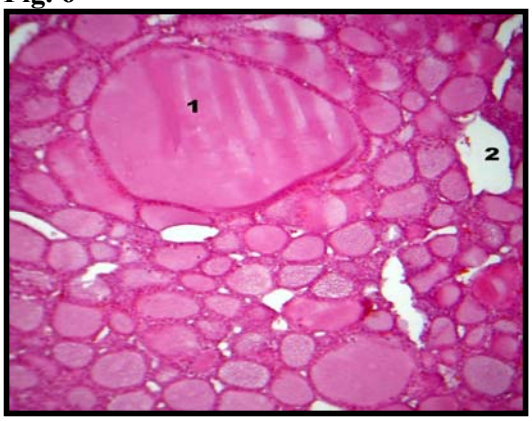


Fig. 7

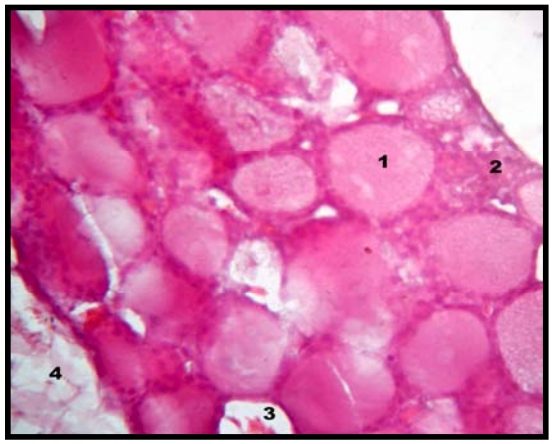


Fig. 8

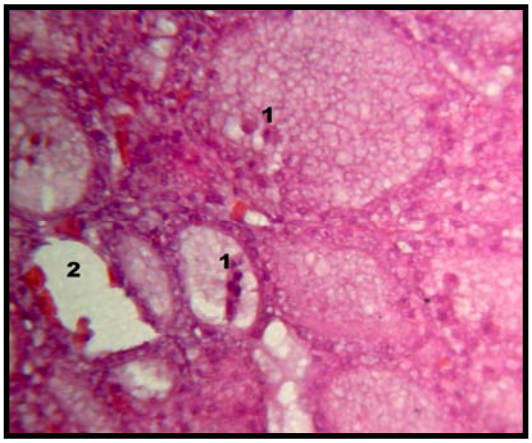
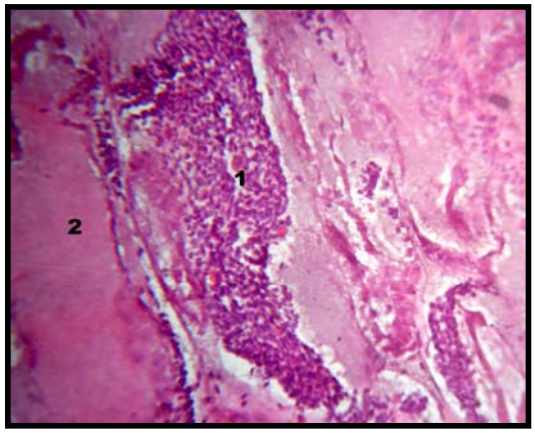


Fig. 9



Legend to Figures

Fig.1 In situ position of thyroid gland (20 wks)
1. Thyroid 2. Syrinx 3. Heart

Fig. 2 Capsule of thyroid (8 wks) H&E x 400
1. Collagen 2. Blood vessel 3. Adipose tissue

Fig. 3 Capsule of thyroid (22 wks) H&E x 100
1. Capsule 2. Artery 3. Thyroid

Fig. 4 Thyroid follicles (20 wks) H&E x 400
1. Follicle 2. Epithelium 3. Capillary

Fig. 5 Active thyroid follicles (20 wks) H&Ex400
1. Foamy colloid 2. Capillary 3. Epithelium

Fig. 6 Thyroid follicles (22 wks) H&E x 400
1. Large follicle 2. Blood vessel

Fig. 7 Thyroid gland (22 wks) H&E x 400
1. Inactive follicle 2. Parafollicular cells 3. Blood vessel 4. Capsule

Fig. 8 Thyroid follicles (20 wks) H&E x 400
1. Langendorff cells 2. Blood vessel

Fig. 9 Thyroid gland (8 wks) H&E x 400
1. Thymic tissue 2. Follicle

Histology

Thyroid gland was surrounded by a capsule which enclosed numerous thyroid follicles which were differentiated in the day-old birds itself. The capsule was made up of collagen fibres predominantly (Fig. 2). The capsule was frequently thickened in areas where small arteries and veins ran within the capsule (Fig. 3). Considerable amount of adipose tissue was seen surrounding the capsule by eight weeks of age. Thickness of the capsule increased with advancement of age.

Parenchyma was composed of follicles which were separated from each other by interfollicular connective tissue made up of collagen and reticular fibres and fibroblasts. The number of fibres increased with the advancement of age but there were no distinct trabeculae dividing the gland into lobules unlike in the case of domestic animals. Each follicle was lined by a single layer of cells, the height of which varied according to the stage of activity. In resting follicles, the epithelium was squamous (height: 2 μm) and the colloid appeared dense and uniformly stained and deeply eosinophilic (Fig. 4). When active, the cells became cuboidal to columnar (height: 6-8 μm) and the colloid was non-uniformly stained, basophilic and often contained numerous vacuoles (Fig. 5). In the same field, both active, foamy follicles and inactive follicles were seen. These cells rested on a distinct basement membrane.

In day-old birds, the follicles were spherical and lined by cuboidal epithelium. The presence of taller cells, highest relative weight and basophilic colloid in the follicle in these birds indicated greater activity of the thyroid at hatch. In young growing birds (6 to 8 weeks of age), the active follicles were lined by low columnar cells with centrally placed, large, vesicular nuclei and granular cytoplasm, inferring the role of thyroid during active growth. Follicles of different sizes and shapes were noticed as age advanced. Diameter of the follicles ranged from 14 μm to 560 μm. Small and medium sized follicles were found throughout the gland while, deeper zone showed larger follicles than the periphery (Fig. 6). Interfollicular spaces showed lightly stained eosinophilic parafollicular cells, numerous blood vessels and nerves. The blood vessels were present around the follicles in a basket like manner (Fig. 4).

Parafollicular cells or C cells occurred as single cells within the basement membrane of follicles and as groups of cells with light stained cytoplasm in the interfollicular spaces (Fig. 7). In three to four months-old birds, the follicles were swollen, inactive and lined by squamous epithelium and were filled with large amount of acidophilic colloid indicating inactive follicles with the colloid that is not being

utilized. In layers (20 to 22 weeks-old birds), the epithelium became columnar and the follicles were filled with basophilic vacuolated colloid indicating regular production and consumption of the hormone, substantiating the higher thyroid activity during egg production.

Colloid cells of Langendorff were observed in some follicles in the present study (Fig. 8). Thymic tissue was also observed in the peripheral region of some of the thyroid glands in growing birds (Fig. 9).

Discussion

The thyroid glands were located on either side of the trachea close to the vascular angle and were reddish brown in colour and elliptical in outline. Similar observations were made in domestic fowl by Hodges (1974), Nickel *et al.* (1977) and Balasundaram (2000). Wight (1986) reported the absence of the left thyroid in 25 per cent female and 15 per cent male Japanese quails. The right thyroid was more cranially and ventrally placed than the left one as reported by Teresa and Tomasz (2004) in the budgerigar (*Meopsittacus undulatus*). The thyroid and parathyroid glands were seen as a cluster embedded in the adipose tissue.

The length and breadth of the gland increased from 1.00 mm and 0.90 mm at day-old to 8.10 mm and 5.00 mm, respectively at 22 weeks of age. Absolute weight of the gland increased from 0.02 g (day-old) to 0.90 g (22 weeks) and contributed to 0.052 % and 0.045 % of the body weight, respectively.

In layer chicken, thyroid gland showed an increase in weight from 0.0014 g in day-old to 0.0728 g at 16 weeks of age and contributed 0.0016 % and 0.0089 % to the body weight, respectively (Balasundaram, 2000). This shows that the relative weight of thyroid in ducks is much greater than in that of the domestic fowl. The high value in the day-old birds indicated greater activity of thyroid at hatch. Hodges (1974) reported that the weight of thyroid varied widely according to iodine content, season and strain of birds. Mori and George (1978) observed a significant increase in weight of thyroid during moult in the Canada goose (*Branta canadensis interior*).

Thyroid gland was surrounded by a capsule which enclosed numerous thyroid follicles which were differentiated in the day-old birds itself. Balasundaram (2005) reported that in the domestic fowl, the thyroid follicles were completely differentiated on 16th day of embryonic life. He also opined that the gland was functionally competent at the time of hatching.

Parenchyma was composed of follicles which were separated from each other by interfollicular connective tissue made up of collagen and reticular fibres and fibroblasts. There were no distinct trabeculae dividing the gland into lobules unlike in the case of domestic animals (Dellmann and Eurell, 1998). Each follicle was lined by a single layer of cells, the height of which varied according to the stage of activity. In resting follicles, the epithelium was squamous and the colloid appeared dense and uniformly stained and deeply eosinophilic. When active, the cells became cuboidal to columnar and the colloid was non-uniformly stained, basophilic and often contained numerous vacuoles. Hodges (1974) reported clear, vacuole- like structures between apical surface of many cells and the mass of colloid and opined that this might be associated with the process of secretion or absorption of the colloid. The presence of taller cells, highest relative weight and basophilic colloid in the follicle in these birds indicated greater activity of the thyroid at hatch. In young growing birds (6 to 8 weeks of age), the active follicles were lined by low columnar cells with centrally placed, large, vesicular nuclei and granular cytoplasm, inferring the role of thyroid during active growth. Follicles of different sizes and shapes were noticed as age advanced. Small and medium sized follicles were found throughout the gland while, deeper zone showed larger follicles than the periphery. Contrary to this, Sathyamoorthy and Vijayaraghavan (1997) in Japanese quail and Balasundaram (2000) in White leghorn chicken found larger follicles towards the periphery of the gland. Interfollicular spaces showed lightly stained eosinophilic parafollicular cells, numerous blood vessels and nerves. The blood vessels were present around the follicles in a basket like manner as reported by Sathyamoorthy and Vijayaraghavan (1997) in Japanese quail.

Parafollicular cells or C cells occurred as single cells within the basement membrane of follicles and as groups of cells with light stained cytoplasm in the interfollicular spaces. According to Dellmann and Eurell (1998), these cells were derived from the neural crest and they reached the thyroid during development via the ultimobranchial body. Parafollicular cells are reported to secrete calcitonin hormone (Banks, 1993). In three to four months-old birds, the follicles were swollen, inactive and lined by squamous epithelium and were filled with large amount of acidophilic colloid indicating inactive follicles with the colloid that is not being utilized. These findings concur with the earlier findings of Sathyamoorthy and Vijayaraghavan (1997) in Japanese quail. In layers (20 to 22 weeks-old birds), the epithelium became columnar and the follicles were filled with basophilic vacuolated colloid indicating regular production and consumption of the hormone, substantiating the higher thyroid activity during egg production.

Colloid cells of Langendorff were observed in some follicles in the present study. These are believed to be to be the aged desquamated cells of the follicles which give way for the developing cells as reported by Kelly *et al.* (1984) in human beings. Thymic tissue was also observed in the peripheral region of some of the thyroid glands in growing birds. The above observations are in accordance with the findings of Sathyamoorthy and Vijayaraghavan (1997) in Japanese quail and Balasundaram (2000) in White leghorn chicken.

Conclusion

The relative weight of thyroid in ducks was much greater than in that of the domestic fowl. The high value in the day-old birds indicated greater activity of thyroid at hatch. In young growing birds, follicles were very active, inferring the role of thyroid during active growth. In three to four months-old birds, the follicles were swollen, inactive. In layers, the epithelium became columnar and the follicles were filled with basophilic vacuolated colloid indicating regular production and consumption of the hormone, substantiating the higher thyroid activity during egg production.

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CHANGES IN BIOCHEMICAL BLOOD INDICES OF THE FOWLS DEPENDING ON THE AMOUNT OF IODINE IN THEIR FEED

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Abstract
In the areas, where the biosphere is deficient in iodine, the feed for domestic animals and fowls should be supplemented with larger than the recommended doses of the trace element iodine. That would enable to concentrate the reserves of this element in the production, thus enriching human nutrition with iodine. The goal of the trial was to investigate the changes in the amount of the thyroid hormones, proteins, and fats in the blood. It is foreseen to perform the same kind of researches with ducks. For the trial, three groups of laying hens were formed, each of them containing 40 hens from 30 to 47 weeks of age. The laying hens of Group 1 (the control group) were fed with the standard compound feed, containing the recommended daily dose of iodine i. e. 1 mg I / 1 kg feed in the form of potassium iodide. The laying hens of Group 2 and Group 3 (the test groups) were fed with the feed of the same composition; however, the usual potassium iodide was replaced by a dry stable iodine supplement "Jodis", which is better assimilated. The amount of iodine in the feed given for the laying hens of Group 2 was 1 mg I/ 1 kg feed, and of Group 3 it was 4 mg I/ 1 kg feed.

During the research in the blood of the laying hens of the test groups the increased amount of thyroglobulin and free thyroxine was determined. The amount of free triiodothyronine in both test groups was defined lower compared with the control group. The changes in these parameters indicate the increased thyroid activity. It was determined that the total cholesterol amount in the test groups was lower than in the blood serum of the laying hens in the control group. The HDL and LDL cholesterol difference between the control and the test groups was not statistically reliable. The amount of triglycerides in the blood serum of the tested hens was lower compared with the fowls of the control group. The amount of albumens and globulin factions in the blood serum of the laying hens was within the limits of the physiological norm.

Key words: fowls; iodine; biochemical blood indices

Introduction

Over thousands of years iodine was washed from the soil in many mountainous as well as continental regions. It has been estimated that about 800 million people worldwide are deficient in iodine (Benoist, *et al*., 2008). The World Health Organization (WHO) recommends a daily 150 μg dose of iodine for adults, 200 μg of iodine daily for pregnant and nursing women, and for children a daily iodine dose should be from 50 to 120 μg. In case less than 50 μg of iodine per day is obtained with food, the thyroid gland can not ensure adequate production of hormones, and this leads to an increase of the thyroid gland (goiter) and hypothyrosis. The consequences of the endemic iodine deficiency are in particular dangerous to the developing fetus and children who need thyroid hormones for the normal neurological development and growth (Leonard and Visser, 1986).

The thyrocites of the thyroid gland actively transport iodides from the blood and concentrate the iodides for the hormone synthesis. Due to this concentration and organification of the intracellular iodine, the amount of iodine in the thyroid gland is very big i. e. 8-10 mg. That makes a reserve of iodine if for

some time there is a shortage of iodine in food. In case of significant iodine deficiency, irreversible consequences i.e. cretinism resulting from the lack of thyroid hormones develop in neonates and infants. Iodine excess suppresses three steps of thyroid hormones production: catching of iodine from the blood circulation, iodination of thyroglobulin, and the secretion of thyroid hormones from the thyroid gland. The impact of this suppression is temporary, and a healthy thyroid gland "escapes, gets off" from the effect of this iodine excess in 10 - 14 days time. These autoregulatory effects of iodides protect the physiological function of the thyroid gland from transient fluctuations in iodine receipt (Gardner *et al*., 2006).

The thyroid hormones thyroxine and triiodothyronine regulate the growth processes and activate metabolism, stimulate the activity of the body's functional systems. Under the impact of thyroid hormones, protein synthesis in the body intensifies. The carbohydrate intake in the alimentary canal depends on these hormones, and thyroid hormones have influence on fats metabolism. In case the amount of these hormones in the body reduces, metabolism gets slower, the quantity of fats increases, and a reserve of fats accumulates (Leonard and Visser, 1986; Nobikuni *et al*., 1989; Kaneko et al., 1997, Nixon *et al*., 1988).

In order to eliminate the problem of iodine deficiency in food and to maintain the health of the population, it is necessary to look for ways how to supplement the diet of domestic fowls with the stable iodine preparations and to ensure good growth of fowls as well as to promote the opportunities for consuming the iodine-enriched eggs and poultry meat (Kepalienė *et al*., 2006). One of the main conditions, which the growth of meat resources depends on, is certainly highly nutritious feed for animals and fowls. Absence or shortage of vital biologically active substances in their feed negatively affects the state of the fowls' health, their productivity, and feed conversion. In the areas where insufficient consumption of iodine is widespread, domestic animals and fowls should get more iodine than required, thus concentrating the residues of this element in milk, eggs, and meat (Lichovnikova *et al*., 2003; Flachowsky, 2007).

Taking into consideration the importance of trace elements, meat and eggs of fowls can be enriched by adding those trace elements to the main feed components. One of such supplements is iodine (Gudavičiūtė *et al*., 2002). In case of iodine deficiency, hens lay fewer eggs, the foetal weight reduces, fewer chickens are hatched and they are weak, with an increased thyroid gland (Stanley and Bailey, 1989).

The goal of our trial was to investigate the changes in the amount of biochemical blood and blood serum indices of fowls by using a stable concentrated preparation "Jodis" instead of the usual potassium iodide in the feed.

As the shortage of this trace element in the feed is important for all the domestic fowls, therefore, the next object of our investigations will be domestic waterfowls i. e. Pekin cross ducks. The goal of the planned trials will be to investigate the changes in the amount of thyroid hormones in the blood serum of ducks as well as the accumulation of iodine quantity in the meat and liver depending on the amount of iodine in the feed by using a dry stabile concentrated iodine preparation "Jodis".

Materials and methods

The investigations were carried out with Hisex brown line combination hens. During the trial with the laying hens at the age of 47 weeks, 3 groups were formed, each of them containing 40 laying hens. The laying hens of Group 1 (the control group) were fed with the standard compound feed (C), containing potassium iodide (KI) as the source of iodine, and the laying hens of Group 2 and Group 3 (the test groups) were fed with the feed of the same composition as the laying hens of the control group; however, the usual potassium iodide was replaced by a dry stable iodine supplement "Jodis", which is better assimilated. In the feed of the laying hens of Group 2 a stable iodine dose was 1 mg I / 1 kg feed, and the feed of the laying hens of Group 3 was supplemented with 4 mg I/ 1 kg feed (the source of iodine was a dry stable iodine supplement "Jodis").

The laying hens were kept in cages, they were fed and had access to water from automatic equipment.

The investigations of thyroid hormones were carried out by applying the immunoenzyme method (ELISA with "Human GmbH" kits for hormones). The hens' total blood protein and protein factions, the amount of triglycerides and cholesterol were determined by an automatic biochemical analyzer. The total amount of nucleic acids of the hens' blood was established spectrophotometrically. Blood tests were performed with the laying hens at the age of 51 weeks.

Husbandry conditions for fowls were complying with good commercial practices and with the Law of the republic of Lithuania on the Care, Keeping and Use of Animals as well as secondary legislation – Order of the State Food and Veterinary service of the republic of Lithuania "On Veterinary Regulations on Breeding, Handling and Transportation of Laboratory Animals" and "On the Use of Laboratory Animals in Scientific Experiments" (Law of the Care, Welfare and Use of Animals; 2002).

The data was processed by applying statistical biometry methods and using Statistica for Windows, Version 6.0 (StatSoft Inc.).

Results

There are about 50 mg of iodine in the human body. 75% of iodine is in thyroid hormones. Iodine concentration in the thyroid gland is 30 times higher than in the blood. A person has to get about 150 μg of iodine with food daily. The human body accumulates a reserve of iodine; therefore, when iodine is not available from the environment, its reserves may be sufficient for approximately 2 months (Gardner and Shoback, 2006).

Thyrotropin (TSH), a hormone of the front part of the pituitary, regulates the production of thyroid hormones (Picture 1). It is one of the most important indicators of the thyroid gland function. It stimulates the secretion of free thyroxine (FT4) and free triiodothyronine (FT3) in the body and also stimulates the thyroid gland growth. TSH concentration in the blood is mostly inversely proportional to the concentartion of FT4 and FT3.

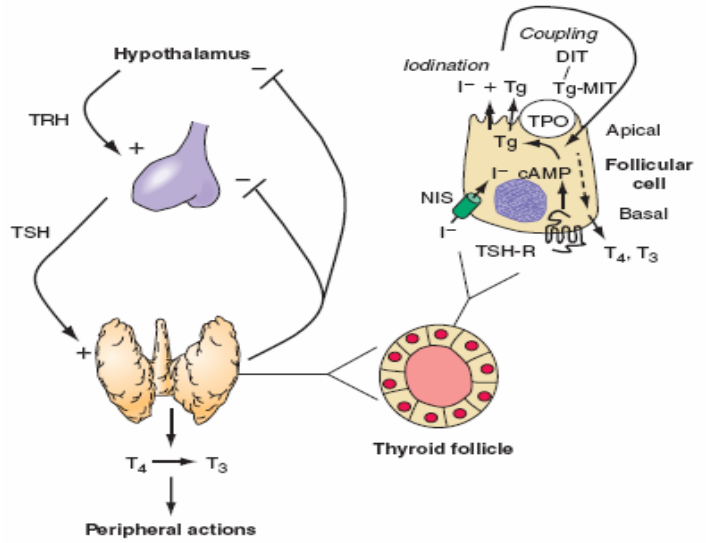

Figure 1 The structure of thyroid hormones (Fauci *et al.*, 2008).

The data of our investigations demonstrate that the amount of TSH in the blood of the laying hens of Group 2 (a test group) was 0.01 mU/mL, or by 14.29% smaller (Table 1), compared with the control group ($P<0.01$), and the amount of TSH in the blood of the laying hens of Group 3 (a test group) decreased by 0.02 mU/mL, or by 28.58%, compared with the control group ($P<0.001$).

Table 1 The amount of thyroid hormones in blood serum of laying hens.

Group No.	Feeding characteristics	TSH mU/mL	Tg ng/mL	FT3 pg/mL	FT4 ng/dL
1	C + KI (1 mg I/ 1 kg feed)	0.07±0.006	0.35±0.034	0.74±0.017	4.35±0.378
2	C + "Jodis" (1 mg I/ 1 kg feed)	0.06±0.027*	0.37±0.012	0.66±0.065	5.49±0.376**
3	C + "Jodis" (4 mg I/ 1 kg feed)	0.05±0.011**	0.39±0.019*	0.62±0.012*	4.74±0.165

The difference between the control and the test groups is statistically significant with (*P<0.01), (**P<0.001).

The thyroid gland synthesizes and secretes a mixture of the hormones thyroxine T4 and triiodothyronine T3, which are important for the normal development of the body and metabolism. Most of them are bound to proteins in the blood, and only an insignificant part of them (0.02-0.04%) is free. Thyroidins, bound to proteins, form a circulating reserve of hormones. Only a free hormone is physiologically active, and its amount in blood plasma is very small (Fauci *et al*., 2008). T4 makes a functional reserve of T3 in the blood. In tissues, T4 is converted into T3, which is 3-4 times more active. As mono- and diiodthyronins bind in the thyroglobulin (Tg), which is located in the thyroid follicles, triiodothyronine and thyroxine are synthesized (Picture 1). Thyroglobulin is an inactive form of thyroid hormones (triiodothyronine T3 and thyroxine T4), a depot of these hormones (Beiša, 2006). During the investigation we determined the amount of thyroglobulin in the blood of laying hens: in the blood of the hens of Group 2 it was 0.02 ng/mL or by 5.71% bigger, compared with the control group. In the blood of the hens of Group 3, thyroglobulin increased by 0.04 ng/mL, or by 11.42%, compared with the control group (P<0.001). Moreover, a bigger amount of free thyroxine (FT4) was established in the blood of hens of the test groups. The amount of this hormone in the blood of the hens of Group 2 increased by 1.14 ng/dL, or by 26.20% (P<0.001), and in the blood of the hens of Group 3 it increased by 0.39 ng/dL, or by 8.96%, compared with the control group.

It was established that the amount of free triiodothyronine (FT3) in both test groups was smaller in comparison with the control group. In the blood of the hens of Group 2, the amount of FT3 was smaller by 0.08 pg/mL, or by 10.82%, compared with the control group, and this index of Group 3 was by 0.12 pg/mL, or by 16.22% (P<0.01) smaller than the one of the control group. Following the data from literature, a major part of this hormone develops not in the thyroid gland but in the periphery (liver, kidney, cells of connective tissue) (Gardner and Shoback, 2006).

According to the results obtained from the investigations of the thyroid hormones, it is possible to state that thyroid hyperfunction in the test groups is observed.

Total cholesterol amount and the amount of triglycerides in the blood serum of laying hens was also investigated (Table 2). It was determined that total cholesterol amount in the blood serum of hens of the test groups was smaller than the one of the control group. In the blood serum of the hens of Group 2,

the amount of total cholesterol was smaller by 1.12 mmol/L, or by 31.12%, and in Group 3 it was also smaller by 1.76 mmol/L, or by 48.89%, compared with the control group (P<0.001). The HDL and LDL cholesterol difference between the control and the test groups was not statistically reliable.

Table 2 The amount of cholesterol and triglycerides in blood serum of the laying hens.

Group No.	Feeding Characteristics	Cholesterol, mmol/L	Triglycerides, mmol/L
1	**C + KI (1 mg I/ 1 kg feed)**	3.60±0.925	20.79±7.235
2	**C + "Jodis" (1 mg I/ 1 kg feed)**	2.480.024**	11.63±1.419**
3	**C + "Jodis" (4 mg I/ 1 kg feed)**	1.84±0.127**	6.60±1.106**

Note: The difference between the control and the test groups is statistically significant with (*P<0.01), (**P<0.001).

The amount of triglycerides in the blood serum of hens of the test groups was smaller in comparison with the fowls of the control group. This decrease in Group 2 was 9.16 mmol/L, and in Group 3 it was 14.19 mmol/L, compared with the control (P<0.001).

During our investigations we determined the amount of albumens and globulin factions in the blood serum of hens (Table 3). These indicators in all test groups were within the limits of the physiological norm.

Table 3 Protein factions in the blood serum of hens.

Group No.	Feeding characteristics	Albumens, %	Globulin factions, %				
			α 1	α 2	β 1	β 2	γ
1	**C + KI (1 mg I/ 1 kg feed)**	30.7	2.1	18.7	13.3	33.3	1.9
2	**C + "Jodis" (1 mg I/ 1 kg feed)**	32.6	2.1	17.3	8.7	36.9	2.4
3	**C + "Jodis" (4 mg I/ 1 kg feed)**	38.0	1.5	16.8	8.1	33.3	2.3

We determined the amount of total proteins in the blood serum and the total amount of nucleic acids in the blood of hens (Table 4). In Group 2, the amount of total proteins was 12.43 g/L or bigger by 25.42%, and in Group 3 it was 17.43 g/L or by 35.64% bigger than in the control group (P<0.001). The total amount of nucleic acids in the blood of hens of the test groups was bigger in comparison with the control group: in Group 2 it was 75.90 mg/L or by 10.29% bigger, and in Group 3 it was 96.99 mg/L or by 13.15% bigger, compared with the control group (P<0.01).

Table 4 The amount of total proteins in the blood serum and the total amount of nucleic acids in blood.

Group No.	Feeding Characteristics	The amount of total proteins, g/L	The total amount of nucleic acids, mg/L
1	**C + KI (1 mg I/ 1 kg feed)**	48.90±2.129	737.26±49.685
2	**C + "Jodis" (1 mg I/ 1 kg feed)**	61.33±6.399**	813.16±81.316*
3	**C + "Jodis" (4 mg I/ 1 kg feed)**	66.33±12.007**	834.25±126.323*

Note: The difference between the control and the test groups is statistically significant with (*P<0.01), (**P<0.001).

Discussion

During the performed investigations we established a decreased amount of the thyrotropin hormone (TSH) in the blood of hens of the test groups. TSH concentration changes depending on age: when getting older, TSH concentration gradually increases (Klimienė *et al*., 2008; Špakauskas *et al*., 2007). Moreover, alongside with the increase of the amount of cholesterol in blood, TSH concentration increases as well (Kepalienė *et al*., 2006). According to data of other researchers, in case of the decreased amount of TSH in the blood, thyroid hyperfunction may be suspected (Weetman, 1997; Fauci *et al*., 2008).

An increased concentration of thyroid hormones in blood itself inhibits the production of TSH in hypophysis (a negative feedback) i. e. the secretion of thyroliberin in the hypothalamus discontinues (Gardner and Shoback, 2006).

Thyroid hormones activate the metabolism (Lu *et al*., 2007), and our obtained data confirm this. FT4 influences the secretion of TSH, and in case TSH secretion is not normal, the excess or deficiency of thyroid hormones is observed. The amount of FT4 in blood is as usual inversely proportional to the amount of TSH i. e. as one of these parameters increases, the other one has to decrease, and vice versa. An increase of free thyroxine and a decrease of TSH is an indicator of the increased function of the thyroid gland. A decrease of FT4 and an increase of TSH indicate an insufficient function of the thyroid gland. According to the data from literature, thyroglobulin ensures permanent hormones access of T4 and T3 into the blood. Under the impact of protease, T4 and T3 separate from thyroglobulin (Klimiene *et al*., 2008). On the basis of the obtained results of the investigations of thyroid hormones, it is possible to state that thyroid hyperfunction in test groups is observed. During this, the main metabolism accelerates; however, oxidation and phosphorylation processes are disbalanced, less energy is accumulated in macroenergetic compounds, and more heat is emitted. Protein metabolism and gluconeogenesis in the liver become more active (Špakauskas *et al*., 2008; Leonard and Visser, 1986; Nikolic *et al*., 2001). Our data coincided with with the data of other researchers that thyroid hormones activate protein synthesis (Kepalienė *et al*., 2006). It is supposed that the amount of thyroid hormones in plasma is more closely related to the feed and the amount of selenium and iodine in the feed (Špakauskas *et al*., 2008; Wichtel *et al*., 1996). On the basis of the data of other researchers, thyroid hormones intensify lipolysis; therefore, the concentration of triglycerides and cholesterol decreases (Nobikuni *et al*., 1989), and this is confirmed

by our obtained data as well. Thyroxine activates the enzyme regulating the intensity of cholesterol synthesis (Beiša, 2006).

Conclusions

The amount of the hormone (TSH) in the blood serum of hens of the test groups decreased by 14.29 % (P<0.01) and 28.58 % (P<0.001), FT3 decreased by 10.82% and 16.22 % (P<0.01), and FT4 increased by 26.20 % (P<0.001) and 8.96 % (P<0.01). The results of the investigation of thyroid hormones show that the thyroid hyperfunction in the test groups is observed.

Due to the intensified lipolysis, the amount of total cholesterol and triglycerides in the blood serum of the hens was smaller (P <0.001) in both test groups, in which potassium iodide in feed was replaced by a stable iodine supplement "Jodis".

The amount of total proteins in the blood serum of hens was bigger in the test groups i.e. in Group 2 it was bigger by 25.42% and in Group 3 it was bigger by 35.64% than in the control group (P <0.001). The total amount of nucleic acids in the blood of hens in Group 2 was bigger by 10.29%, and in Group 3 it was bigger by 13.15%, compared with the control group (P <0.01). That indicates more intense protein metabolism in the test groups.

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HISTOLOGY OF THE GALL BLADDER IN KUTTANAD DUCK (*ANAS PLATYRYNCHOS DOMESTICUS*)

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Running Title: Islets of Langerhans in Kuttanad ducks

Abstract

The study was aimed at observing the normal histological characteristics of gall bladder of Kuttanad ducks (*Anas domesticus*) using 72 ducks of various ages from day-old to 22 weeks. Gall bladder was a small sac lying on the visceral surface of liver. Its weight increased from 0.03 by day-old to 1.26g by 22 weeks. Thickness of wall increased from 13 µm to 169 µm by this age. Layers of gall bladder from inner to outer were: mucosa, muscularis, perimuscular connective tissue layer and serosa. There was no muscularis mucosa or submucosa. Mucosa consisted of simple, tall, columnar, homogeneous epithelium and lamina propria. Cytoplasm of epithelial cells was weakly acidophilic and at the free edge, appeared to be thickened probably due to the presence of microvilli. Nuclei were large, basal and oval. Lamina propria consisted of a layer of connective tissue with elastic and muscle fibres which was strongly folded into villus-like projections when the gall bladder was contracted and was much thinner with only small folds when the bladder was distended. Beneath lamina propria, the muscularis consisted of interlacing fascicles of smooth muscle fibers and abundant intervening connective tissue, forming a thin irregular and decussating fibromuscular coat. These muscular layers provided numerous spaces between their fibres, which were filled up with reticular, elastic or collagenous fibres and fibroblasts. Smooth muscle was found in longitudinal, transverse and oblique directions. Outer, circular or oblique layer was more constant and gave off strands passing into base of the villi. Longitudinal layer occurred only irregularly, as large bundles of fibres lying at the base of the villi. The perimuscular layer of dense connective tissue contained blood and lymphatic vessels (for abundant water reabsorption from bile) and nerves, and it formed an adventitia (fibrosa) on the surfaces in contact with liver. Other surfaces were covered with a serosa, which was moderately thick and vascular in some areas but thin and avascular in others. It was composed of coarse collagen fibres interspersed with small number of elastic fibres. Gall bladder provides a storage site for bile synthesized in liver and also concentrates it owing to ion-transporting activities of the epithelium lining the lumen. Lipids reaching the duodenum signal the release of polypeptide hormone, cholecystokinin from endocrine cells of mucosa into blood. Cholecystokinin has receptors in wall of gall bladder, which result in contraction of smooth muscle and release of bile via bile duct on to duodenum.

Keywords: Gall bladder, histology, Kuttanad duck

Introduction

The gall bladder provides a storage site for bile synthesized in the liver and also concentrates it owing to ion-transporting activities of the epithelium lining the lumen. Cyclostomes, birds like budgie and some members of the parrot family, and some mammals, including elephants, horses and cervids, have no gall bladder. This study was aimed at observing the normal histological characteristics of the gall bladder of the Kuttanad ducks (*Anas platyrynchos domesticus*).

Materials and Methods

The study was conducted using 72 ducks of various ages. Six birds each were collected at fortnightly intervals from day-old to 22 weeks of age. The birds were anaethetised by chloroform and euthanized by bleeding the jugular vein. The abdominal cavity was opened and the sternum was also split open in the midline. The gall bladder was collected, fixed in 10 percent neutral buffered formalin for 48 hours, processed by routine histological techniques and embedded in high-melting paraffin. Five to six micron sections were taken and stained by routine histological procedures.

Results

The gall bladder was a small sac lying on the visceral surface of the liver. Its weight increased from 0.03 by day-old to 1.26g by 22 weeks with a corresponding increase in the thickness of its wall from 13 to 169 μm. The gall bladder consisted of different layers from inner to outer as the mucosa, muscularis, perimuscular connective tissue layer and serosa. When contracted, its mucosal surface was thrown into numerous typical ridges and folds (Fig. 1). But, when the gall bladder was filled with bile, these folds disappeared. The mucosa consisted of a simple, tall, columnar, homogeneous epithelium lining the lumen and lamina propria. The epithelium also covered the mucosal crypts, which were small epithelial diverticuli that sometimes gave the impression of being glands. There was no muscularis mucosa or submucosa. The cytoplasm of the epithelial cells had weak acidophilic characteristics. The nuclei were large, basal and oval. The cytoplasm in the region of the free edge appeared to be thickened due to the presence of microvilli (Fig. 2). The luminal surface was covered by a basophilic substance (Fig. 3).

The lamina propria of the mucosa consisted of a layer of connective tissue containing elastic fibres and muscle fibres which entered into villus-like projections (Fig. 2). There was absence of glands in this layer, except a few glands at the region of the neck (Fig. 4). Even though the gall bladder presented villus-like projections of mucosa when contracted (Fig. 2), the wall was much thinner with only small folds when the bladder was distended (Fig. 5). Beneath the lamina propria, the muscular layer was consisting of interlacing fascicles of smooth muscle fibers and abundant intervening connective tissue, forming an irregular and decussating fibromuscular coat (Fig. 6). These muscular layers provided numerous spaces between their fibres which were filled up with the reticular, elastic or collagenous fibres with the presence of fibroblasts also. The smooth muscle, was not easily divided into definite layers. It ran in longitudinal, circular and oblique directions. The outer, circular or oblique layer was more constant and gave off strands passing into the base of the villus like projections of the mucosa. The longitudinal layer occurred only irregularly, usually as large bundles of fibres lying at the base of the villi (Fig. 5).

The perimuscular layer of peripheral dense connective tissue (Fig. 6) contained blood and lymphatic vessels and nerves, and it formed an adventitia (fibrosa) on the surfaces in contact with the liver. The gall bladder had a serosal covering on other surfaces, which was moderately thick and vascular in some areas (Fig. 7) but thin and avascular in others. The serosa was composed of coarse collagen fibres interspersed with small number of elastic fibres.

Fig.1

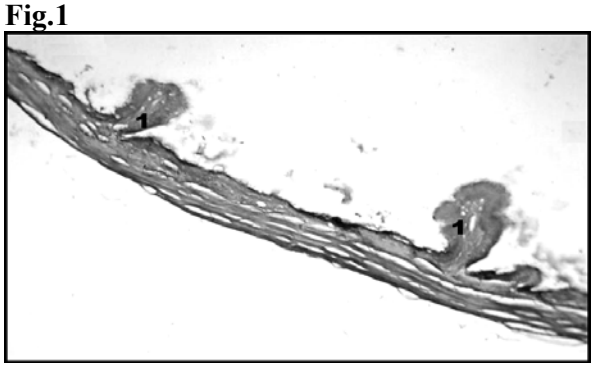


Fig.2

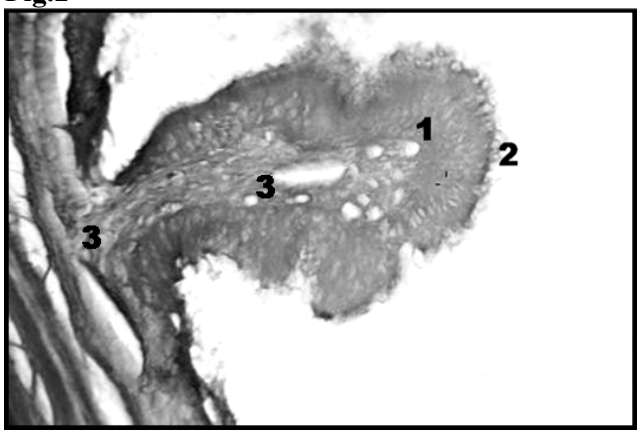


Fig. 3

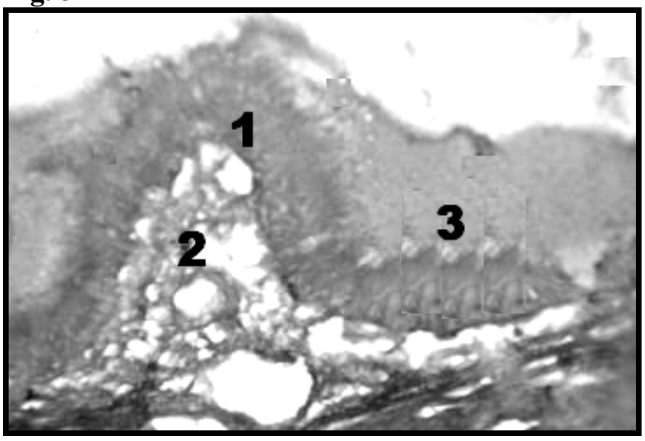


Fig.4

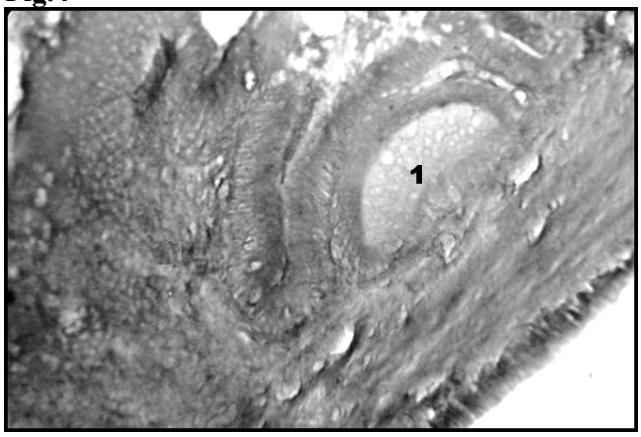


Fig. 5

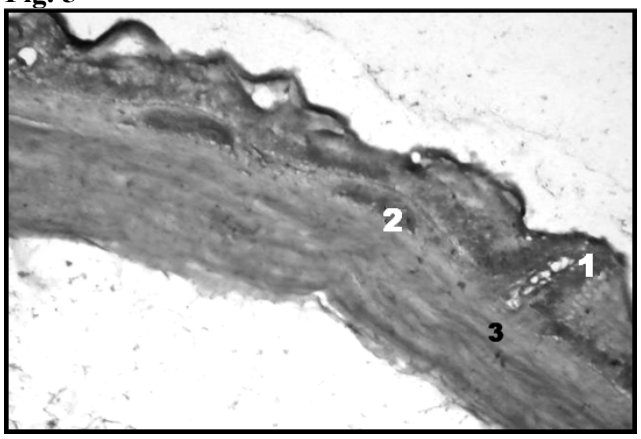


Fig. 6

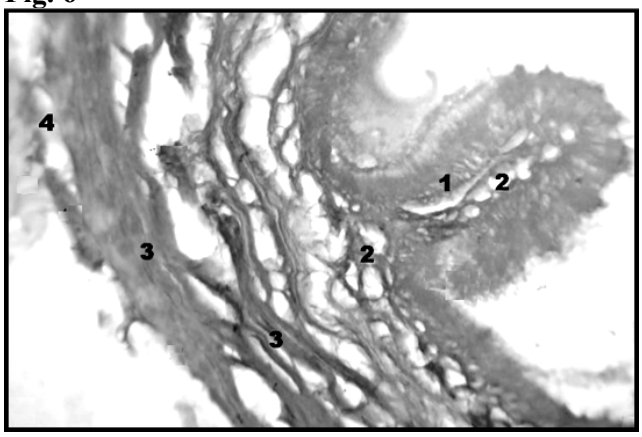
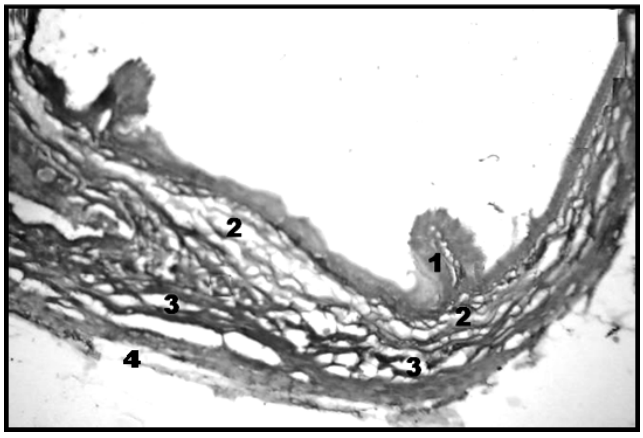


Fig. 7



LEGENDS TO FIGURES

Fig. 1 C. S. of Gall Bladder at 8 weeks of age. H & E x 100
1. Folds

Fig. 2 C. S. of Gall Bladder at 22 weeks of age. H & E x 400
1. Epithelium 2. Surface with microvilli 3. Lamina propria

Fig. 3 C. S. of gall bladder at 16 weeks of age. H & E x 400
1. Epithelium 2. Lamina propria 3. Basophilic substance covering the epithelium

Fig. 4 L. S. of neck of gall Bladder at 22 weeks of age. H & E x 100 1. Mucous glands

Fig. 5 C. S. of neck of gall Bladder at 22 weeks of age. H & E x 100
1. Villus 2. Longitudinal muscle layer 3. Circular muscle layer

Fig. 6 C. S. of gall Bladder at 20 weeks of age. H & E x 400
1. Mucosa 2. Lamina propria 3. Muscular layer 4. Perimuscular connective tissue

Fig. 7 C. S. of gall Bladder at 20 weeks of age. H & E x 100
1. Villus 2. Lamina propria 3. Muscular layer 4. Serosa

Discussion

The histological observations on the gall bladder in Kuttanad duck revealed a mucosa, muscularis and adventitia or serosa. The homogeneous simple columnar epithelium lining the lumen presented microvilli and was covered by a basophilic substance. Hayward (1965) opined that the established function of the large scale resorption of water and salts from the intracystic bile resulting in an increase in pigment concentration is probably accompanied by an adaptation of the fine structure of the epithelial cell surfaces and intercellular spaces. Yamada and Hoshino (1972) also reported the presence of sulfated, carboxylated and neutral mucopolysaccharide- protein complexes in the gall bladder epihtelium of domestic fowl. Stinson and Calhoun (1993) opined that the tight junctions present between the adjacent cells of gall bladder prevented the intercellular passage of fluids from the lumen of the organ.

Hodges (1974) described the corium of the villi as infiltrated with lymphoid tissue in the adult bird. But such a gall bladder associated lymphoid tissue (GbALT) as also observed in domestic animals like ruminants (Chandrasekhar and Lalitha, 1993) was not seen in the gall bladder of Kuttanad ducks. This change may be attributed to a variation during the development or due to environmental or management variations resulting in a change in the immune status of the bird.

The muscular layer presented outer, more constant circular or oblique layer and an irregular longitudinal layer agreeing with the observations of Calhoun (1954), in chicken.

The perimuscular layer formed an adventitia (fibrosa) on the surfaces in contact with the liver and had nerves and blood and lymph vessels probably, in view of abundant water reabsorption from bile. It also had a serosal covering on other exposed surfaces in accordance with the findings of Calhoun (1954) and Hodges (1974), in chicken.

Conclusion

A bird's digestive system is extremely efficient because it has to keep up with the metabolic reactions of the bird. Among these, the function of the gall bladder is to make the process of digestion run more smoothly in the presence of fat. Bile is a liquid that the body uses to digest fat and neutralize acid. When large amount of fat is eaten, it signals the duodenum to release the polypeptide hormone, cholecystokinin (Greek term for "move," "sac," and "bile"), from endocrine cells of the mucosa into the blood. The cholecystokinin has receptors in the wall of the gall bladder, which result in the contraction of the smooth muscle and the release of the bile via the bile duct on to the duodenum. Thus, the intestines signal the gall bladder to secrete extra bile to help the digestion. If the gall bladder has been removed, the body does not have an extra store of concentrated bile to inject all-at-once to digest a large quantity of fat. But fat in reasonable amounts is perfectly digestible even after the surgical removal, especially if it is eaten in combination with other foods.

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EFFECT OF CALCIUM AND PHOSPHORUS IN CERTAIN EGG QUALITY OF INDIGENOUS LAYER DUCKS IN CAGE SYSTEM OF REARING

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Abstract

A 3x3 factorial experiment was carried out in the department of Poultry Science, KAU to study the egg qualities of indigenous layer ducks of Kerala in cage system of rearing. Ninety female ducks at 20 weeks of age housed in 45 California type cages at the rate of two ducks per cage. Nine experimental diets containing three levels of Ca viz., 3.0, 3.5 and 4.0 per cent with three levels of P viz., 0.4, 0.5 and 0.6 per cent were formulated and fed to nine treatments. The mean egg weight (EW) and the per cent shell were highly significant ($P<0.01$) and the egg weight of 60.1±0.575 g averaged with 3.0 per cent Ca and 0.5 per cent phosphorus level were high. The Ca and P levels in the diet did not influence the shell thickness.

Contains 3 tables

Key words: Indigenous ducks, cages, calcium, phosphorus and egg quality.

Introduction

Most of the indigenous ducks in India are reared under extensive system by herding them in harvested paddy fields, riverbanks, canals and/or ponds. This is considered to be insufficient for optimum egg production as reflected by low egg production and egg weight in herded ducks under extensive system of rearing.

In poultry production, the mineral nutrition is equally important as other nutrients since the imbalances, deficiencies and excesses produce severe consequences in biological system. The major minerals calcium and phosphorus are vital for egg production and shell formation in laying ducks and they use variety of mechanisms to control the calcium-phosphorus ratio and its metabolism. The ratio of these elements in the diet has been the subject of interest since calcium and phosphorus are compete each other for absorption in the intestines.

The availability of mineral resources for inclusion in the diets to maintain the egg weight and shell quality has been a crucial problem faced by duck farmers in this region. In order to address the above problem, the present study was undertaken to assess egg qualities in varying levels of calcium and phosphorus in the diet.

Materials and Methods

Three levels of calcium viz., 3.0, 3.5 and 4.0 per cent with three levels of available phosphorus viz., 0.4, 0.5 and 0.6 per cent were employed in the diet in a 3 x 3 factorial arrangement. The experimental rations containing 18 per cent CP and 2650 Kcal ME/kg was formulated as suggested by Srivastava and Panda (1982). The calcium and available phosphorus levels in the diets were maintained by adding varying quantities of oyster shell grit and dicalcium phosphate. The experiment consisted of four periods of 28 days each from 25 to 40 weeks of age.

The mean egg weight in each treatment was arrived at based on the individual egg weights recorded daily. From this data, mean egg weights and the total egg mass were determined in each treatment.

During the last three consecutive days of each 28-day period, three eggs from each treatment were selected at random for shell quality studies. The eggshell thickness were recorded by using "Ames pocket Thickness Measures" after removing shell membrane. The shell weight of each egg was recorded after breaking the eggs. The per cent shell was calculated based on egg weight. The data collected were subjected to statistical analysis as per Snedecor and Cochran (1980).

Results and discussion

There was significantly higher the egg weight (60.1±0.57) was recorded with 3.0 per cent calcium and 0.5 per cent phosphorus levels ($P<0.01$). The interaction effect was also significant for egg weight. The higher egg weight noted with 3.0 per cent calcium was possibly due to the consequence of low egg number in this group (Table 1). The early sexual maturity with 4.0 per cent Ca and 0.6 per cent P might have contributed for low egg weight (59.0) also be due to the correlated response between EN and egg weight. This value is considered as low when compared with the egg weight values obtained from desi ducks reared in foraging conditions. Before arriving at the optimum levels of Ca and phosphorus levels it is suggestive of looking in to the total egg mass. The total egg mass per duck recorded the highest value (4.85) with diet containing 4.0 per cent calcium and 0.6 per cent phosphorus level.

Andrews *et al.* (1984) reported an egg weight of 60.4 g and 60.7 g under the intensive and semi intensive system among indigenous ducks of Kerala, fed with diet containing 3.31 per cent calcium and 1.17 per cent total P. While Reddy *et al.* (1981) reported the egg weight of 60.67 g in KC ducks fed 2.75 per cent calcium and 0.55 per cent phosphorus level with 17 per cent CP and this values were compared with egg weight of 60.1±0.57 g obtained with 3.0 per cent Ca and 0.5 per cent P. Mahanta (1997) reported first egg weight of 61.27 and 61.87 g in Chara and Chemballi ducks of Kerala respectively under semi intensive system of management. Tian Fwu *et al*. (1998) obtained the egg weight of 64.93 and 64.68, 66.50 g when fed with 3.0,3.5 and 4.0 per cent calcium respectively, with constant level of (0.46 per cent) P. This values were comparatively higher than the present study in all the three levels of calcium.

The overall per cent shell recorded with 0.4 and 0.6 per cent phosphorus levels (Table 2) was significantly higher (10.0) than that of 0.5 per cent phosphorus level ($P<0.05$). The shell thickness with 0.5 per cent phosphorus level was also numerically low (0.53±0.004 mm). Higher the values were reported by Mahanta *et al.* (1993) in Pati and Khaki Campbell eggs (12.11 ± 0.01 and 12.01 ± 0.13 per cent respectively). In Tsaiya duck eggs, Tian Fwu *et al.* (1998) showed 9.58 with 4.0 per cent dietary calcium level. This is comparable with the present study with the same level of calcium.

The varying levels of calcium and phosphorus levels did not influence the shell thickness from 25-40 weeks of age (Table 1 and 2). The shell thickness recorded in the present study was higher than that reported by Reddy *et al.* (1981) in KC duck eggs (0.42 mm) from group fed diet containing 2.75 per cent calcium and 0.54 per cent phosphorus and Tian Fwu *et al.* (1998) reported 0.37 mm at 4.0 per cent dietary calcium level. Whereas Davis *et al.* (1993) reported shell thickness of 0.54 and 0.53 mm in Pekin ducks egg at 40th week of age, and this is comparable with the present study with all levels of calcium and phosphorus.

Conclusion

The mean egg weight of 60.1±0.58 g recorded with 3.0 per cent calcium and 0.5 per cent phosphorus level was superior and was highly significant over other levels ($P<0.01$). Whereas while considering the cumulative egg mass from 21 to 40 weeks of age was 4.85 kg per duck with 4.0 per cent Ca and 0.6 per cent P and it was numerically better than the other treatment groups. So the result are suggestive of recommending dietary calcium and phosphorus levels of 4.0 and 0.6 per cent respectively for layer ducks housed in cages.

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EFFECT OF CALCIUM AND PHOSPHORUS IN SOME CARCASS TRAITS OF INDIGENOUS LAYER DUCKS IN KERALA

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Abstract

The effect of three levels of calcium viz., 3.0, 3.5 and 4.0 per cent with three levels of AP viz., 0.4, 0.5 and 0.6 per cent respectively on certain carcass traits of indigenous layer ducks of Kerala was studied. Among the edible parts, the Ca and AP levels did not influence significantly in any of the traits studied except at gizzard weight, where there was significantly ($P<0.05$) higher the gizzard weight was observed at 0.5 per cent AP levels (41.21±3.60) than the other two levels. The overall mean live weight and dressed weights were 1577±28g and 1383±26g respectively. The giblet weight was 99.42g (heart, liver and gizzard weight were 10.95±0.23 g, 53.50±2.62g and 34.97±1.56g respectively). The overall mean eviscerated weight and ready to cook weight was 932±30 and 1032±30g respectively.

Contains 2 tables

Key words: Indigenous ducks, cages, calcium, phosphorus and carcass traits.

Introduction

Indigenous duck meat is very much popular amongst the rural consumers of Kerala. Several works has been conducted on carcass traits of indigenous layer ducks. But no investigation, especially on the influence of calcium and available phosphorus on carcass traits of this duck appears to have been undertaken. Therefore, the present study was conducted to investigate the effect of calcium and available phosphorus levels on different edible component traits of indigenous duck carcasses of Kerala.

Materials and methods

An experiment was carried out at the Department of Poultry Science, Kerala Agricultural University to study the carcass traits influenced by various levels of calcium and available phosphorus in the diets during 20 to 40 weeks of age. Three levels of calcium viz., 3.0, 3.5 and 4.0 per cent with three levels of available phosphorus viz., 0.40, 0.50 and 0.60 per cent were employed in the diet in a 3x3 factorial arrangement. Thus, there were nine treatment combinations and each treatment was replicated five times comprising two birds per cage.

At the end of 40 weeks of age, three birds from each treatment group were selected at random and fasted overnight slaughtered and dressed. The data collected were subjected to statistical analysis as per Snedecor and Cochran (1980).

Results and Discussion

The influence of dietary calcium and available phosphorus levels on dressing percentages at 40 weeks of age is shown in Table 1 and its interaction effect on dressing percentages is shown in Table 2.

The 40^{th} week body weight did not influence significantly by any of the calcium and available

phosphorus levels in the diet. The overall mean live weight was ranged from 1478±74 to 1735±111 g with an overall mean of 1577±28 g (Table 2). This is in agreement with 1465±115 g in Khaki Campbell ducks in deep litter system of rearing reported by Reddy and Rao (1990) and 1425.50±28.86 g at the time of slaughter in desi ducks was reported by Sangilimadan (1997). The higher the values of 1912±358.6 g and 1800±301.2 g in male and female Pati ducks at 40th weeks of age were reported by Mahanta *et al*. (2000) reared in extensive system of rearing. Whereas Sahoo, (1990) reported the body weight of 2077.5±264 g in desi ducks at 44 weeks from the marketing channel of meat shops in Kashmir. The inclusion level of Ca and P were not reported by the above said authors.

The statistical analysis revealed that neither Ca and AP levels nor the interaction effect significantly influenced the dressed weight. The overall mean dressed weight recorded was 1383±26 g (87.7 per cent). This is in agreement with 1593±212 g (88.5 per cent) reported by Mahanta *et al*. (2000) in Pati ducks of Assam at 40 weeks of age. Whereas 1106 g (89.14 per cent) reported by Gajendran *et al*. (1990) in desi ducks at 72 weeks of age. The lower the body weight was 66 per cent reported by Sahoo (1990) in desi ducks of Kashmir at 44 weeks of age.

The overall mean giblet weight on live weight basis was 99.42g (6.30 per cent) and it was not significant in any level of calcium and available phosphorus in the diet. The mean percent giblet weight of 9.44±0.25 per cent was reported by Sangilimadan (1997) in spent desi ducks.

The Ca and P levels did not influence the heart and lever weight significantly. The overall mean heart weight recorded was 10.95±0.23 g (0.69 per cent). This is in agreement with 13.93±3.4 g (0.69 per cent) in desi ducks of Kashmir at 40 weeks of age (Sahoo., 1990). Whereas 12.53±4.13g (0.77 per cent) in Pati ducks of Assam at 40 weeks of age reported by Mahanta *et al*. (2000).

The overall mean liver weight was ranged from 40.67±5.33 to 70.33±4.11 g with an overall mean of 53.50±2.62 g (3.39 per cent). This is in agreement with 39.8 g (3.21 per cent) reported by Gajendran *et al*. (1990) in desi ducks. Whereas 45.17±10.94 g (2.17 per cent) reported by Sahoo (1990) in desi ducks of Kashmir and 39.11±10.06 (2.17 per cent) reported by Mahanta *et al* (2000) in Pati ducks of Assam

There was significantly higher the gizzard weight were recorded (41.1±3.6)with 0.5 per cent P level than at 0.4 and 0.6 per cent available P levels. The higher the value was 47.3 g (3.81 per cent) reported by Gajendran (1990) in desi ducks at 72 weeks of age. Whereas 56.00±10.03 g (2.70 per cent) reported by Sahoo (1990) in desi ducks of Kashmir and 53.20±11.92 g (2.96 per cent) reported by Mahanta *et al*. (2000) in Pati ducks of Assam.

The overall mean eviscerated weight was ranged from 824±60 to 1125±140 g with an overall mean of 932.72±30 g (59.15 per cent). This is in agreement with 60.87±0.30 per cent reported by Sangilimadan (1997). Whereas Mahanta *et al*. (2000) reported 1178.69±151.56 g (65.48 per cent) in Pati ducks of Kashmir and 73.53 per cent reported by Sarma *et al*. (1985) in Khaki Campbell ducks at 14 th week of age. The lower the eviscerated weight of 862.17±85.29 (41.50 per cent) was reported by Sahoo (1990) in desi ducks of Kashmir.

The Ready to Cook Weight (RCW) on live weight basis is not influenced by calcium and available phosphorus levels in the diet. The overall mean ready to cook weight was ranged from 931±54 to 1231±138 g with an overall mean of 1032.13±30 g (65.45 per cent).This is not in agreement with 908.2 g (73.18 per cent) reported by Gajendran *et al*. (1990) in desi ducks at 72 weeks of age. Whereas Mahanta *et al*. (2000) reported 1286.10±112.30 (71.45 per cent) in Pati ducks of Assam and 70.94±0.40 per cent was reported by Sangilimadan (1997) in spent desi ducks. The lower the value was 943.50±94.79 (45.41 per cent) reported by Sahoo (1990) in desi ducks of Kashmir.

Conclusion

The overall mean live weight and dressed weights were 1577±28g and 1383±26g respectively, The giblet weight was 99.42g (heart, liver and gizzard weight were 10.95± g, 53.50±2.62g and 34.97±1.56g respectively). The overall mean eviscerated weight and ready to cook weight was 932±30

and 1032±30g respectively. The result of this experiment showed that any of the calcium and available phosphorus levels did not influence significantly on the dressing percentage except on giblet weight where there is significantly ($P<0.05$) higher the gizzard weight was observed.

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EFFECT OF SEASON ON FERTILITY AND HATCHABILITY OF DUCK EGGS

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A study was conducted to know the effect of season on fertility and hatchability of eggs from White pekin and Kuttanad (local) ducks maintained at University Poultry Farm, Kerala Agricultural University. Four different seasons were considered as summer (March -May), South-west monsoon (June-September), Post- monsoon (October-November) and winter (December - February) for the study. Analysis of data from White pekin eggs showed significantly ($P<0.05$) higher fertility per cent (96.58 ±0.45%) in south-west monsoon than summer (91.18 ±1.29%) and winter (89.37 ±2.35%) seasons. The seasonal effect on hatchability also showed highest value in south-west monsoon season (67.20 ±2.20%), but difference between four seasons was not significant. The results of analysis of data from Kuttanad eggs showed significantly ($P<0.05$) higher fertility per cent in post-monsoon season (96.65 ±0.54%) than summer (94.27 ±0.79%) and the fertility in other two seasons were intermediary. The per cent hatchability was highest in south-west monsoon (58.14 ±1.87%) and lowest in summer season (52.76 ±1.99%). The variation in hatchability between different seasons was non-significant in Kuttanad ducks also. The results of the present study indicated that south-west monsoon is the most suitable season for hatching eggs from White pekin and Kuttanad ducks in Kerala

Kewords: Fertility; hatchability; seasonal effect; duck egg

Introduction

The world duck population is estimated to be 2.2 billion of which 80 per cent concentrated in Asia and in India it was reported to be 22.1, 62.6, 82.5, 95.5 and 107.0 millions during the years 1992, 1999, 2000, 2001 and 2002 respectively with the annual growth rate (1992-2002) of 16.8 per cent (FAO 2003). The extensive coast line (4000 km long) with many inland water bodies in several parts of the country like Assam, Andhra Pradesh, Haryana, Jammu and Kashmir, Kerala, Orrisa, West Bengal and Tami Nadu states offer excellent natural habitat of ducks. Though, duck rearing offers promise economically, socially and scientifically, it is yet to gain popularity in India (Gajendran *et al*. 2009). Kerala state has long coastal belt of about 500 K.M. and topography of some districts is peculiar in that it lies one meter below mean sea level making it very much suited for duck rearing. Many households are practicing duck rearing in traditional manner that is integrating with paddy cultivation which is major source of their livelihood (Jalaludeen *et al.* 2004). It appears that duck can be raised cheaper than broiler if market is properly organized (Singh, 2001). Novice poultry producers usually become interested in artificial incubation on their own chicks. The success of this type of project depends on proper care and incubation of the hatching eggs so healthy, vigorous chicks are produced (smith 2000). At present, natural incubation is getting replaced by artificial incubation using forced draft incubators for hatching large number of duck eggs. However natural incubation using broody hen is being carried out in households. Kerala state has different seasons in a year those are summer (March- May), South-west monsoon (June – September), Post-monsoon (October & November) and winter (December- February) in respect of temperature and relative humidity (Rao *et al.* 2005). Research has proved that climate has direct bearing on the productive and reproductive performance of the animals. Determination of the seasonal effect on hatchability should be given priority because of their adaptability, resistance to disease and successful rearing of duck. Considering the above circumstances the study was undertaken with a view to determine the effects of season on the fertility and hatchability of local Kuttanad and White pekin duck eggs as well as to identify better season for hatching of eggs.

Materials and methods

The study was conducted in University Poultry Farm, College of Veterinary and Animal sciences, Mannuthy, Thrissur under Kerala Agricultural University. This farm also supplies ducklings to farmers once per week. Data were collected from the record register of the farm. The managerial condition of the farm during the observed period was uniform. Two breeds of ducks viz; White pekin and Kuttanad (indigenous) are maintained in the farm for breeding purpose. The birds were reared under semi-intensive system of management with provision of wallowing tank. Balanced duck breeder ration was provided throughout the period and the ducks were fed twice daily with wet mash. They were vaccinated with duck plague vaccine. In breeding flock one male duck was provided for every ten females. Good quality, medium size and clean eggs were collected for hatching purposes avoiding cracking ones. Hatching eggs were stored in cold-humid storage area. Ideal storage condition included 15^0C temperature. The incubator temperature was maintained between 99^0F and 100^0F and relative humidity between 75-80 per cent. Hatchability was calculated on the basis of number of eggs set into the incubator and number of duckling hatched. The un-hatched eggs were broken and the infertile and dead germs were recorded. From this data, the fertility and hatchability on total eggs were calculated. The data were collected from the registers maintained in the farm covering the years 2003-04.Data were analyzed to determine the effect of season on the fertility and hatchability of duck eggs.

Results and discussion

Analysis of data from White pekin eggs showed significantly ($P<0.05$) higher fertility per cent (96.58 ±0.45%) in south-west monsoon than summer (91.18 ±1.29%) and winter (89.37 ±2.35%) seasons. The seasonal effect on hatchability also showed highest value in south-west monsoon season (67.20 ±2.20%), but difference between four seasons was not significant. The results of analysis of data from Kuttanad eggs showed significantly ($P<0.05$) higher fertility per cent in post-monsoon season (96.65 ±0.54%) than summer (94.27 ±0.79%) and the fertility in other two seasons were intermediary. The per cent hatchability was highest in south-west monsoon (58.14 ±1.87%) and lowest in summer

Table 1)-Season wise fertility analysis

Season	Kuttanad duck eggs	White pekin duck eggs
	Mean ±SE	Mean ±SE
Summer	94.27 ± 0.79^{A}	91.18 ± 1.29^{A}
South-west monsoon	95.18 ± 0.50^{AB}	96.58 ± 0.45^{B}
Post-monsoon	96.65 ± 0.54^{B}	92.64 ± 2.42^{AB}
Winter	96.19 ± 0.93^{AB}	89.37 ± 2.35^{A}

Mean bearing same superscript within the column did not differ significantly ($P<0.05$).

Table 2)-Season wise hatchability analysis

Season	Kuttanad duck eggs	White pekin duck eggs
	Mean ±SE	Mean ±SE
Summer	52.76 ±1.99	63.44 ±2.15
South-west monsoon	58.14 ±1.87	67.20 ±2.20
Post-monsoon	57.51 ±3.36	60.04 ±2.89
Winter	55.22 ±2.72	64.23 ±3.41

NS - Non-significant.

season (52.76 ±1.99%).Similar result found by Das (1999) and he showed that fertility of duck eggs produced in summer season was significantly lower than other seasons. Babiker (2008) reported that there was no significant difference between seasons in case of per cent hatchability analysis of chicken egg. Chowdhury *et al*. (2004) reported that hatchability in summer season was significantly lower than other seasons in case of duck eggs. Farooq *et al*. (2003) that the hatchability of chicken eggs was significantly higher in spring than summer season. Chung *et al*. (1990) showed that semen quality was better in cold season than hot one.

Conclusion

The effect of season on hatchability of duck eggs implies that monsoon season was the best for hatching of duck eggs. The results of the present study indicated that south-west monsoon is the most suitable season for hatching eggs from White pekin and Kuttanad ducks in Kerala. So effort should be taken for more duckling production at that particular season to meet the increasing demand of ducklings in the region.

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NATURAL OCCURANCE OF AFLATOXIN B1 IN SOME INDONESIAN FEED PRODUCTS AND RESPONSE OF DUCKS TO AFLATOXIN B1 IN DIETS

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Abstract
Aflatoxin B1 is naturally occurring mycotoxin produced by Aspergillus flavus and Aspergillus parasiticus. The feedstuff is composed by various agriculture-commodities are very conducive for fungal growth, such as corn, soybean and peanut. One of the natural factors affecting the quality of agriculture commodity is the fungal growing on the feedstuff supported by condition in tropical climate, in which high temperature, high humidity and the high rainfall. Contamination of aflatoxin B1 in animal feed is one of the problems in the development of poultry industries, particularly in tropical countries. In Indonesia, based on research conducted in 1988, nearly 95% of the commercial poultry contain aflatoxin B1 around 52 ppb. Few years later, in 1994, the level is increased - becomes 100 ppb, taken from 83% of the sample. In 2001, aflatoxin B1 also detected in feed products was 27 ppb. The other research conducted on 35 samples consists of 19 samples of commercial feed, 8 samples of bran and 8 samples of feed mixtures by farmers. The results reported that all of the commercial contaminated aflatoxin B1, 75% of bran samples contaminated aflatoxin B1 and samples of feed mixtures by farmers were found 12.5% samples contaminated aflatoxin B1. The Aflatoxin B1 is associated with carcinogenicity and chronic toxicity. Aflatoxicoses most often found in ducks has been reported in several regions in Indonesia. Aflatoxin B1 in duck's diets caused severe damage because duck is the most sensitive birds against aflatoxin B1. The effect in birds will depend on dosage, duration of exposure, species, age, nutrition and disease. A positive association between aflatoxin B1 ingestion and liver cancer has been found in many population studies in Indonesia. Further, histopathological changes in the various organs occur much earlier than any effect on the body weight is visible. The pathological lesions associated with acute aflatoxicosis include hepatocellular necrosis. Aflatoxin B1 has contagious effects to poultry, such as lowering the enzymatical effects whose important to fat metabolism. The losts associated with aflatoxin B1 contamination on poultry are the diminishing of growth and poultry conversion, egg production, and the increase of mortality. Generally, aflatoxin B1 contamination chronically causes the profit of the duck business.

Key words: aflatoxin B1, Indonesian feed, duck

Introduction

Mycotoxins are toxic and carcinogenic compounds produced by various fungal species that grow on various agricultural commodities (Cullen and Newberne, 1994), when consumed or absorbed by animals, cause sickness or behavioural changes (Riley and Pestka, 2005). Only seven mycotoxins were reported to occur significantly in naturally contaminated in feeds: aflatoxins, fumonisins, ochratoxin A, deoxynivalenol, patulin and zearalenone.

Aflatoxins, the most widespread of all the mycotoxins, are common in warm and humid climate condition like in Indonesia, where hot and humid climatic conditions prevail during most of the year. Under favorable conditions of temperature and humidity, it has been observed that these fungi can grow on certains feedstuffs. When aflatoxin is found to be contaminating a feed, at least one component of the feed has supported mould growth. Wyatt (2005) reported that as the mould grows on either feed ingredient or complete feed, the nutrient to support mould growth and metabolism are derived by the mould directly from the feedstuff. Mouldy feed may posses lower than normal levels of specific nutrients.

The aflatoxins are a group of structurally related toxic compounds produced by certain strains Aspergillus flavus and Aspergillus parasiticus. Major forms of aflatoxins include B1, B2, G1 and G2, and two additional metabolic products, M1 and M2, with aflatoxin B1 being the most common and biological active toxin (Devegowda and Murthy, 2005). However, only aflatoxin B1 is considered by International Agency for Research on Cancer as having produced sufficient evidence of carcinogenicity in experimental animals to be identified as a carcinogen.

Aflatoxin B1 is the most potent hepatotoxic having carcinogenic and severe performance depressing effects on poultry and other livestocks (Devegowda, 2002). Exposure to aflatoxins may result in nephrotoxicity, hepatotoxicity, genotoxocity, carcinogenesis, and immunotoxicity (Gabal and Azzam, 1998). Aflatoxins contributing to altering immune function, unexplained animal diseases, and in performance problems in farm animals (Bondy and Pestka, 2000; Osweiler, 2000).

Economic losses associated with aflatoxin exposure include poor growth and feed conversion, increased mortality, decreased egg production, leg problems, and carcass condemnations. The frequent aflatoxin contamination of agricultural commodities and the chronic exposure of poultry to these toxins can mean the difference between profit and loss to a poultry operation (Hamilton, 1984; Devegowda et al., 1998).

Biodegradation of aflatoxin at six ways: attack by hydrogen or water molecules on the isolated vinyl ether or 2,3 double bond, other forms of degradation of the bisfuranoid moiety, demethylation of the methoxy-coumarin structure, hydrolytic fission of the 7,8 C-O bond in the coumarin ring, reduction of the cyclopentenone moiety, and hydroxylation at one or more points in the molecule prior to conjugation (Willie and Morehouse, 1977).

Aflatoxin B1 is metabolized by the liver through the cytochrome P450 enzyme system to the major carcinogenic metabolite AFB1-8,9-epoxide, or to less mutagenic forms such as AFM1, AFQ1 and AFP1 (Shimada and Guengerich, 1989). It is considered that the carcinogenicity and mutagenecity of AFB1 most probably arises from the formation of a reactive epoxide at the 8,9 position of terminal furan and its subsequent covalent binding to nucleic acid: such nucleic adducts may last for some weeks after formation (Smith et al., 2005).

Because aflatoxins are toxic and carcinogenic in animals, Indonesia has attempted to limit exposure to aflatoxins by imposing regulatory limits on commodities for use as feed. Regulation is concerned with controlling aflatoxin B1, because it is considered the most toxic and carcinogenic of the naturally occurring mycotoxins. Maximum level can occur in feed, such as 20 ppb.

Aflatoxin B1 affects all poultry species. Although it generally takes relatively high levels to cause mortality, low levels can be detrimental if continually fed. Poultry, especially ducks and turkeys, are very susceptible. As a general rule, growing poultry should not receive more than 20 ppb in the diet. However, feeding levels lower than 20 ppb may still reduce their resistance to disease, decrease their ability to withstand stress and bruising, and generally make them unthrifty (Ferrer, 1991).

Indonesia has several types of duck, such as Mojosari, Peking, Karawang, Alabio. In Indonesia, ducks as a producer of eggs and meat. More than 19% eggs satisfied by duck eggs, but its role as producers of meat is still low at 0.94% of total demand of meat. In 2008, duck egg production is 217.696 tons (Directorate General Livestock of Indonesia, 2008).

Occurance of Aflatoxin B1 in Some Indonesian Feed Products

According to the United Nation's Food and Agriculture Organization (FAO), approximately 25% of the world's grain supply is contaminated with mycotoxins, of which the most common is aflatoxin B1. Many of raw materials will contain aflatoxin B1, Lim (2008) reported that 52% of feed samples from South East Asia (Indonesia, Malaysia, Philippines, Thailand and Vietnam) contaminated by aflatoxin with average 50 ppb and maximum level 345 ppb.

Aflatoxin can be produced in standing grain before harvest. If condition of moisture and temperature support continued mold activity after harvest, aflatoxin can continue to be produced during storage. Actual feed production, where in most cases the raw materials are ground before making a meal or pellet, further allow an opportunity for additional mold and aflatoxin development. Osweiler (2005) reported that aflatoxin, once produced, is quite stable to heat, milling, pelleting and many chemicals. Furthermore, transport and bulk bin standards on farms offer another well-proven area for the contamination of the feedstuffs with toxigenic moulds.

Fungal growth and aflatoxin contamination are the consequence of interaction among the fungus, the host and the environment. The appropriate combination of these factor determine the type and amount of aflatoxin produced. Water stress, high-temperature stress and the insect damage of the host plant are major determining factor in mold infestation and toxin production. Similarly, specific crop growth stage, poor fertility, high crop densities and weed competition have been associated with increased mold growth and toxin production.

It is important to be able to detect and quantify the mycotoxin concentration in feeds destined for animal consumption. Zahari and Tarmudji (1995) measured about 35 samples: 19 samples of feed, 8 samples of rice bran and 8 samples of feed mixtured by farmers, then reported that all of feed, 75% of rice bran and 12,5% feed mixtured by farmers contaminated aflatoxin B1 with range between 3-160 ppb. This toxin was also detected in feed products at level 27 ppb (Nuryono, 2001). The results showed that contamination of aflatoxin B1 are quite high. Table 1 showed the distribution of aflatoxin B1 in animal feedingstuffs raw materials respectively.

Table 1. The level of aflatoxin B1 contamination in some Indonesian feeds and feedstuffs

Samples	Number of samples	Positive samples	Percentage of positive	Aflatoxin B1 (ppb) contamination
Feed products*	290	275	95	52
Feed products**	19	19	100	3 - 160
Rice bran**	8	6	75	3 - 160
Feed mixtured by farmer**	8	1	12.5	3 - 160
Feed product ***	193	189	98	1.7 - 732
Feed products ****	4	4	100	27

* Widiastuti et al. (1988) ** Zahari and Tarmudji (1995) *** Bahri et al. (1995)
**** Nuryono et al. (2001)

Corn is probably the commodity of the greatest worldwide concern, because it is grown in climates that are likely to have perennial contamination with aflatoxin. Table 2 showed aflatoxin levels (ppb) in corn from some corn-producing areas in Indonesia.

Table 2 The level of aflatoxin B1 in some corn-producing areas in Indonesia, 2003-2004

No	Corn-producing area	Level of aflatoxin (ppb)
1	East Java	2 – 214
2	Central Java	87 – 236
3	Lampung	2-36
4	Makasar	218-517
5	South Sulawesi	72.6 – 197
6	North Sumatera	19.1 - 79.6

Yanuartin (2004)

Aflatoxin B1 can contaminate cereals, sorghum, peanuts, and other oil-seed crops. The feedstuff is composed by various agriculture-commodities and agriculture-by product, such as rice bran, coconut oil cake, cassava dregs, chocolate rind, corncob, soybean oil cake, palm oil cake, copra oil cake and pollard. Table 3 showed the level of aflatoxin B1 in some agriculture-by product. Rice bran is by-product from rice milling. Coconut oil cake, soybean oil cake, palm oil cake and peanut oil cake are by-product from oil production. Contamination of mold or mycotoxin is concentrated on the hull and bran (Raghavan, 2008).

Table 3 The level of aflatoxin B1 in some agriculture-by product in Indonesia, 2003-2004

No	Samples	Level of aflatoxin (ppb)
1	Rice bran	18.1
2	Coconot oil cake	10.9
3	Cassava dregs	9.63
4	Chocolate rind	38.55
5	Corncob,	24.11
6	Soybean oil cake	7.12
7	Palm oil cake	23.57
8	Peanut oil cake	25.0
9	Pollard	18.93

Maryam and Sastrawihana (1994)

Response of Ducks to Aflatoxin B1 In Diets

Aflatoxin has been associated with various diseases, such as aflatoxicosis. Aflatoxicosis is the poisoning that results from ingesting aflatoxins. Two forms of aflatoxicosis have been identified: the first is acute severe intoxication, which results in direct liver damage and subsequent illness or death, and the second is chronic subsymptomatix exposure (Williams et al. 2004). The symptoms of aflatoxicosis in poultry ranged from none to acute or chronic disease, which varied with the species of bird, the amount of toxin consumed and the length of time over which it was ingested.

Aflatoxicosis caused impaired absorption, distribution and utilization of nutrients. Osborne and Hamilton (1981) reported that aflatoxicosis results in low activities of pancreatic trypsin, lipase and amylase. The low activities were apparently due to failure of enzyme synthesis rather than specific enzyme inhibition. Poor digestion of feedstuffs results in lower concentrations of monomeric units (amino acids, fatty acids, simple sugar, etc). Since nutrients for absorption are not attained through digestive processes, there is a lack of sufficient nutrients to support optimal growth and reproduction. Inhibition of protein synthesis associated with aflatoxicoses leads one to infer that amino nutrition in animals is critical during outbreaks of aflatoxicosis. Furthernore, it can be assumed that the most limiting amino acid nutrition would be the single is most important (Wyatt, 2005).

The susceptibility of individual animals to aflatoxin considerably depending on species, age, sex and nutrition. Among poultry, ducks are the most susceptible to aflatoxin. The most common features in the original outbreaks in ducklings were the sudden loss of appetite, the appearance of nervous symptoms and a high and rapid mortality in young birds (Pasteiner, 1994). Clinically, the signs of aflatoxin toxicity include anorexia, decreased weight gain, decreased egg production, specific visceral haemorrhage, and embryo toxicity (Devegowda and Murthy, 2005).

Liver is the site of the majority of detoxification activity (Liska, 1998). Duckling liver is more sensitive than rat liver to the inhibitory effect of aflatoxin on protein synthesis (Willie and Morehouse, 1977). Avian liver metabolizes aflatoxin rapidly and the major metabolite is the hemiacetal of aflatoxin. The 2,3-epoxide of aflatoxin B1 appears to be extremely reactive and hence even if formed by the liver as aminor metabolite, presumably still be susceptible to the carcinogenic action of the toxin, but the 2,3-epoxide is probably a minor metabolite in duck.

The aflatoxin B1 is tipycally associated with interference of resistance to infectious diseases. The primary reasons for this lay in the fact that this mycotoxin is known to inhibit protein synthesis, cause hypoplasia of lymphatic tissue (bursa of fabricius, thymus, and gut-associated lymphoid tissue), and cause alterations of the blood system including the bone marrow (Wyatt, 2005).

Metabolically activated aflatoxin is known to bind covalently to DNA, RNA, and complex proteins impair protein formation in the body. This binding results in failure of the RNA polymerases to recognize DNA as the substrate and inhibition of protein synthesis results. The may thus cause organ damage and cancer from prolonged exposure (Osweiler, 2005). Histhopathology reveals, fatty liver, liver necrosis and bile duct hyperplasia is the most common findings in duct affected with aflatoxicosis (Devegowda and Murthy, 2005). Futhermore, fatty changes are found to occur in liver in aflatoxin poisoning

Aflatoxicosis most often found in ducks has been reported in several regions in Indonesia. Day old Peking and Karawang ducklings which fed daily with aflatoxin showed signs of intoxication. These include roughened coats, stunted growth and high mortality. The liver appeared yellowish to grayish white. Histological of duck liver showed fatty degeneration, haemorrhages and necrosis, proliferation of epithelial cells of bile ducts, especially those located in the portal areas. The epithelial cells of bile duct appear blue, nucleus and nucleoli are swollen. On the proliferation of bile duct epithelial cells were prominent and extensive, sometimes found in the formation of new bile duct with a patent lumen. Bone marrow showed damage and replaced by fat tissue. The results of this study indicate that all of the ducks had poisoning. Both Peking and Karawang ducklings were very susceptible to aflatoxin (Budiarso et al., 1995).

Aflatoxicosis observations on Alabio ducklings in South Kalimantan had reported by Zahari and Tarmudji (1995) histopathological changes are proliferation and hyperplasi of bile duct and fat degeneration. The symptoms related to contaminated aflatoxin B1 on rations between 4-160 ppb. The treatment of aflatoxin B1 150 ppb on ducks for 6 weeks, caused residues in the liver as much as 12,8 ppb (Rahmawati and Hamid, 2008).

The presence of aflatoxins in feeds may decrease feed intake and animal performance. In addition, the possible presence of toxic residues in edible animal product (egg and meat) may have some detrimental effect of human health (Yiannikourisa and Jouanya, 2002). Aflatoxin B1 is well recognized as a cause of liver cancer, but it has additional important toxic effects. These effects have not been widely studied in human, but the available information indicates that at least some of the effects observed in animals also occur in human. Chronics effects are a concern for the long term health of the human population making low levels of aflatoxin in food.

Conclusion

Public awareness of issues surrounding aflatoxin is increasing. Aflatoxin has received greater attention because of it demonstrated potent carcinogenic effect. The first line of defense against aflatoxin is at the farm level and starts with implementation of good agricultural practices to prevent infection. Preharvest include maintenance of planting and growing (soil testing, crop rotation and irrigation), antifungal treatments and adequate insect and weed prevention. Harvesting include clean and dry collection and transportation equipment. Post harvest include appropriate storage condition and use of transport vehicles that are dry and fre of visible fungal growth.

The prevention of aflatoxin contamination of feeds could have a significant effect on animal health, especially duck, and deserves significant attention. The losts associated with aflatoxin B1 contamination on poultry are the diminishing of growth and poultry conversion, egg production and increase of mortality. Generally, aflatoxin B1 contamination chronically causes the profit of the duck business.

The feed industry should take the lead in this effort, because it will lead to improved economic sustainability of poultry industry, enhanced feed safety efforts, and enhanced international trade effort.

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NUTRIENT AVAILABILITY OF FORAGING DUCKS IN KERALA

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A study was undertaken to assess the nutrient availability of foraging ducks Kerala. The crop contents of the foraging ducks in the harvested paddy fields were collected from three foraging areas, namely Kuttanad, Palakkad and Thrissur. Preliminary examination of the crop contents revealed that the major contents were paddy grains, crabs, snails and worms and some weeds. Some of the crop samples contained paddy grains, crabs, snails and worms, while some other samples contained paddy grains alone depending on the foraging area. Among the total crop samples collected, the per cent mean value of paddy grains present accounted to 64.01 ± 4.93. Per cent content of crab was 23.15 ± 4.63, snail 4.07 ± 0.83, worms 2.02 ± 0.48 and other weeds was 6.75 ± 1.87. Analysis of chemical composition of the crop samples revealed that moisture content varied between 41.0 to 53.0 per cent. The mean crude protein content among samples ranged from 10.2 to 17.5 per cent, crude fibre from 11.3 to 19.8 per cent, fat from 1.8 to 3.7 per cent and total ash from 9.5 to 17.0 per cent. The mean percentage of fibre fractions viz., Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were ranged between 28.1 to 39.5 and 12.7 to 23.4 per cent respectively. The results indicated that the crude protein availability from foraging fields is widely variable. The feed of the foraging ducks contained more fibre that can be efficiently utilized by them as evidenced by ability to maintain high egg production in the foraging conditions.

Key words: Nutrient availability; foraging duck; Kerala

Introduction

The poultry industry in India is mainly oriented towards chicken production. Ducks are the second important species among poultry. The indigenous varieties contribute more than 90 per cent of the total duck population in the country and are being reared extensively under free range and backyard conditions. Kerala, the south peninsular region of India, has a unique system of duck rearing. Plenty of backwaters, lagoons and canals with intermittent paddy fields form the natural feeding places for ducks The vast stretch of paddy fields after harvest forms a potential and sustainable feed resource for the ducks in the State under the foraging system of rearing The availability of nutrients from their natural feeding places may be insufficient in certain periods to support optimum production of eggs, as reflected by fluctuations in egg production. The availability of nutrients, especially crude protein and crude fibre, from the natural feed resources vary widely between regions. The feeds of scavenging ducks were either deficient in crude protein or excess in crude fibre (Haque *et al*. (1994). However, for better production of indigenous ducks, feed supplementation should be considered according to the probable nutrient requirement of the ducks and the nutrients available from the foraging sources. Therefore, accurate assessment of feed and nutrient intake by the scavenging ducks are important prerequisites for improving feeding systems and management. Hence the study was carried out to assess the feed and nutrient availability of foraging ducks in Kerala.

Materials and methods

Nutrient availability of foraging ducks was studied utilizing 15 ducks of 38-44 weeks of age, from three regions viz., Kuttanad, Palakkad and Thrissur. The birds were procured immediately after foraging in paddy fields and their crops were collected for further studies. The samples collected were stored in deep freezer for further analysis. The crop contents were subjected to visual examination. Further, the contents were weighed separately and processed for chemical analysis. Statistical analysis of data was done according to Snedecor and Cochran (1990).

Results and discussion

Among the crop samples examined, the main item found was paddy grains which was64.01 ± 4.93 per cent. The next major item was crab 23.15 ± 4.63 per cent, while that of snails, worms and other weeds was 4.07 ± 0.83 and 2.02 ± 0.48 and 6.75 ± 1.87 per cent respectively. Chemical composition of crop contents varied widely depending on the nature of items present in it. Crop samples contained paddy and other weeds had high fibre content, while those contained crab, snails, worms etc. had more protein content. Thus it is evident that foraging ducks meet the requirement of energy, protein and other nutrients from the feed resources available from foraging fields. Similar study was conducted in laying ducks under scavenging conditions in Bangladesh by Haque *et al*. (1994) and reported that rice polishings, snails and weeds were the common feeds in the crop and gizzard. Mwalusanya *et al*. (2002) and Rashid (2003) observed that whole paddy rice was a major grain in the crop of chicken during the paddy harvest season.

Analysis of chemical composition of the crop samples (Table 2) revealed that dry matter content varied between 47.0-59.0 per cent. The mean crude protein content among samples ranged from 10.20 to 17.5 per cent, crude fibre from 11.30 to 19.80 per cent, fat from 1.8 to 3.7 per cent and total ash between 9.5-17.0 per cent. The mean percentage of fibre fractions viz., Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) ranged between 28.1 to 39.5 per cent and 12.7 to 23.4 per cent respectively. Earlier works in ducks are not available for comparison. However, the values are close to that reported in hen during harvesting season (51.4 per cent) by Rashid (2003). The dry matter per cent in the crop of laying hen reported by Gunaratne *et al*. (1993), Tadelle and Ogle (1996) and Mwalusanya *et al*. (2002) were 34.4, 52.3 and 43.1 per cent respectively.

The crude protein values reported by the above authors varied from 8.8 to 10.4 per cent, ether extract 1.9 to 9.2 per cent, crude fibre 5.4 to 10.2 per cent and total ash from 12.5 to 16.0 per cent. Crude protein (10.2 to 17.5 per cent) and crude fibre (11.3 to 19.8 per cent) values of the crop contents in the present study are higher than values reported by Haque *et al*. (1994) in scavenging ducks while the values for ether extract (1.8 to 3.7 per cent) and total ash (9.5 to 17 per cent) are close to those reported by the same author in ducks (1.2 to 1.61 and 8.8 to 14.8 per cent respectively).

Table 1.Physical examination of crop contents collected from foraging ducks

Average fresh weight of Crop contents (g)	41.53 ± 4.23
Mean content of paddy grains in the crop (%)	64.01 ± 4.93
Mean content of Crab (%)	23.15 ± 4.63
Mean content of Snail (%)	4.07 ± 0.83
Mean content of worms (%)	2.02 ± 0.48
Mean content of other weeds (%)	6.75 ± 1.87

Table 2 Chemical composition of Crop contents (per cent) collected from Foraging ducks

Nutrient	Per cent
Moisture	41.0-53.0
Crude protein	10.2-17.5
Crude fibre	11.3-19.8
Ether extracts	1.8-3.7
Total ash	9.5-17.0
Neutral detergent fibre	28.1-39.5
Acid detergent fibre	12.7-23.4

Conclusion

Based on the findings of the study, it can be inferred that the crude protein availability from foraging fields are widely variable. The feed of the foraging ducks contained more fibre that can be efficiently utilized by them as evidenced by ability to maintain high egg production in the foraging conditions.

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DESI DUCKS (*Anas platyrynchos domesticus*) OF KERALA AND THEIR SERUM MINERAL PROFILE

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Running Title: Kuttanad ducks salient features and serum mineral profile

Abstract

A study was envisaged to evaluate the serum mineral status of Desi ducks of Kerala (Kuttanad ducks). Serum samples from eight female ducks each of 20 and 22 weeks of age and maintained in the University Poultry Farm were used for the study. The samples were analysed for Calcium (Ca), Magnesium (Mg), Copper (Cu), Cobalt (Co), Iron (Fe), Manganese (Mn) and Zinc (Zn) using Atomic Absorption Spectrophotometer (Perkin Elmer AAS-3110). Sodium (Na) and Potassium (K) concentrations were estimated using Flame Photometer (Systronics Flame Photometer 128). Level of inorganic Phosphorus (iP) was determined photometrically by Phosphomolybdate method. The range of different minerals were Ca – 1.68 - 3.60 mmol/l, iP – 1.40 - 2.80 mmol/l, Mg – 0.21 - 0.84 mmol/l, Na – 75.25 -132.44 mmol/l, K – 8.84 -17.68 mmol/l, Cu - 0.01 - 0.03 mmol/l, Co – 0.09 - 0.15 mmol/l, Fe - 0.10 - 0.36 mmol/l, Mn – 0.14 - 0.29 mmol/l and Zn - 0.01 - 0.05 mmol/l. There was no significant difference in the mineral composition between birds of 20 and 22 weeks of age.
Keywords: Kuttanad ducks, phenotypic characters, serum mineral composition

Introduction

Desi ducks of Kerala are the Kuttanad ducks, identified from the Kuttanad area in Alapuzha district of Kerala. These ducks resemble the wild ducks and are believed to have originated from wild ducks domesticated centuries ago. Chara and Chemballi are the two varieties of Kuttanad ducks named according to their plumage colour pattern. Even though many phenotypic variations are noticed among the indigenous flock, black or partially black or spotted birds with white feathers intermingled are common and completely white ducks are rare.

Salient Features of Kuttanad Ducks:

Jalaludeen *et al*. (2004) described the major features of Kuttanad ducks. Typical Chara drakes are squat in posture and gait with yellow or yellowish black bills. The head is lustrous greenish black and feet bright orange in colour (Fig. 1.a.). The neck is longer in drakes than in females and has brownish black plumage with a full or half white band. The drakes are larger than females and have few tail feathers curled upward and forward and this character is used for sexing (Fig.1.a). The drakes produce a short hoarse voice.

The plumage colour of female Chara birds is blackish brown in the back, tail and wings. Black feathers are predominant over brown (Fig. 1.d.). The bill is usually orange with or without black spots. The head as well as back and tail plumage are brownish black (Fig. 1.d.). The plumage in breast region appears brownish black, light brown or white. By about 20 weeks of age the males will attain a weight of around 1643g and females around 1538g.

Chemballi drakes resemble the Chara drakes in their posture and gait. The bill is longer in drakes than in females and is yellow or yellowishblack in colour. The head is dull greenish black and feet will be bright orange (Fig. 1.b.). The neck is longer in males than females. However, the body length is similar in both sexes. Most of the drakes have brownish black plumage over the back with light brown plumage on the other parts. The tail plumage is blackish brown (Fig. 1.b. & 1.c.). Wing feathers are mainly brownish grey with primary and secondary feathers being light and deep brown mixed with white (Fig 1.b). The

average height of Chemballi drakes is 22.36cm. The breast plumage resembles that of Chara drake (Brownish black, light brown or white). At 20 weeks of age the drakes weigh around 1658g and females around 1498g.

The Chara and Chemballi drakes are identified by the difference in their plumage colour of head region. It is lustrous greenish black in Chara and dull greenish in Chemballi drakes (Fig. 1.c.). The general plumage colour of Chemballi female is brownish black with brownish grey in back tail and wings (Fig. 1.d.). Brown feathers are more than Black. The bill is generally orange or orange with black spots (similar to Chara ducks). The feet will be dull orange in colour. The head is brownish black, neck brown with or without white band (Fig. 1.b& 1d.). The back and tail coverts are mainly brownish black.

Though phenotypic variations of these ducks are available reports of basic physiological data regarding these birds are scanty. Basic data on various physiological parameters are essential to assess the health status and well being of animals. The physiological parameters vary with species, breed, sex, age, nutritional status etc. Mahanta and Jalaludeen (1999) and Sreekumar *et al.* (2000) reported some haematological and biochemical parameters of Kuttanad ducks. However, no reports are available regarding the serum mineral profile of Kuttanad ducks. So a study was envisaged to assess the serum mineral status of kuttanad ducks maintained in the University Poultry Farm, under semi intensive system with standard duck ration and standard managemental conditions.

Materials and Methods:

Eight female ducks each of 20 and 22 weeks of age and maintained in the University Poultry Farm were used for the study. The birds were maintained under semi intensive system of management with standard duck ration (Table1). The blood samples were collected by the wing vein puncture and serum samples were separated. The samples were analysed for Ca, Mg, Cu, Co, Fe, Mn and Zn using Atomic Absorption Spectrophotometer (Perkin Elmer AAS-3110). Sodium and potassium concentrations were estimated using Flame Photometer (Systronics Flame Photometer 128). Level of inorganic Phosphorus was determined photometrically by Phosphomolybdate method. The data were analysed using‘t’ test.

Result and Discussion:

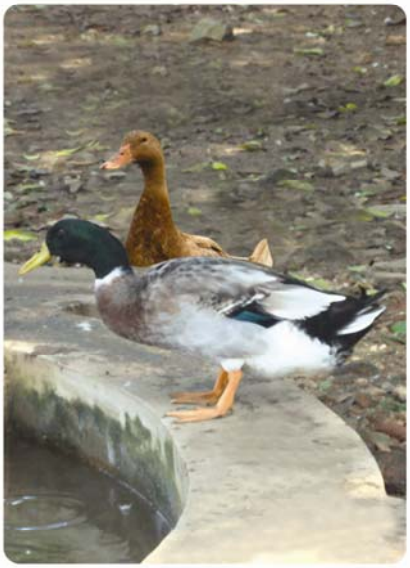
The serum concentration of various minerals is represented in Table 2 and Fig. 2. At 20 weeks of age the levels of different minerals were Ca- 2.41 ±0.09 mmol/l, iP- 1.79 ± 0.29 mmol/l, Mg- 0.45 ± 0.04 mmol/l, Na- 111.29 ± 3.23 mmol/l, K- 12.78 ± 0.43 mmol/l, Cu- 0.02 ± 0.001 mmol/l, Co- 0.10 ± 0.003 mmol/l, Fe- 0.18 ± 0.007 mmol/l, Mn- 0.19 ± 0.003 mmol/l and Zn- 0.02 ± 0.005 mmol/l. At 22 weeks of age the mineral status was Ca- 2.43 ±0.09 mmol/l, P- 2.42 ± 0.07 mmol/l, Mg 0.56 ± 0.04 mmol/l, Na- 106.14 ± 2.49 mmol/l, K- 12.62± 0.44 mmol/l, Cu- 0.02 ± 0.001 mmol/l, Co- 0.11 ± 0.004 mmol/l, Fe-0.29 ± 0.01 mmol/l, Mn- 0.24 ± 0.004 mmol/l and Zn- 0.03± 0.001 mmol/l. No significant difference in mineral composition was noticed between birds in 20 and 22 weeks of age.

In Kerala duck production gets along with paddy cultivation in an integrated farming system. But, paddy cultivation which was 7.03 Lakh tones is decreasing by about 10 per cent every year. This situation poses serious challenges to the duck industry (Jalaludeen *et al*. 2004). So in the coming years the duck farmers will be compelled to move from the low cost integrated farming system to the costly semi-intensive farming system. Hence the knowledge on the mineral profile will help to formulate better nutritional management of these birds, especially in the changing scenario of duck farming.

Acknowledgement:

The authors are indebted to Dr. E. Nanu, Dean of the Faculty; and Dr. A.D. Mercy, Professor and Head and Smt. Dhanya, Senior research fellow, Department of Animal Nutrition as well as Dr. Jayavardhanan, Associate Professor Department of Veterinary Biochemistry and Dr. Ajith Babu PG student Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy for all the help rendered for the analysis of the samples and preparation of the manuscript.

Fig. 1 Kuttanad Ducks



a. Chara Male & Female

b. Chemballi Male & Female

c. Chara & Chemballi Males

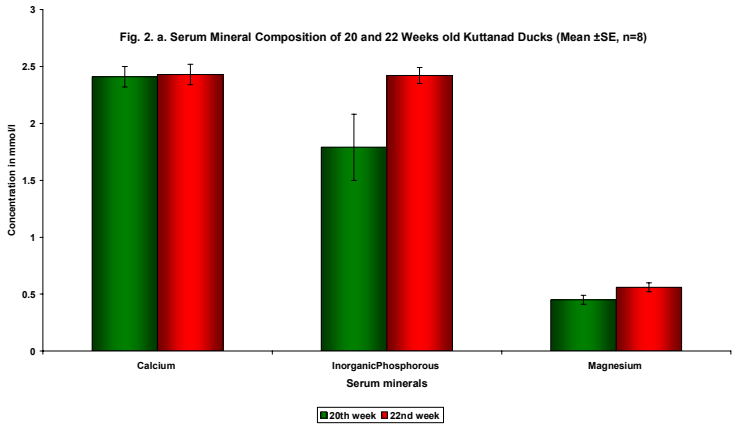
d. Chara & Chemballi Females

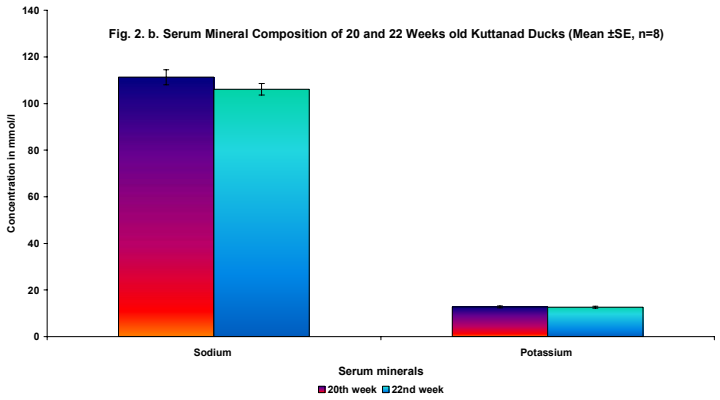
Table.1 Composition of duck ration

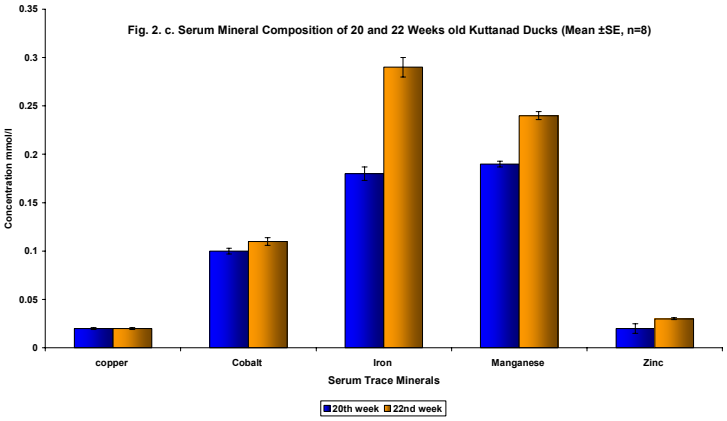
Sl. No.	Ingredients	Quantity (g/1000g)
1.	Yellow maize	477.30
2.	Deoiled rice bran	178.6
3.	Soyabean meal	98.60
4.	Calcite	56.6
5.	Unsalted dried fish	187.50
6.	Common salt	0.40
7.	Choline	1.0
	Total	**1000**
1.	Di calcium phosphate	1.1
2.	Trace Mineral mixture	1.0
3.	Vitamin mixture(B& E)	0.10
4.	Vitamin mixture(A,B,D,K)	0.10

Table.2 Serum Mineral Composition of 20 and 22 Weeks old Kuttanad Ducks (n=8)

Mineral	Concentration (mmol/l) Range
Calcium (Ca)	1.68 – 3.60
Inorganic Phosphorous (iP)	1.40 – 2.80
Magnesium (Mg)	0.21-0.84
Sodium (Na)	75.25-132.44
Potassium (K)	8.84-17.68
copper (Cu)	0.01 - 0.03
Cobalt (Co)	0.09 - 0.15
Iron (Fe)	0.10-0.36
Manganese (Mn)	0.14 – 0.29
Zinc (Zn)	0.01 - 0.05







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PREDICTION OF EGG WEIGHT BASED ON AGE OF INDIGENOUS DUCKS: A LINEAR REGRESSION MODEL

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Abstract:

Two hundred and eleven (211) indigenous layer ducks of Kuttanad variety were housed in a well ventilated duck house under intensive system of management. They were reared on deep litter up to 40 weeks of age in order to study the production traits of desi ducks under intensive system of management. The age at sexual maturity (ASM) was found to be early in Kuttanad ducks and the age at first egg (AFE) recorded was at the age of 122 days. All the eggs laid (11829 eggs) from 18 to 40 weeks of age were weighed individually (Table 1) in order to ascertain the relationship between the age and the mean weekly egg weights in indigenous ducks. The study revealed that the R^2 value for egg weights was 0.80 with the standard error of 2.62 (Table 2) indicating closer prediction. The weekly mean egg weight (EW) was ranged from 51.89 to 66.9 g from 18 to 40 weeks of age, with an overall mean EW of 60.27 g. The frequency distribution of egg weight revealed that 51.89 per cent of the eggs weighed more than 55.5g. The weekly mean egg weights were predicted using the equation y = a + bx where, 'y' is the predicted weekly mean egg weight and 'x' is the age of ducks in weeks (Table 1 and Fig.). The constant (a) and regression coefficient (b) were found to be 38.16 and 0.76 respectively. The goodness of fit of linear prediction was tested by chi-square test revealing non-significant differences (P>0.01) between expected and observed values. It can be concluded from this experiment that the weekly egg weights in Kuttanad ducks could be predicted by linear prediction method with high accuracy under optimum conditions of management.

EGG PRODUCTION AND HATCHABILITY IN BREEDER KUTTANAD DUCKS

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Abstract

A study was undertaken in University Poultry and Duck Farm, Mannuthy, Thrissur to assess the production performance and hatchability traits of breeder Kuttanad ducks reared in confinement with a run area. A breeding flock of 223 ducks constituted the sample for the study. Egg production was recorded from the start of lay upto 61 weeks of age. The first egg in the flock was at 136 days of age. The settable eggs were collected from 146 days of age and the peak production attained was 49.0 per cent at 6th month of age. The fertility and hatchability were studied in hatching eggs from the flock of breeder ducks maintained with a mating ratio of 1:10 during the period July, 2008 to March, 2009. The findings of the study revealed that infertility was least (6.8 %) in September while a highest per cent of infertile eggs was observed in the month of July (23.1 %) followed by March (22.7 %). The dead germs were lowest in July (7.5 %) and February (8.0 %) and it was highest (9.8 %) in the eggs set in September. Similarly, the per cent dead in shells was least (16.1 %) in the month of October and highest (32.5 %) in December. The overall hatchability per cent was significantly higher (p<0.5) in October (64.4 %) followed by September (50.6 %) and November (45.9 %) while the overall hatchability was lowest (36.3 %) in March, 2009.

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INFLUENCE OF SUNSHINE HOURS ON EGG PRODUCTION OF WHITE PEKIN DUCKS

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Abstract

The study was carried out at Department of Poultry Science, on the 196 White Pekin layer ducks maintained at the farm. Weekly egg production and weather data such as maximum and minimum temperature, relative humidity in the forenoon and afternoon, vapour pressure, evaporation rate, sunshine hours, wind speed, rain fall and rainy days were recorded for a period of 13 weeks lasting from January to March 2009. Statistical analysis revealed a higher level of influence by the sunshine hours on the egg production compared to the other environmental factors. The mean values of sunshine hours were 9 h 18 min, 9 h 56 min and 9 h 54 min in first three weeks in January 2009, where the egg production showed a healthy curve with duck day percentage egg production of 49.27, 52.33 and 45.43 respectively. However, in fourth week there was a significant decline in the sunshine hours reaching 7 h 38 min initiating a negative trend in egg production percentage (39.48) which, along with a stressful temperature fluctuation showing steep increase in the mean maximum temperature (35.17 ºC) accompanied by a steep decrease in the mean minimum temperature (20.17 ºC) led to plummeting of the egg production curve by the fifth week (29.53). The succeeding weeks recorded longer sunshine hours bringing back the egg production curve to normalcy. Again, during the ninth week of the study, the sunshine hours showed a declining trend which impacted the egg production in a similar manner. Therefore it can be concluded that increase of sunshine hours does have a positive impact on the egg production of White Pekin ducks.

Key words: White Pekin duck, sunshine hours, egg production.

PRODUCTION SYSTEM

DUCK PRODUCTION SYSTEM IN TAMIL NADU

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Waterfowl production is becoming increasingly important in many countries during the past three decades. World duck population is one million and China accounts for 69.3 %. The top five duck –egg producing countries are China, Thailand, Indonesia, Philippines and Brazil, which account for 96.73 % of the duck egg produced in the World. China accounts for 67.23 % of the World Duck meat production and Duck meat produced in India is only 1.86 %. In India, during 2007 -08, the total number of Desi and improved Duck population was 1,19,11,000 and 6,15,000 and egg production was 13,633 lakhs number and 1,015 lakhs number respectively. West Bengal ranked 1st place in duck egg production followed by Assam and Kerala. The average Desi duck egg yield per annum was 101.93 and improved Duck was 171.86. As far as in Tamil Nadu is concerned, scientific duck rearing is not followed and most of the farming is in nomadic pattern. Mostly desi ducks are reared in Tamil Nadu with wide phenotypic variation. Intensive system of rearing is needed to be followed to meet out the food demand as well as to increase the income of the farming community.

Key word: Duck production system, Management

Introduction

Duck farming in India is characterized by nomadic, extensive, seasonal and is still held in the hands of small, marginal farmers, agricultural labourers as well as poor section of the community. Ducks are mostly reared for eggs, but also consumed as meat. In Tamil Nadu, villages shun their consumption due to the belief that duck eggs and meat have a peculiar smell and produce excessive gas in the stomach and also lead to joint pains. Traditionally West Bengal and Kerala are the major consumer states for duck egg and meat and one of the reasons is that duck egg and meat highly suits and remains tastier for their fish based culinary preparations.

The distribution and demographic dynamics of duck population revealed that they are concentrated in Eastern, North eastern and Southern states of the country. The States of West Bengal, Assam, Bihar, Manipur, Kerala, Andhra Pradesh, Tamil Nadu and Orissa have a sizeable duck population.

Ducks are more prolific and produce 15-20 eggs more than backyard chicken. Size of the duck egg is 10-15 gram larger than chicken egg. Ducks have long productive and profitable life i.e., they will lay in second and third year also. Ducks supplement their feed by foraging; hence it will reduce the feed cost. Ducks are useful in controlling unwanted plants in ponds, lakes and streams like green algae, duckweed, pond weed, musk grass, arrow head wild celery etc. In areas plagued by liver flukes ducks can help correct the problem.

Marshy, swampy river side, wet lands, barren lands not suitable for chicken can be used for duck rearing. Ducks lay their eggs during early in the morning (3 am to 8 am) and saves time and enables easy egg collection. Duck farming is having symbiotic relationship with paddy cultivation, so ducks and paddy cultivation can be integrated in the entire paddy farming areas. Ducks are quite intelligent birds and they can easily trained for their daily routine and it reduces the labour management. Ducks are quite hardy birds and can be easily brooded and are resistant to common avian diseases.

DUCK EGG AND MEAT PRODUCTION

Waterfowl production has become increasingly important many courtiers in the past three decades. Duck meat accounted for only 3.3% and Goose meat accounted for 1.5 of poultry meat in 1970. Duck meat Production increased from 3.3 to 4.2% and Goose meat production increased from 1.5 to 2.9% in 2005. During this period, the average, percentage of annual increase in duck production around the world was 3.7%. The lowest growth was 1.92% observed between 2003 and 2004, due to avian influenza outbreaks (FAOSTAT, 2007).

Table No.1 Top ten duck-meat production (1000 tonnes) countries in the world

Country	Year					% of the world (2005)
	2001	2002	2003	2004	2005	
China	1965.9	2087.7	2230.5	2262.3	2350.1	67.23
France	231.1	253.9	240.2	238.1	208.0	5.95
Malaysia	68.8	52.7	81.6	102.0	105.0	3.00
Vietnam	77.4	81.6	82.8	88.2	88.2	2.52
USA	56.3	52.9	50.8	58.0	85.1	2.43
Thailand	105.0	93.0	72.0	84.8	85.0	2.43
Taiwan	58.8	56.7	56.7	59.6	69.8	2.00
Hungary	45.5	66.8	64.7	65.0	68.0	1.95
India	57.2	59.8	62.4	65.0	65.0	1.86
Republic of Korea	45.0	56.0	46.0	46.0	48.0	1.37
World	3025.1	3181.9	3322.9	3386.8	3495.7	100
Source: FAOSTAT, 2007, Council of Agriculture,2007						

The top ten duck-meat-producing countries in 2005 accounted for 90.75% of the world production are shown in Table No.1 (FAOSTAT, 2007). In 2005, China had 67.23% of the world duck production, followed by France (5.95%), Malaysia (3.00%), Vietnam (2.52%) and Thailand (2.43%) (FAOSTAT, 2007). Table No.1 shows that the fastest growth in the production increase between 2004 and 2005 occurred in the USA (46.7%), followed by Taiwan (17.1%) and China (3.9%).

The top five duck-egg-producing countries are China (84.85), Thailand (6.06), Indonesia (3.52), Phillippines (1.41) and Brazil (1.16), which account for 96.73% of the duck eggs produced, is shown in Table No.2. Although the values obtained form FAOSTAT are eggs excluding hen eggs, these number in most of Asian countries in Table No.2 are believed to be derived mostly from duck eggs.

In India, during 2007 -08, the total number of Desi and improved Duck population was 1,19,11,000 and 6,15,000 and egg production was 13,633 lakhs number and 1,015 lakhs number respectively. Ducks are the second largest source of table eggs and there are about 14648 lakhs of duck eggs produced in India. West Bengal has the highest duck population followed by Assam, Kerala, Tripura and Jharkhand.

Table No.2 Top ten egg production (excluding hen eggs) (1000 tonnes) countries in the world

Country	Year					% of the world (2005)
	2001	2002	2003	2004	2005	
China	3533.4	3721.4	3937.7	4111.2	4326.1	84.85
Thailand	297.5	304.0	304.0	305.0	310.0	6.06
Indonesia	157.6	169.7	185.0	173.2	180.3	3.52
Phillppines	73.8	74.4	74.0	72.0	72.0	1.41
Brazil	65.0	59.0	59.5	59.5	59.5	1.16
Taiwan	31.4	30.7	31.0	27.1	31.7	0.62
Republic of Korea	23.5	25.0	28.0	26.0	28.0	0.55
Bangladesh	26.0	26.0	26.0	26.0	26.0	0.51
Myanmar	10.5	11.0	12.5	13.5	14.2	0.28
Romania	23.8	33.0	30.6	34.0	10.2	0.20
World	4295.3	4511.0	4745.1	4927.2	5115.0	100
Source: FAOSTAT, 2007, Council of Agriculture,2007						

Table No.3 Duck egg production in India (1999-2008)

Year	Duck egg production (lakh Nos)		Total (lakh Nos)
	Desi	Improved	
1999-2000	13080	1114	14194
2000-01	12879	1172	14051
2001-02	12489	1270	13759
2002-03	13458	1271	14729
2003-04	13531	1369	14900
2004-05	12843	1267	14110
2005-06	13337	1180	14512
2007-08	13633	1015	14648
Source: State / UT Animal Husbandry Departments			

Table No.4 No. of Desi ducks and average egg yield per annum in India (1999-2008)

Year	No. of layers (000 Nos)	Average yield per annum (Nos)
1999-2000	11142	117
2000-01	11480	112
2001-02	11569	108
2002-03	12329	109.15
2003-04	12673	106.77
2004-05	12897	99.58
2005-06	13080	101.93
2007-08	11911	138.42
Source: State / UT Animal Husbandry Departments		

Table No.5 No. of Improved ducks and average egg yield per annum in India (1999-2008)

Year	No. of layers (000 Nos)	Average yield per annum (Nos)
1999-2000	611	182.28
2000-01	729	160.75
2001-02	959	132.40
2002-03	985	129.05
2003-04	849	161.16
2004-05	741	169.79
2005-06	686	171.86
2007-08	615	169.00
Source: State / UT Animal Husbandry Departments		

DUCK DEVELOPMENT PROGRAMMES IN INDIA

- Duck development programmes started on a small scale during the early 1960s.
- The Regional Duck breeding Farm at Haringhatta, West Bengal, was established in 1971 to popularize the improved varieties of ducks and to train the farmers for which, 3000 Khaki Campbell ducklings were imported from the United Kingdom. These superior egg-layers were distributed to states such as Assam, Andhra Pradesh, Haryana, Jammu and Kashmir, Kerala, Orissa and West Bengal.
- In 1976, the Regional Exotic Duck Breeding farm was established near Agartala (Tripura) and in 1981, 2978 Khaki Campbell ducklings were imported from the United Kingdom.
- The duck farm established at Sumbal-Kashmir, was then developed into a modern duck breeding and hatching facility for Khaki Campbell and White Pekin Ducks.

- The Kerala state government has established a modern duck-breeding farm at Thiruvalla in addition to the farm at Niraman.
- Duck-breeding farms were established in the West Bengal and Sipajhar regions of Assam, to boost the economy of the weaker sections of the rural community.
- In 1986 the Tamil Nadu Agricultural University established two Duck Research and Development Centres at Kattupakkam and Trichy in Tamil Nadu.
- The Indian Council of Agricultural Research (ICAR) has established a National Research Centre, at Bhubaneswar, Orissa, for the improvement of duck production, by studying the adaptability of exotic duck breeds under Indian agro-climatic conditions.
- National Agricultural Technology Projects, ICAR has sanctioned projects on "Productivity Enhancement of Ducks" in Kerala, Tamil Nadu, Andaman and Nicobar.
- Under NATP, Agricultural Technology Management Agency (ATMA) hatching eggs and duckling to the farmers of Yerukala farmers in Singarayakonda Mandal in Andhra Pradesh.

BREEDS

India has 24 breeds and 34 varieties of local ducks. While there are several small sedentary groups of breeders, nomadic duck herders keep moving their herds in a cyclic fashion from one region to another, depending on the amount of feed available, on rainfall and cropping patterns.

In India, 90-95 percent of ducks and indigenous or non-descript types, which are hardy, with mediocre egg production and highly suitable for extensive system of rearing. The important Indian breeds are Sythet mete and Nageswari of eastern region, Aarani ducks of Tamil Nadu, Chara and Chemballi of

Kerala, desi breeds of West Bengal and other states. Apart from these, distinct local varieties have also been identified. Pati, Deo, Cinahanh and Raj Hanh are local indigenous breeds found in Assam.

Nageswari

. Nageswari ducks are also called "Nagi", the snake deity, may be due to its head-high snake like posture with a white stripe in the neck extending up to the breast and for the eggs which have a bluish tinge. The Nagis are also called White Breasted Nageswari.

Chara

Drakes are squat in posture. Head is lustrous greenish black and neck is brownish black plumage with full or half white band on the front. Bill and feet are orange. Body weight at 20 weeks is 1.6 kg. Head is brownish black, back and tail is brownish black and breast is brownish black. Bill is yellowish black and feet are orange. Body weight at 20 weeks is 1.5 kg.

Chembally

Drakes are squat in posture and gait. Head is dull greenish black, neck is brown with full or half white bands and back is brownish black. Bill is yellow with black spot and feet is bright orange. Body weight at 20 weeks is 1.6 kg. Head is primarily brownish black, neck is brown with or without white bands and back is brownish grey. Breast is light brown or brownish black. Body weight at 20 weeks is 1.5kg.

Among improved varieties distinct breeds for egg and meat production is available. Khaki Campbell and Indian Runner are the most popular breeds for egg laying. White Pekin, Muscovy and Aylesbury are known for meat production. High-laying strains of ducks are available at the Central Duck Breeding Farm, Hessarghatta and Bangalore.

MEAT TYPE DUCKS

Pekin

These ducks originated in from cool climate of China and White Pekin is the most popular duck. The plumage is creamy white, the flesh is yellow and the bill and legs are deep orange. Early maturity, fleshing and good laying capacity is the special feature of this breed.

Rouen ducks

These birds originated from France. Once upon a time, this formed the basis (male line) for developing Campbell ducks. It is heavy breed; Good layer. Male duck is light grey with a green neck and the female is light brown like mallards.

White ducks

These are mainly through the crossing of White pekins and Aylesbury ducks.

Muscovy

This ducks comes originally from Central America. It is good for meat production. The male have no drake feathers and have a knob on the head like a crest. Because of its size and grazing behaviour, there is still a doubt whether Muscovy should be included in ducks and goose. If Muscovy is crossed with other ducks, the progeny will be "sterile" called Mule ducks having high growth rate and lean meat and meant for meat purpose. The incubation period is 35 days.

Ornamental type

Buff Orpington, Mandarin, Crested white etc. are ornamental type used for fancy purpose.

EGG LAYING BREEDS

Campbell

Campbell ducks were developed by Mrs. Campbell during the beginning of the 19th century by crossing Rouen (male line) with Indian Runner (female line) and later with wild mallards. Khaki Campbell is a variety resulting form color selection of the Campbell breed. The base color is Khaki and

drake is having lustrous green bronze color in head, neck up to sternum and the remainder body is of shades of Khaki and the duck is having uniform shades of khaki throughout the body which makes is useful for sex differentiation. The bill is dark and legs and feet are orange. The other varieties of Campbell like white and dark are less popular. Khaki Campbell is well suited to a tropical climate. It is capable to laying up to 250-300 egg per year. In Asia the breed is used for improving the productivity of local breeds.

Indian Runner

The Indian Runner or Runner ducks derives its name its place of introduction, East India. It is having perpendicular carriage, which is the out standing feature of this breed. It does not have pronounced shoulders and the body shape and carriage resemble the penguins. There are 3 standard varieties of Runner ducks. Indian Runner is also layer having an average record of more than 250 eggs per annum and is second only to Khaki Campbell

PRODUCTION SYSTEM

Migratory duck farming

Migratory duck farming is a method of duck farming practiced by the poor agricultural laborers in South India. Farmer starts duck farming during December by rearing ducklings. Ducklings were obtained from large farmers. By February as the harvest of second crop of paddy is over the laborers starts migration with the ducks.

The paddy cultivators of Tamil Nadu and Kerala generally welcome the ducks. The ducks feed on left away paddy grains on the field as well as snails and small fishes. Water stirring caused by the ducks activities inhibits the growth of weeds through photosynthesis reduction when the water becomes turbid. Their activities also enhance the rice root, stalk and leaf development, thereby accelerating rice growth. In addition, a reduced application of pesticides and fertilizers benefits the ecological system.

During night the ducks are stays on the fields. One or two hours after sunrise, the ducks are released, by which time egg laying is almost completed and eggs can easily be collected. Owners of the land are given duck eggs as remuneration. The ducks grows well by feeding on paddy fields and the fields in turn become fertile by duck castings.

Integrated Duck-fish farming

The waste from the duck shed can be recycled and may be used for fish culture in integrated duck – fish farming. This increases the production of natural food in the ponds, which inturn enhances the fish production. By integrating the duck and fish culture, more returns can be achieved. This gives the good benefits to the farmers. If the ducks are allowed to swim freely in the fishponds, the waste can be dispersed uniformly in the ponds and it can also be used as a good fertilizer. Because of these, expenses for fertilizer, feed, supplementary feed for fish is minimized. Since the ducks are in the fishponds, it prevents the growth of the aquatic weeds and increases the biological productivity of the ponds. Because of the swimming action of the ducks, the amount of oxygen in the ponds gets increased. Ducks eat the weeds, insects, larvae, worms etc present in the pond, hence there is no need to add more additional feed to them.

In duck - cum fish culture, fishes with 10 cm length only to be stocked. Because, fishes less than this length may be eaten by the ducks. Fish seeds can be stoked at the rate of 10000 Nos./ha. Depending upon the nature of the fishpond and the availability of fish seeds the stocking density may vary. Raising of ducks depends upon the type of the species and egg laying capacity. To get more meat and egg from the duck-fish culture, proper management plays a vital role. The shed should be well ventilated and stagnant of waste water should be prevented. For fertilizing 1 ha pond, 200 ducks are sufficient. Ducks

get their natural food from the pond itself. The domestic waste, rice bran, broken rice and pulses are more than enough for them.

ECONOMICS FOR 1 HECTARE INTEGRATED DUCK - FISH CULTURE SYSTEM

i). Capital Investment

Cost of construction of duck pen, pump set and inlet-outlet structure	**Rs. 50,000/-**
(a) Fixed costs	
Depreciation, insurance and labour cost etc.	**Rs. 35,300/-**
(b) Variable costs	
Pond preparation, cost of fish seed, cost of ducks and electrical expenses etc.	**Rs. 70,400/-**
Total costs (a+b)	**Rs. 1,05,700/-**
(c) Net returns	
Sale of fish, duck egg and culled birds	**Rs.1,76,500/-**
Net Returns	**Rs. 70,800/-**
	(US $ = Rs.45/-)

DUCK MANAGEMENT

Socio- Economic status

According to Zaman *et al*.(2005), Duck farming was a primary source of income for 28 % of the population in North – East India,where as it was a secondary source of income along with the agriculture for the rest of the farmers. In Kerala, mostly Christians were involved in duck farming and only 2 % were mot educated (Ravindran, 1983). Similarly, most of the farmers in Andhra Pradesh belonged to a backward class and economically poor were adopting the farming as a family profession
(Rithamber *et al* ,1986).

Housing system

Mostly ducks are produced in extensive or semi-intensive practices near ponds, lakes, streams, canals, because snails and fish can be acquired more easily.
Some environmentally controlled duck houses have been built in Taiwan. In India, ducks are normally raised in low-lying areas.

Feeding system

Most of the duck farmers fed with broken rice, rice bran, coconuts stem powder or similar products between hatching and 4 weeks of age. In some places ducklings are given sago and grains purchased from market as feed. According to Reddy (1987), the duck farmers in Tamil Nadu fed their ducklings different diets according to age. After that Insect, snails, kitchen waste, paddy grains and weeds are the food sources for ducks in addition to the feed received from foraging. The duck excreta become the fertilizer for the rice paddy.

Reddy (1987) reported main feeding source for adult ducks were post-harvested paddy fields for grains, ponds and waterlogged areas for fish, snails and insects. Duck farmers in Kerala, Andhra Pradesh and Tamil Nadu feed adult ducks with the mixture of locally available feed ingredients.

Table No. 6 Nutrient requirements of Ducks

Nutrient	0-2 weeks	3-7 weeks	Breeding
ME Kcal/kg	2900	3000	2900
CP %	22	16	15
Lysine %	0.70	0.65	0.60
Methionine %	0.40	0.30	0.27
Ca %	0.65	0.60	2.75
Phosphorus %	0.40	0.30	0.30
Vitamin A , IU	2500	2500	4000
Vitamin D_3, ICU	400	400	900
Vitamin E Mg	10	10	10
Vitamin K Mg	0.50	0.50	0.50
Riboflavin ppm	4	4	4
Pantothenic acid ppm	11	11	11
Niacin ppm	55	55	55
Pyridoxine ppm	2.5	2.5	3.0
(Adopted from Scientific Poultry Production by P.V. Sreenivasaiah, 2006)			

Production Performance

The flock size is generally estimated in dozens. The common unit size is 25 to 30 dozens maintained by a well trained team of two or three family members under free range system. It was noticed that the most of the farmers had flock size of around 200-400 (16-32 dozens) with the drake duck ratio of 1:12 (Gajendran *et al.,*1991).

Indigenous type kept for egg production on natural foraging and have a production potential of about 130-140 eggs/bird/year. However, the annual egg production under the nomadic system of rearing averages 180-200 eggs. The male-to-female ratio ranges from 1:15 to 1:25, but one drake for one dozen ducks results in good fertility. Indigenous ducks, the "Sythet mete" and "Nageswari" breeds, produce 200-220 eggs per year. Khaki cambel and crossbred ducks are start laying at an age of 20 weeks. On an average they lay more than 250 eggs annually. Vigova super-M duck is a dual purpose breed best suited for meat. Vigova duck will attain a body weight of about 3 kg at an age of 8 weeks.

Incubation

A mating ratio of 6-8 ducks per drake in layer breeding and 4-6 ducks in broiler breeding is advisable. Hatching eggs are to be collected 15 days after mating, will give better hatchability. The hatching weight of duck egg should be 70-75 g. Duck eggs are more porous, fumigation is advised only for 20 minutes after collection. The incubation period for duck egg is 28 days and for Muscovy duck egg is 35 days.

Hatching duck egg and selling ducklings (5 to 7 day old) to the needy farmers is being supplied by Agricultural Technology Management Agency (ATMA), under NATP. It became livelihood option of Yerukala farmers in Singarayakonda Mandal, Andhra Pradesh. Nearly 25 farmers operating duck hatching units in Singarayakonda mandal by procuring fertile duck eggs from East and West Godavari areas and hatching them in incubating racks (Locally designed by the farmers) for 28 days and rearing the ducklings for 5 to 7 days and selling them to the needy farmers of Andhra Pradesh and Tamilnadu.

The incubator is designed locally by the farmers @ Rs.7000/- per incubator of 8000 eggs capacity against an automatic incubator of 10,000 eggs capacity for Rs.1,20,000/- by reputed companies. The technical specifications are (maintenance of temperature, turning of eggs, five turnings

per day) accurately maintained by the farmers and hatching percentage is almost equal to automatic incubator (80 to 90 %) depending upon the fertility of the eggs.

Diseases of Duck

Important Diseases of ducks
Duck plague (Duck viral enteritis)
Duck cholera (Pasteurellosis)
Hepatitis
Botulism and
Aflatoxicosis

Reddy (1987) found that mortality was 10-15 % in ducklings and below 10 % in adults in the North Arcot district of Tamil Nadu. The health protection offered by the farmers included occasional vaccination against duck plague, treatment with common antibiotics and potash solution. Duck flocks were routinely vaccinated against duck plague in Kerala.

Credit facility and Marketing

Table egg production was the primary purpose of duck raising in Andhra Pradesh and Tamil Nadu where the eggs were sold to eggs dealers (Ramachandran and Ramakrishnan, 1982, Ravindran, 1983 and Reddy (1987). Duck farming was supplementary source of income to the farmers of Kerala (Ravindran, 1983), Andhra Pradesh (Rithamber *et al* ,1986) and Tamil Nadu (Reddy, 1987). These three states were financed by wholesale merchants.

Duck eggs produced in Kerala are sold to shops and households during migration. Since duck eggs are considered colder and soothing for diseases like piles, it has good demand and fetches at Rs. 4/-per egg.

Steps to Improve the Duck production

- Educate the duck farmers to follow scientific method of rearing.
- Educate the farmers on bio-security measures to avoid disease problems.
- Educate the consumer about nutritive value of duck egg and meat.
- To avoid the exploitation by middlemen, farmers should sell their products directly to the consumer.
- Quality duckling and feed should made available to the needy farmers.
- Organized marketing system should be developed to avoid fluctuation in price of the egg and meat.
- Credit and insurance facility should made available to the needy farmers.

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AQUA FORESTRY AND DUCK INTEGRATION IN TAMIL NADU

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Abstract

Integration of Ducks in fish ponds and plantation of short and medium duration varieties of plant/crop on the pond bunds may help the farmers to get higher income. A study was taken up on integration of ducks in Aqua forestry in private and community lands in Tamilnadu Veterinary and Animal Sciences University for a period of four years. In private land 33 beneficiaries in 50 Ha of land from nine Districts and 25 beneficiaries maintaining 50 Ha of community water bodies in eight Districts of Tamilnadu were selected to implement this model. 24 to 240 ducks were integrated per hectare of water body based on the water spread and availability of natural feed resources. The plantation grown on bunds was fodder, fruit, Coconut, Teak, Bamboo, Casurina, Tamarind trees and Vegetables. Performance of 10 aquaculture farms with at least one farm in each district where the duck integration was not taken up was collected to serve as field control. To serve as control a similar model was established in the University farm land with and without integration of ducks.

In private water bodies Coconut trees and Banana fetched additional revenue of Rs.7500/- and Rs.6000/- per Hectare per year respectively. During the first year the average fish production from the private land model was 1552 Kg and in the second year it went up to 1731Kg / Hectare while in community ponds the yields were 1610 and 1337 Kg for the first and second year respectively. In control farm with integration of ducks the revenue was higher by two folds over the control. In field control units there was no increase in fish yield over the years. This indicated that the integration of ducks had given added economic advantage to the farmers. In private and community water bodies 60 ducks could be stocked per ha for a period of 6 to 7 months and the remaining period the birds have to be hand fed or allowed for foraging in the post harvested paddy fields. In private land the beneficiaries from Thanjavur District got highest egg yield of 148 eggs per bird per year and the lowest was in Tiruvallur District with 90 eggs during the first year of laying. In the second year of laying also the farmers at Thanjavur obtained 118 eggs per bird followed by Villupuram and Kancheepuram Districts. In community water bodies at Thanjavur district the maximum egg production of 144 eggs per bird followed by Kancheepuram district with 127 eggs per bird. This model of aqua forestry with integration of ducks and plantation was found to be more sustainable for the local fish farmers.

Introduction

Under Indian conditions the demand for green fodder is high and it is time to convert the waste lands and marshy lands for fodder cultivation to tide over the situation. Many models such as Agrisiliviculture, Agrisilvipasture, Hortipasture, Hortisilvipature, and Silvipasture are in vogue. Many of these systems have long incubation period for generation of income to the practicing farmers. Under agro forestry system aqua forestry is one of the accepted models.

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Key words: Aqua forestry, duck integration, Plant integration, duck egg production

In this system trees are planted on the banks of fish ponds or lakes or reservoirs. Fish harvest takes at least six to one year time and trees will fetch revenue after five to ten years of time only. This model is seldom practiced and has not come to the notice of private fish farm owners for adoption. The land owner suffers from want of money for his day to day requirements even after possessing water

bodies or marshy/swampy land or hiring out of community ponds or lakes or reservoirs. Integration of Ducks in fish ponds and proper planning of planting some of the short duration crops mixed with medium duration varieties of plant may help the farmers and women to get better economic returns. This will not only generate employment through out the year but also provide quick returns, enrich soil, control soil erosion and bring about more economic sustainability. Addition of organic manure increases soil porosity and retention of moisture. Much research work has been carried out on various agro forestry models with integration of Livestock but the work on domesticated birds in agro forestry system is scanty.

Present scenario of duck farming:

Many landless poor farmers rear their ducks in lakes, ponds and reservoirs; post harvested paddy fields for meeting their feed requirements to get egg production. The duck growers mostly prefer to stay in water logged areas for a longer duration to get better foraging facilities. When the water gets depleted they start migrating in search of post harvest paddy fields or water bodies. They migrate miles at a stretch in search of post harvested paddy fields thus leaving the family in lurch.

They may become bankrupt also in due course and become bonded slaves for life to the egg marketing people who advance money for rearing their birds and earn revenue. A sustainable model of this type is essential at present.

Materials and Methods

A study was taken up on Integration of ducks in Aqua forestry in private and community lands in Tamil Nadu Veterinary and Animal Sciences University with the objective of

- To establish duck rearing in aqua forestry to suit the private and community water bodies in Tamilnadu
- To study the problems and advantages of duck cum fish farming for generating better income to the farmers.

In private land a total of 33 beneficiaries practicing fresh water fish farming were selected from nine Districts of Tamilnadu (Chennai, Kanchepuram, Virdhachalam, Thanjavur, Ramanathapuram, Tiruvallur, Vellore, Madurai and Villupuram) for implementation of model. The details of beneficiaries and the area of fish farm and duck integration are shown in Table 1.

Table 1. District wise distribution of beneficiaries for implementing duck rearing in aqua forestry system in Private Water bodies

S.No	District	No. Beneficiaries	Area of Farm (Ha)	No. Ducks integrated/Ha of pond (Range)
1	**Chennai**	2	2.75	156 (60-96)
2	**Kanchepuram**	8	12.95	792 (24-240)
3	**Virdhachalam**	3	4.5	302 (96-120)
4	**Thanjavur**	10	15.15	912 (24-120)
5	**Ramanathapuram**	1	0.4	12
6	**Tiruvallur**	1	1.0	60
7	**Vellore**	6	11.75	660 (72-120)
8	**Madurai**	1	1.0	60
9	**Villupuram**	1	0.5	24
	Total	**33**	**50**	**2978 (24-240)**

The ponds where fish was grown for a period of 6 months and above only were taken for the study. In Tamil Nadu the varieties prescribed to be grown in composite fish culture were Rohu (*Labeorhita*) Mirgal (*Cirrhina mirgala*) Catla (*Catla catla*) Common Carp (*Cyprinus carpio*) Silver Carp (*Hypophthalmichthys moliotrix*) and Grass Carp (*cteno pharyngodanidella*). A total of 50 Ha water bodies owned by private land owners were identified to establish this model where the fishing operation alone was in progress. Number of ducks integrated per hectare (Ha) of water body ranged from 24 to 240 based on the water spread and availability of natural feed resources. When the ponds were dug for growing of fish a depth of 1.5 metres was taken at the centre and about 1 metre at the sides. The dug up soil was made use of for the formation of bunds. The width of the pond bund varied from 0.5 to 1.0 meters depending up on the size of the pond. Approximately one fifth of the land was utilized for the formation of pond bunds. In one acre of pond area 20 cents was utilized for the formation of the bund. This land mass was lying fallow and was utilized for the development of aqua forestry model. The pond owners who were having small and large ruminants were interested to rear grass and fodder trees and others were interested in fruit trees and vegetables. Most of the fish growers planted coconut trees (*Cocos nucifera*) on the pond bunds. The total plantations that were taken up in 50 Ha of pond bunds in private lands were

Fodder - *Albezia lebeck* (300), Neem (*Azardica indica*) (1000), *Erythrina indica* (4000), *Glyricidia sepium* (3000), Jamun (*Syzygium cumini* 150), *Thespesia populena* (100) and *Pithcolumbium dulce* (150) **Fruit trees -** Coconut (600), Mango (1000), Guava (600), Pomegranate (600), Acid lime (500), Anona (500), Jack fruit tree (100) and Pappya (1000) **Timber and fodder trees -** Teak (150), Bamboo, Casurina, Tamarind (150) and Prosopis (600) **Vegetables seeds:** Tomato, Water melon, Pumpkin, Brinjal, Drumstick, Yam, Okra and Spinach **Grass slips or seeds -** Para grass, Guinea grass, Napier X Bajra hybrid, Desmanthus (5Kg), Stylo haemata (10Kg) and *Leuceana leucocephala* (25Kg) Similar model was implemented in community water bodies such as lakes and reservoirs and ponds in eight Districts of Tamil Nadu viz. Kanchepuram, Chennai, Tiruvallur, Ramanathapuram, Vellore, Thanjavur, Thoothukudi and Pudukkottai. Most of the lakes and reservoirs were leased out by the Panchayats and the similar type of fishes culture mentioned for the private ponds was stocked and reared. After a period of 6 to 8 months or till the water was available in the water bodies it was reared and then harvested. The details of beneficiaries' number and the area of pond or lake and duck number integrated are furnished in Table 2.

Table 2. District wise distribution of beneficiaries in community water bodies

S.No	District	Beneficiaries (No)	Area of Implementation (Ha)	No. of Ducks/Ha integrated
1	Chennai	10	28.75	24-120
2	Kanchepuram	7	6.75	24-96
3	Tiruvellore	3	3.25	6-24
4	Ramanathapuram	1	0.4	60
5	Vellore	1	1.25	58
6	Thanjavur	1	1.1	76
7	Thoothukudi	1	7.5	10
8	Pudukkottai	1	1.0	36
	Total	25	50.0	6-120

A total of 25 beneficiaries were selected who have taken community ponds or lakes on lease in eight Districts to implement this model. The pond bunds of the community water bodies were utilized to grow Neem, Palmyra, Prosopis, Eucalyptus, Coconut, Mango and Guava. The pond bunds are used as path way for the villagers to reach their fields and the fruit saplings planted were destroyed. Due to this reason many beneficiaries preferred to grow timber, fuel and fodder trees on the pond/lake bunds. *Cencrus ciliaris* seeds were sown on the pond bunds during monsoon rains. This model was primarily developed to utilize the partial waste land in pond bunds and dykes for cultivation of trees to reduce soil erosion. In community lakes/ponds seventeen of the beneficiaries were from Chennai and Kanchepuram Districts. This is due to availability of Community ponds/lakes under the control of Fish farmer's development agency (FFDA). The FFDA supplied fingerlings and also helped in rearing and marketing of fish. Out of the allotted 50 Ha of land 30.5 Ha was identified in Chennai and Kanchepuram Districts. Remaining 14.5 Ha was distributed among Thoothukudi (7.5Ha) Tiruvallur (3.25Ha) Ramanathapuram, Vellore, Thanjavur and Pudukkottai (3.75Ha). When selecting the beneficiaries the area of water body in the lake during the peak summer was taken as the area of implementation. Based on the area ducks were distributed as shown in table 1 and 2 in private and community water bodies respectively. The number of birds was finalized with the spread and depth of water and its duration of for fish culture. Yadava and Bhatnagar (1992) observed that 100 ducks per hectare of water body would be needed to excrete duck droppings (6000 Kg/ha/yr), to meet the 'safe' level dose of the duck wastes for one year. Experiments conducted at fish ponds indicated 100 percent recovery of test fish from duck waste treated water and the estimated net and gross fish production were high. We collected performance of 10 aquaculture farms with at least one farm in each district where the duck integration was not taken up. To serve as control a similarly model was established in our University farm in 0.5 Ha land with integration of ducks and with out integration of ducks.

Results and discussion:

The private land beneficiaries from Vellore, Ramanathapuram and Tiruvallur were able to maintain the ducks for a period of 6 to 7 months only while other Districts farmers were able to maintain the birds in their ponds from 8 to 15 months period. This is due to shortage of water as they are highly drought prone Districts. Hence the ducks had to be taken for foraging in the post harvested paddy fields and nearby marshy lands and also migrated to nearby Districts or States in search of foraging facilities. Some of them had to adopt hand feeding of ducks with paddy chaff and broken grains and had to invest lot of expenditure. Coconut trees started fetching revenue from fourth year onwards. Each tree fetched more than 80 to 90 nuts per year. In every hectare of pond bunds about 40 trees were grown and fetched around 2500 nuts per year and added to their revenue to a tune of Rs.7500/- Many farmers have grown Banana (*Musa paradisiaca*) on the pond bunds. In each hectare of water body around 60 banana trees were grown. They were able to make money through the leaves, fruits and flower every day. The torn leaves also were used for feeding the Grass Carp fish and nothing was wasted from Banana crop. From each plant a revenue of Rs.100/- and around Rs.6000/- was earned from 1 Ha of pond bunds. Growing of Mango (*Mangifera indica*), Pomegranate, Guava (*Psidium guajava*), Acid lime (*Citrus aurantifolia*) were also taken up by many fish growers. Pomegranate tree had low survivability in the study area. Some fish growers at Kanchepuram District had preference for growing vegetables on the pond bunds like Water melon (*Citrus lanatus*), Tomatoes (*Solanium lycopersicum*), Cucumber, Pumpkins (*Qucurbita maxima*), Brinjal, Drumstick (*Moringa oleifera*) and spinaches. This gave additional revenue besides use of the vegetables for their home consumption.

Some farmers in community ponds and reservoirs planted teak on the pond bunds for long term benefits. These saplings had more than 90% survivability upto three years of age and have grown to three metres height. Similarly those maintaining small ruminants had grown Neem and *Albezia lebbeck* and these tree saplings had good survivability up to three years and had grown up to three metres height with good canopy cover. Integration of ducks in aqua forestry model has its own advantages as there was daily

income from eggs for the farmers. In addition to yield from fruit bearing trees, no soil erosion from pond bunds was observed. Addition of organic manure to the pond helped in the development of phytoplankton (*diatomacce, Chlorphycea and Myxophycea*) and zooplankton (*rotifers, cladocerans, Copepods* and their larvae) which served as fish feed. Due to paddling of webbed feet of ducks there was increase in oxygen level in water body which helped in better growth of fish. Integration of ducks eliminated snails, crabs, trash fish earth worms and aquatic weeds from water bodies. Growing of Para grass and Guinea grass had served as feed for Grass Carp fish. Seedlings of Subabul were twined at early age and grown on the pond bunds and this method had served as live fence for protection fish against poaching. Growing of fruit bearing trees and vegetables had attracted women to take part in cultivation and also for plucking the fruits and spinach from their own land. Many farmers realised the importance of growing fodder grass by using the pond bunds for feeding Grass Carp fishes and also for their large and small ruminants and has started growing them on pond bunds. The Para grass (*Brachaiaria mutica*) variety was able to survive and gave good yield in the stagnant water also. When the pond was partially dry the grass seeds were sown and thereby good growth was noticed in a period of one month. This grass was consumed by Grass Carp fingerlings as soon as it was stocked in the ponds.

This grass grows through out the year on self seeding and had grown on bunds and was continuously providing yield for the fish and also for other Livestock. This grass cultivation has controlled the soil erosion from pond bunds too. Those who had established this grass on their pond bunds had not incurred expenditure on strengthening of the bunds for more than four years. On the outer side of the bund the Napier X Bajra grass and Guinea grass were cultivated. From each acre of pond area about 3 – 5 tons of grass was cultivated per year thus providing green biomass to the fishes and Livestock continuously. Due to planting of vegetable and fruit trees in private water bodies and rearing of ducks the fish farmers engaged labourers to look after them. They found women were more responsible in collection of eggs and plucking of fruits and vegetables than men labourers. One of the beneficiaries had grown jasmine plants on the pond bunds and engaged the women to pluck flowers daily for marketing. Another one had utilized his barren water pond for six months to grow chilly crop as it had enough natural manure by integration of duck in the farm. This model has provided employment opportunity, additional income through eggs, duck meat, fruits, vegetables, nuts, flowers, and a major harvest of fish once in a year. A mixed enterprise had improved the productivity and profitability besides transforming the ecology with synergistic interactions among different farm enterprises. This type of farm had provided a sustainable integrated resource management approach for livelihood security for small and marginal farmers.

The community lake/pond owners planted fodder fuel and timber varieties only on the bunds as the income was useful to the community but not to the fish growers as the lake/ Reservoir can be utilized for the leased period of one or two years only. They also could not engage any labourers to look after and protect the saplings. Some additional advantages noticed were the soil pH came down from 8.0 to 7.6 after implementation of this model which is more conducive for fish growth in community as well as in the private water bodies. Problems of crabs, snails, trash fish and toads were effectively controlled.

During the first year the average fish production from the model developed by private farmers was 1552 Kg and in the second year it went up to 1731Kg. The fish harvest was higher in II and III year of production which may be due to higher residual manorial quantity, higher natural feed from planktons and higher availability of oxygen to fish in the ponds as seen in Table 3.

Table 3. Production and income generation from duck integrated aqua forestry farm in private lands

Districts	Fingerlings stocked (No)/Ha		Culture Period (Months)		Feed Expenses for Ducks and Fish (Rs)		Fish Produced (Kgs)		Receipt (Rs)	
Years	I	II	I	II	I	II	I	II	I	II
Chennai	4000	4000	15	12	8000	8800	1900	3000	47500	75000
Kancheepuram	4000	4000	8	9	10333	11218	1250	1557	31250	38925
Virdhachalam	6000	6000	8	10	21650	21930	2600	2742	65000	68550
Thanjavur	4000	4000	13	12	22780	27060	2170	2830	54250	70750
Ramanathapuram	1600 /ac	1600 /ac	5	6	12000	12500	600	770	15000	19250
Tiruvellore	4000	4000	8	9	19333	18218	1450	1657	36250	41425
Vellore	-	4000	-	7		12000		1500	-	37500
Madurai	-	4000	-	11	-	16720	-	1900	-	47500
Villupuram	-	4000	-	7	-	12000	-	1450	-	36250
Total	4333	4222	8.1	9.2	15682	16193	1552	1731	38800	43275

In community ponds the average fish yield was 1277 Kg during the first year and during the second year was 1624 Kg only even though the feeding expenditure was almost same (Table 4). Here also the fish production increased in the second year as seen in the private water bodies even though there was poaching problem in the community lakes and reservoirs.

Table 4. Fish production in Community Water bodies (Per Ha)

S. No	District	Fish Stocked (No)		Culture period in Months		Duck and Fish Feed Expenses (Rs.)		Fish Production (Kg)		Recipts (Rs)	
		I	II	I	II	I	II	I	II	I	II
1	Chennai	4000	5000	13	7	2466	3000	1505	1671	37625	41775
2	Kancheepuram	4000	4000	6	7	2711	2786	1215	1600	30375	40000
3	Tiruvellore	4000	4000	9	9	3127	3865	1715	1600	42875	40000
4	Ramanathapuram	4000	-	6	-	2000	-	1200	-	30000	-
5	Vellore	4000	-	7	-	2000	-	1000	-	30000	-
6	Thanjavur	4000	-	7	-	2400	-	1000	-	30000	-
7	Thoothukudi	4000	-	6	-	2460	-	1800	-	45000	-
8	Pudukkottai	3000	-	6	-	1700	-	700	-	17500	-
	Average	3875	4333	7.5	7.6	2376	3217	1277	1624	32922	40592

The private ponds where there was no integration of ducks was taken up there were no increase in fish yields over the years although the expenditure was almost same (Table 4). The second year average ield of fish was higher over the first year and the receipt also increased. The fish culture period also increased by more than a month during second year and consequently the feeding expenditure too increased. The fish production increased in integrated duck cum fish farming due to addition of duck manure and oxygen in
water in private water bodies in all the Districts studied. The increased receipt is shown in Table 3. When the culture period was increased the yield of fish also increased. It may be concluded that based on the
marketing preference of big sized fish the remuneration from fish is more. This can be seen from those units where the ducks were not integrated and the profit margin decreased in the same Districts reared for almost the same period (Table 5)

Table 5. Production and income generation from private aquaculture farm without integration of ducks in private lands (Per Ha)

District	Fingerlings stocked (No)			Culture Period (Months)			Fish Feed Expenses (Rs)			Fish Produced (Kgs)			Receipt (Rs)		
Years	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Chennai	4000	5000	-	14	12	-	6000	7000	-	1750	2000	-	31500	36000	-
Kanchee puram	4000	4000	-	8	8	-	10000	10000	-	1000	1100	-	15000	16500	-
Virdhac halam	6000	6000	-	8	9	-	20000	20000	-	2000	2000	-	40000	40000	-
Thanjav ur	4000	4000	-	10	11	-	20000	20000	-	2100	2000	-	42000	40000	-
Ramanat hapuram	-	4000	-	-	6	-	-	10000	-	-	300	-	-	6000	-
Tiruvell ore	4500	4500	-	8	9	-	20000	20000	-	1200	1500	-	26400	33000	-
Vellore	-	5000	5000	-	6	6	-	20000	20000	-	1000	1200	-	37000	36000
Madurai	-	4500	-	-	10	-	-	4000	-	-	800	-	-	24000	-
Villupur am	-	-	4000	-	-	7	-	-	4000	-	-	400	-	-	10000
Total	**4500**	**4625**	**4500**	**9.6**	**8.8**	**6.5**	**15200**	**14000**	**12000**	**1610**	**1337**	**800**	**30980**	**29062**	**23000**

The fish production did not show any increase when there was no integration of the ducks in private water bodies. When the ducks were integrated in fish ponds the fish growth was good. This indicated that the integration of ducks had given added economic advantage to the farmers. This was again proved in an experimental condition at Livestock Research station with 1.25 ac of pond area with integration of ducks where the revenue was higher by two times over the control with out integration of ducks (Table 6).

Hu and Yang (1984) reported that input-output relationship, integrated fish farming with ducks is considered to be the best model of integration. In the case of integrated fish farming with chicken, there is no "symbiotic relationship" which exists in the case of geese, but the quantity of goose eggs produced is comparatively small and the market demand is low. Hence, fish-cum-duck farming not only had the best economic benefits but also demonstrated a close integrated relationship. When compared with the fish-cum-cow integrated farming, the economic efficiency is higher in the former. Anon (2009) reported that duck cum fish culture using Khaki Campbell ducks in the integrated system has produced 270 eggs per duck/yr and 6000 kg fish/Ha/yr and without addition of any other fertilizer in the pond. The Assamese State census revealed that the number of ducks required to fertilize a hector of water spread area is a matter of consideration. One duck voided about 125- 150 g excreta in a day. Therefore by stocking 250- 300 ducklings/ Ha water spread area the required quantity of duck excreta, i.e. 10000-15000 kg/ year / Ha water spread area, can be received. So it has been found that about 200- 300 ducks/ Ha water spread area is sufficient to produce manure to fertilize a pond of 1 Ha water spread area under fish culture. The deviation in different stocking density of ducks in the present study may be due to the period of the study and the natural feed that gets accumulated in the water bodies. The difference in the duck egg yield may also be due to the breed of ducks reared and the availability of feed to them. Bhagaban Kalita (2006) observed that out of the varieties of ducks studied such as Nageswari, Sylhet Meat, Indian Runner and Sera Chameli the Khaki Campbell crossed with local Pati variety had higher production performance in condition prevailed at Assam State condition. By duck integration a production of 3500-4000 kg of fish, 18000-18500 eggs and 500-600 kg duck meat from 1 Ha of pond area in 1 year without any supplementary feed and fertilizers was obtained. In the present study the yield was low than that reported which may be due to the breed, feeding, age of the bird, fish varieties stocked and feeding of fish followed.

Thanjavur beneficiaries owning private water bodies could get highest egg yield of 148 eggs per bird per year and the lowest was in Tiruvallur District with 90 eggs during the first year of laying. This difference was due to availability of water for 10 months and availability of natural vegetation for grazing by the birds in Thanjavur District and only 6 months at Vellore District. In then second year of laying also the farmers at Thanjavur had 118 eggs per bird followed by Villupuram and Kanchepuram. The district wise duck egg yields in private water bodies is given in Table 7. The duck egg yield in the community water bodies integrated with ducks is presented in Table 8.

Table 6 Production performance of Composite Fish culture with integration of ducks at Livestock Research Station (Control farm)

S.No	Parameter Studied	Control				Treatment			
	Year	I	II	III	IV	I	II	III	IV
1	**Water Spread area (ac.)**	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
2	**Water level (ft)**	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5
3	**Fish Culture period (days)**	197	134	135	145	197	134	135	145
4	**Total feed issued to fish (Kgs)**	84.5	75.0	100.0	100.0	-	-	-	-
5	**Fingerlings stocked (Nos.)**	5000	5000	5000	5000	5000	5000	5000	5000
6	**Average initial weight of Fingerlings (g)**	0.82	0.96	0.76	0.66	0.82	0.96	0.76	0.82
7	**Harvest weight (g)**	60	164.8	173.75	156.25	80	194.2	258.75	253.75
8	**Total No. of Fish harvested**	1777	2000	2220	1610	2235	2270	2635	2120
9	**Total Harvest (Kg)**	81.3	306.0	257.75	245.7	169.25	347.7	592.65	521.00
10	**Survival Percentage**	35	39.4	33.0	32.75	44.51	44.56	47.0	41.5
	Total receipt(Rs)	**1041.00**	**4040.50**	**4810.75**	**3439.50**	**2188.75**	**4807.50**	**8265.75**	**7492.50**

Table 7 Duck egg production under integrated farm in private water bodies

S.No	District	No. of beneficiaries	Area (Ha)	No. of eggs produced Per bird/Year		
				1994-95	**1995-96**	
1	Chennai	2	2.75	107.0	67.0	
2	Kancheepuram	8	12.95	127.0	90.0	
3	Virdhachalam	3	4.5	101.0	97	
4	Thanjavur	10	15.15	148.0	118.0	
5	Tiruvellore	1	1.0	90.0	82	
6	Vellore	6	11.75	91.0	-	
7	Madurai	1	1.0	-	70.30	
8	Ramanathapuram	1	0.4	90.5	70.0	
9	Villupuram	1	0.5	-	97.0	
	Total/Average	**33**	**50.0**	**110.6**	**86.41**	

Table 8 Duck egg production in community water bodies

S.No	District	No.Beneficiaries	Area of Implementation (Ha)	Duck egg production (Nos.)			
					1995-96	1996-97	1997-98
1	Chennai	10	28.75		120	90	70
2	Kancheepuram	7	6.75		127	90	69
3	Tiruvallur	3	3.25		70	-	-
4	Ramanathapuram	1	0.4		70	55	-
5	Vellore	1	1.25		125	105	-
6	Thanjavur	1	1.1		144	120	-
7	Thoothukudi	1	7.5		90	70	40
8	Pudukkottai	1	1.0		70	40	-
	Total	**25**	**50.0**				

In Thanjavur district the maximum egg production of 144 eggs per bird was recorded followed by Kancheepuram district with 127 eggs per bird. During the monsoon rains heavy inflow of trash fish was found in community ponds and these trash fish served as a good source of feed for ducks. After the harvest of fish the trash fish in the slushy water were consumed by scavenging by the ducks and the egg production was good. The beneficiaries did not show interest to feed the ducks with concentrates except for paddy chaff unlike the beneficiaries of private ponds. The community pond owners were allowing the birds for foraging in the nearby post harvested paddy fields when the water bodies dried up. The beneficiaries could maintain the birds for about three years in these two Districts. The lowest fish yield was at Pudukkottai District which is due to short period of culture maintenance. The yield from fish was also increased as the years passed by in Chennai and Kanchepuram. In other Districts the fish culture and integration was not done for the entire period due to shortage of water. The second year average yield of fish was higher over the first year and the receipt also increased in community lakes also. The fish culture period was almost same during second year the feeding expenditure was increased due to more enthusiasm and planning to achieve higher gains.

The pond bunds of the community water bodies were utilized to grow Neem, Palmyra, Prosopis, Eucalyptus, Coconut, Mango and Guava. The pond bunds are used as path way for the villagers to reach their fields and the fruit saplings got destroyed. Due to this reason many beneficiaries preferred to grow timber, fuel and fodder trees on the pond/lake bunds. Cencrus ciliaris seeds were sown on the pond bunds during monsoon rains and within a months time there was good growth of green cover. This grass was consumed by grass carp fish and had put on good weight. In addition to manuring by the birds the villagers bring their cattle for bathing and also allow their black cattle to wallow in the ponds and lakes which added manure to the water body continuously. This had resulted in the fish getting adequate amount of natural flora and fauna for meeting their feed requirements. The production performance of composite fish culture with integration of ducks at our control farm is given in Table 6. The fish harvest was higher in the integrated system and thereby high receipt was earned. The survival rate of fingerlings also showed remarkable improvement showing better ecology created by the integration of ducks in aquaculture.

Conclusion: In private and community water bodies 60 ducks could be stocked per ha for a period of 6 to 7 months and the remaining period the birds have to be hand fed or allowed for foraging in the post harvested paddy fields. Ducks have to be fed with concentrate feed at 50- 100 g per day containing grains 50 percent Gingelly oil cake or Sun flower oil cake 25 percent Wheat bran 20 percent Mineral mixture 3 percent and Shell grit 2 percent for continuous laying. In addition they can be fed with paddy chaff ad libitum. Birds can be maintained up to two years of age and later on had to be replaced with young stock for maintaining good egg yield. Under private water bodies Coconuts and Banana plantation gave highest profit in short span of time. Mango Guava and Pomegranate growing was not advantageous.

Guinea grass and Para grass got established on the pond bunds in private water bodies and avoided soil erosion. In community water bodies' cenchrus ciliaris grass and para grass got established well. Under composite fish culture the lowest preference was for Common Carp and Silver Carp fishes. Other fishes had good acceptance. Common Carp and Silver Carp could fetch only Rs.20/- per Kg while other fishes such as Mirgal, Rohu, Catla and Grass Carp could fetch Rs.30 to 35/- per Kg.

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FARMING SYSTEM OF CHARA-CHEMBALLI DUCKS IN NORTH -EASTERN INDIA (ASSAM)

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An investigation was undertaken to study the farming system of Chara- Chemballi ducks in North- Eastern part of India (Assam). For this, a total of 2352 Self-Help Groups (SHGs) comprising of about 24055 women beneficiaries were taken. These groups maintained above stated ducks which were native of Kerala state under the agro climatic condition of Assam in the year 2003-2008. A total 120 respondent were selected randomly covering 12 villages and 24 SHGs within four districts of Assam, i.e., Kamrup, Darrang, Jorhat and Dibrugarh. Result of the study in respect of socio economic status of the farmers, husbandry practices, managemental and feeding practices, incidence of diseases, mortality pattern and health protection programmes, marketing, finance and average annual income from the flocks are highlighted.

Key Words: Farming System; Chara- Chemballi ducks; North East India

Introduction:

North– eastern India is diverse in the field of Agriculture and animal husbandry with different genetic groups of livestock and poultry (Zaman *et al*., 2005). The state of Assam belongs to this region and is famous for different varieties of indigenous ducks reared by farmers under traditional system of rearing (Islam *et al*., 2002). Among these *Pati* (85.6%) constitute major duck population of the state (Mahanta *et al*., 2001 & Islam *et al*., 2002). This desi duck is poor in egg production with an annual egg production record of 80-90 per duck (Islam *et al*., 2002). In order to improve duck egg production and profitability, the State Institute of Rural Development (SIRD) under the Panchayat and Rural Development Department, Govt. of Assam introduced native Chara-Chemballi ducks of Kerala state in the year 2003 in selected clusters of villages of the state to give a new face to the traditional activity of duck rearing under range condition. At present, a total of 2352 Self Help Groups (SHGs) comprising of about 24055 women beneficiaries have been maintaining Chara-Chemballi ducks for feasibility studies and performance evaluation under the agro climatic condition of Assam (Anon, 2007-08).The studies showed that the agro-climatic condition of Assam is one of the best suited areas for the Chara- Chemballi ducks. It has been reported that the average annual income of 1600 SHGs was Rs. 9.60 crores with more than 2 lacs of egg production through backyard duck farming (Anon, 2005-2006).

The present study examines the farming system of Chara-Chemballi ducks in respect of the socio-economic status of the farmers, husbandry practices, managemental and feeding practices, incidence of diseases, mortality pattern, health protection programmes, marketing, finance and average annual income from the flock of the area under study.

Survey Procedure

The survey was conducted in four districts namely Kamrup, Darrang, Jorhat and Dibrugarh where Chara-Chemballi ducks were supplied to the women SHGs under Govt. sponsored project. The primary data were collected through direct contact with the leaders of the SHGs. The survey was conducted in 12 villages of four districts. In each district three villages were selected and in each village two SHGs were selected for the study. Five respondents were selected randomly from each SHG and thus a total of 120 farmers were selected by adopting the probability proportionate size sampling technique of Lahiri (Snedecor and Cochran, 1989). The required information were collected through a structured schedule (questionnaire) which was developed and administered for this purpose, by personal interview with the owner and the secondary sources like records and registers. The data collected were then compiled, computed and tabulated by using standard procedure.

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Results and Discussion:

SOCIO ECONOMIC STATUS OF THE FARMERS:

Duck farming was a primary source of income for 20.4% of the population under study, whereas it was a secondary source of income along with the agriculture for the rest of the farmers. Of the 120 respondents in the survey, the percentage of marginal (land holding of < 2 acre), small (2-5 acre) and medium (5-10 acre) farmers was 44.2, 53.2 and 2.4 respectively. About two third of farmers were educated up to class five standard and the others were educated up to the higher secondary level.

n the earlier survey on duck farming in North eastern India, Zaman *et.al.* (2005) reported two third of the farmers as illiterate whereas, Islam *et.al.* (2002) recorded one third as illiterate.

HUSBANDRY PRACTICE

Flock Size:

The average number of Chara-Chemballi ducks in small (1 to 15 Nos.) and medium (16 to 25 Nos.) flocks was 30.6 and 69.4 respectively. The overall average flock size was 14.25 with a range of 6 to 25. Earlier, much larger flock size of 5-100 (Mahanta *et al.,* 2001) and 20-200 (Islam *et al.,* 2002) have been reported in local ducks of Assam.

Sex ratio for breeding :

Farmers maintained a male and female sex ratio of 1: 5 to 1: 7. Similar sex ratio of 1:5 to 1:6 was recorded by Mahanta *et.al.* (2001) and Zaman *et.al.* (2005) in local ducks of Assam.

Incubation practice

The Chara-Chemballi ducks were generally hatched during the month of April – May, whereas April – July was recorded for Nageswari and Pati ducks of Assam (Islam *et al.* 2002 and Zaman *et al.* 2005). The average hatchability percentage on total egg set was found to be 81.74% in Chara-Chemballi ducks under natural incubation using broody hens or ducks. In similar type of survey, Zaman *et al.* (2005) found lower hatchability (55-63 %) in Nageswari ducks of Assam.

MANAGEMENTAL AND FEEDING PRACTICES

Ducklings

The Chara-Chemballi ducklings were kept in confinement in bamboo basket up to the age of 3-4 weeks. In day time they were kept in day light with some artificial barriers to protect from the predators. At night the ducklings were sheltered inside dwelling house of the farmers or some times they were kept in specially designed shed. Zaman *et al.* (2005) also reported similar type of husbandry practices in local ducks of Assam. Artificial heating system in the form of electrical or kerosene lamp was used at night, especially in winter season to protect them from extreme weather up to 3-4 weeks of age. Nind and Tu (1998) also reported the use of artificial heating sources for brooding the local ducks in South Vietnam.

Chara- Chemballi ducklings supplied to the SHGs under the project were fed initially duck starter supplied as Govt. assistance. They were also fed with broken rice, cooked rice and commercial chicken mash up to the age of 4 weeks thrice in a day. Thereafter they were provided with rice polish and kitchen waste twice in a day. However, they also acquired feed by foraging in the paddy field, ponds and other waterbeds. Islam *et al.* (2002) and Zaman *et al.* (2005) also recorded similar feeding system for local ducks of Assam in range condition except the supplementary duck starter feed provided to them.

Adult Ducks:

Adult ducks were usually kept under free range condition. During day time ducks were allowed to forage in the nearby paddy field or water bodies, whereas at night they were kept in the duck shed made of locally available materials like bamboo, thatch etc. erected nearby dwelling house of the farmer or nearby household pond. Paddy straws were usually used as bedding materials. Zaman *et.al.* (2005) also reported similar type of managemental practices for adult local ducks of Assam.

Adult Chara-Chemballi ducks acquired most of their feed by foraging in the field, ponds, river, and other water bodies. Snails, small fishes, left over paddy grains, insects, earth worms etc. were the main natural feeds for the ducks. Majority (85%) of the duck farmers provided commercial mineral mixture along with rice polish for the ducks, especially during laying period. Few farmers (47%) fed commercial chicken mash to the ducks. This finding was similar to that of Reddy (1987), Islam *et al.* (2002), and Zaman *et al*.(2005). Contrary to this, duck farmers of Kerala, Andhra Pradesh, Tamil Nadu and Indonesia fed their adult ducks with mixture of locally available ingredients like coconut grating, palm core and small fishes.

INCIDENCE OF DISEASES, MORTALITY PATTERN AND HEALTH MAINTAINANCE PROGRAMME:

The major causes of mortality among Chara-Chemballi ducks were Duck Plague and Duck Cholera followed by Salmonellosis, Enteritis, Hepatitis, Leg weakness and victims of Predators. Similar type of diseases was reported by Zaman *et al.* (2005) in Nageswari ducks of Assam.

Percent of mortality was highest during the month of February (25.6%) followed by March (8.9%) and May (3.2%). The average percentage of mortality in ducklings (0-8 weeks), growers (9-20 weeks) and adult (21-72 weeks) in Chara-Chemballi ducks was 26.67, 9.09 and 20.0 respectively. Contrary to these findings, Zaman *et al.* (2005) recorded much higher percentage of mortality in all age groups of Nageswari ducks in Assam. However, Islam *et al*. (2002) and Sharma *et al.* (2003) recorded

much lower percentage of mortality (below 10 %) in adult Nageswari ducks. Majority of farmers (80%) rearing Chara-Chemballi ducks vaccinated their ducks against duck plague. Routine schedule of deworming and other health care practices were also adopted by the farmers rearing Chara- Chemballi ducks. Similar finding was reported in Kerala (Ramachandran and Ramakrishnan, 1982 and Ravindran,

1983). However, farmers of Nageswari ducks of Assam did not adopt vaccination, deworming and other health care practices (Zaman *et al.* 2005).

Marketing and finance

Chara-Chemballi ducks were raised for both egg and meat production in Assam. Eggs produced were collected from the SHGs by egg dealers of SIRD centre located at different districts of Assam. The dealers used to pay directly to the respective member of the SHG. In Kerala, Andhra Pradesh and Tamil Nadu table egg production was the primary purpose of duck rearing and the eggs were sold to egg dealers (Ramachandran and Ramakrishnan, 1982; Ravindran, 1983; Rithambar *et al.,* 1986 and Reddy, 1987).

Surplus drakes and spent ducks were sold either at the local market or at the farmer's doorstep to individuals or local trader. Similar observation was made by Nind and Tu (1998) at South Vietnam.

Two main marketing channels: Channel I (producer-middleman-consumer) and Channel II (producer- consumer) were observed for marketing both eggs and meat. Khan *et al.* (1994) observed the same in Andhra Pradesh.

The members of the SHGs maintaining Chara-Chemballi ducks were financed by the bank for the costs involved in rearing and management. Similarly, in Kerala (Ravindran, 1983), Andhra Pradesh (Rithambar *et al.,* 1986) and Tamil Nadu (Reddy, 1987) duck farmers were financed by wholesale merchants.

Average annual income from the flock:

he average annual income of a farmer from a flock of 15-25 Chara- Chemballi ducks was calculated to be Rs. 15000/- with a range of Rs. 10000/- to Rs. 20000/- through selling of the eggs with an egg price of Rs.4/- each. Thus, rearing of Chara- Chemballi ducks was a remunerative enterprise for the women SHGs under study. The women were also earning through selling excess male ducks. This had also enabled the women in the villages to earn on their own. The women spent their earnings on education of their children, health care and their own requirement besides regular saving. The income found in the present study was much higher than those reported in the findings of Ravindran (1983), Rithamber *et.al.* (1986), Reddy (1987), Islam *et al.* (2002) and Zaman *et al.* (2005).

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USING FRESH PRAWN WASTE

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Abstract: A study on the duck rearing system for egg production existing in the coastal belt of Aroor region in Kerala state, India was carried out by means of structured questionnaire designed to collect data on socio-economic and husbandry factors affecting production. This system was unique in that the birds were fed on fresh prawn waste (FPW), a waste product of prawn processing industry. The internal and external qualities of eggs laid by ducks fed on fresh prawn waste were compared with ordinary market eggs. The study revealed that this system was the most economical enterprise compared to any other animal husbandry enterprises in this region. The fresh prawn waste not only incorporates a salmon red colour to the yolk (due to the pigment xanthene) but also improves considerably the egg weight, albumen index, yolk index and shell quality. This system demonstrate how a waste product, which was causing lot of environment pollution can be effectively utilized to produce high quality balanced food, the eggs for human consumption economically.

Key words: Duck rearing, prawn waste
***Abbreviations*:** F.P.W., Fresh Prawn Waste

Introduction

The Indian sub-continent with its varied agro-climatic zones has favored the development of wide varieties of plants and animal resources not seen else where on the globe. The total duck population in India was 22 million (A.H statistics G.O.I, 1999) out of which 6.6 million ducks belong to the state of Kerala. Alapuzha district known as "Venice of east" is a costal district famous for its backwaters and canals. There, ducks were reared mainly for eggs. According to 17th quinquinneal census (2003) the total duck population of this district was 2, 50,164. Kuttanad area was the main pocket of duck rearing in this area, but now the farmers of the coastal belt of Aroor are venturing into this enterprise in a big way.

The common practice of duck rearing in Kerala is 'duck-rice' free-range system in which the birds in large numbers are allowed scavenging on harvested paddy fields of Kuttanad, the "rice bowl of Kerala". The present study was undertaken at Aroor region of the district where a unique semi-intensive system of duck rearing is followed. The farmers of Aroor region rear local variety of ducks, the 'Chara' and 'Chemballi' in semi-intensive system as an economic enterprise. The peculiarity of this system was that the birds were fed on inexpensive fresh prawn waste, which was freely available waste product of prawn pealing industry spread throughout this area. The F.P.W, which is the main unconventional protein source, meets the complete protein requirement enhancing egg production and quality. This in turn, has also solved the crisis of water and air pollution prevalent in these areas since a long time due to disposal of prawn waste into the water bodies.

Materials and Methods

The husbandry practices of the farmers were studied using structured questionnaire method. A 68 item questionnaire was drawn to cover the respondent's biodata on important aspects of duck rearing such as socio-economic status of the farmer, procurement of birds, housing, feeding, health care, egg production, management practices, marketing, incidence of disease, cost, returns, the problems faced by the farmers and constraints. A multi stage stratified random sampling was used to select the sample households. The questionnaire was administered through personnel interview with the farmers at their

convenience. The biodata was collected from 102 farmers in Arror, Kodanthuruthu and Kuthiathode panchayath Numerical aspect of the data was analysed using simple descriptive statistics.

Egg quality studies were conducted at the Center of Advanced Studies in Poultry Science, College of Veterinary & Animal Sciences, Mannuthy, Thrissur, Kerala. Egg weight, shape index, albumen index, yolk index, shell thickness and colour of yolk were compared with ordinary duck eggs available in the market from another place where F.P.W. was not available.

Results

Ninety four percent of the farmers engaged in duck rearing belonged to educationally and socially backward, low-income groups. Sixty three percent of the farmers were marginal farmers possessing less than 10 cents of land.

The average stock of the farmers ranged from 200 to 1200 ducks, which were procured at the age of 150 to 200 days at a cost of Rs 90/- per duck from near by hatcheries. Regular laying starts at the age of 300 days. Egg production declines after 2-3 years of regular laying and the spent ducks were sold at the rate of Rs 50/- per duck. All the farmers practiced semi-intensive duck housing system adjacent to their homestead.

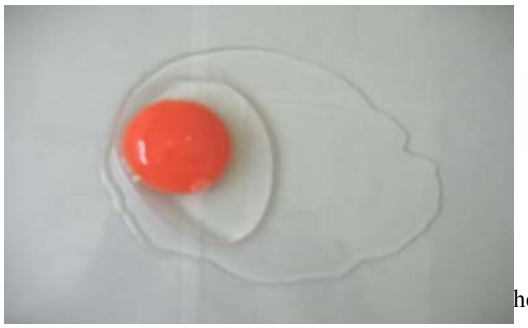
The daily duck ration consisted of only F.P.W and broken rice grain. The prawn waste which formed the major unconventional protein source was available from the nearby pealing sheds and fed at the rate of 230 to 250g/day/duck.The broken rice grain, which is a by-product of rice mills, is procured at low cost through middlemen and fed at the rate of 94 to 100g/day/duck

On an average 50 percent of birds lay eggs every day and the maximum production recorded was 85 percent.

TABLE I **Internal and External Qualities of Market Eggs v/s Aroor Eggs)**

Eggs	Egg Weight (g) (n =30)	Shape Index (n =30)	Yolk Index (n =30)	Albumen Index (n =30)	Shell Thickness (mm) (n =30)
Market Eggs	66.1 ± 0.98	76.2 ± 0.97	0.31± .02	0.056 ± .01	0.37 ± 0.01
Aroor Eggs	70.74 ± 2.0	74.53± .78	0.70±0.01	0.072±0.01	0.38 ± 0.01

Feeding of FPW improves considerably all the external and internal qualities of egg *viz*, live egg weight, yolk index, albumin index, and shell thickness as seen in Table I.



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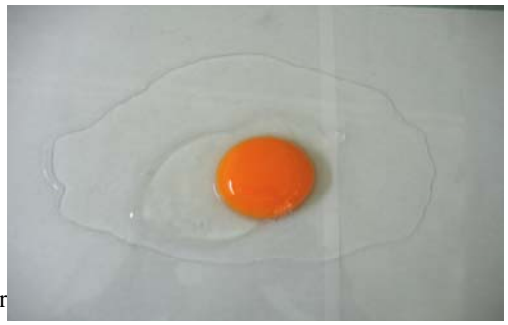

Feeding of FWP incorporates a salmon red colour (Fig 1) to the yolk due to the pigment Xanthene (Elizabeth et al., 1982). However the shape index was slightly lower indicating that the eggs were longer than the market egg.

TABLE II

Cost- benefit analysis of 100 Duck unit for a laying period (2.5 years)

Economic analysis

A. Fixed Cost
   1. Cost of 100 Ducklings @ Rs 90/ bird = Rs.9000.
   2. Cost of night shelter @ Rs 705/sqm = Rs.5005.5
      (Floor space provided for 100 birds = 7.1sqm)
      Total fixed cost = Rs 14005.5

B Variable Cost
   1. Feed Cost of F.P.W for 100 birds
      for 2.5 years @ Rs 1.06/Kg = Rs. 22246.75
      (20987.5 Kg)
   2. Feed cost of broken rice for 100 birds
      for 2.5 years @ Rs 6.9/Kg = Rs.59184.75
      (8577.5 Kg)
      Total Feed cost for 2.5 years = Rs. 813431.5
   3. Miscellaneous Expenditure
      (Deworming, Vaccination, Veterinary Aid, Mineral Mixture) = Rs.5000.
      Total variable cost = Rs. 8643.

      Total Expenditure =Rs. 100437.

C. Output.
   Total number of eggs produced per day by 100 ducks = 51.
   Total number of eggs produced by 100 birds for 2.5 years = 46,538.
   1. Cost of 46,538 eggs @ 2.70/ egg = Rs 1,25,652.6
   2. Cost of spent ducks @ 50/bird = Rs. 5000

Total Income = Rs.1, 30,652.60

Net profit for 2.5 years = Rs 30,215.6
Profit for one year = Rs 12,086.24
Profit per day for 100 birds = Rs 33.11
Input-Output Ratio = 1:1.30.
Cost-Benefit Ratio = 1:0.30.

The cost-benefit ratio of this system was 1:0.30

Discussion

The farmers adopted duck rearing as a subsidiary occupation as it supplemented their income and provided financial security during emergencies. No religious bias was noticed for this enterprise, as people from all religious groups were involved in duck farming. The procurement price of ducks were Rs

90/- per duck at the age of age of 150 to 200 days. There were middle men who supplied ducks at half the price but those farmers have to supply egg to them until the cost of ducks are met. Most of them provided housing with a night shelter with a fenced range with nylon nets abandoned by the fishermen. The 'runs' invariably included a water body like pond or stream. The night shelter was made of arecanut tree planks. The roof was supported by bamboo poles, thatched with coconut leaves and covered by plastic sheets to prevent seepage of water during heavy rain. This shelter protected the birds from adverse climatic conditions and heavy rains during monsoon. The muddy floor was covered with wood shavings as litter material. Top dressing of the litter was practiced once in six months. Later the built-up litter was sold as organic manure.

Fig 2

The daily duck ration consisted of only F.P.W and broken rice grain. The prawn waste which formed the major unconventional protein source was available from the nearby pealing sheds and fed at the rate of 230 to 250g/day/duck. The annual availability of FPW was estimated to be around 40,000 tones in the country (Ramachandran and Madhavan 1975). The broken rice grain, which was a by-product of rice mills, was procured at low cost through middlemen and fed at the rate of 94 to 100g/day/duck. Apart from this, few farmers incorporated mineral mixture in the daily ration, which improved the egg shell quality. The chemical composition of fresh prawn waste was 42.21% Crude protein, 9.8% Ether extract, 13.73% crude fibre, 6.6% Nitrogen free extract 27.6% Ash, 13.5% Chitin and 1750 K cal/Kg DM Digestible energy. (Mohan and Sivaraman., 1993).

Fig

The only health care management practice adopted by the farmers was the yearly immunization against duck plague. Routine management practices like deworming, disinfection, fumigation were not at all practiced by the farmers.

Ectoparasiticidal spraying was also not adopted. Pasteutrellosis was the major disease causing huge mortality and economic loss to farmers. Farmers are looking for an effective

vaccine against Pasturellosis. Bumble foot was a common problem encountered in this system. The incidence of this condition was high due to the prick wound produced on the legs by the hard chitinous exoskeleton of the prawns.

Egg production starts from $6^1/_2$ - months of age. Most of the birds lay eggs early in the morning by 5 A.M. Therefore, collection and marketing of egg was very easy. Eggs were collected daily at 6.30 A.M and stored up to 2-3 days at room temperature. These eggs were sold to the middlemen who supply the duck to the farmers. There are few farmers who practice direct marketing and they make more profit than others. Local people relish duck egg and there is a huge demand for eggs in the domestic market. So the eggs are not exported outside the state.

From the cost-benefit analysis of this system presented in Table II, it is evident that feed cost was the major recurring expenditure. The average daily expenditure of a farmer rearing 100 ducks comes to Rs 97.72 and the average daily returns per day amounted to Rs 137.70. The market price of duck egg is Rs 3.50 per egg, but the procurement price at farmer's door was only Rs. 2.70 per egg and at middlemen level was Rs. 3.00 per egg. If the farmer ventured for direct marketing they could generate an additional income of 40 ps per egg. The selling price of the spent duck was Rs. 50 per duck. Even with this low price the cost-benefit ratio of 1:0.30 was indicating that this system is very economical.

The changing climatic conditions impose lot of stress on birds affecting egg production. Heavy rain reduces the feeding time and lowers the egg production. Extreme summer was also found to be disadvantageous for egg production.

Another major problem encountered was the foul smell emanating on account of improper disposal of waste. The problem can be solved by collecting the leftover prawn waste and sun drying. The dried waste has no odour and can fetch revenue if sold to chitin production unit.

Some farmers were of the opinion that feeding of prawn waste added bad smell to the eggs also. So they boiled the FPW in order to reduce the smell.

There is a growing demand for FPW from the newly established chitin production units, which may create scarcity of this locally available cheap feed in the future and increasing its price.

The farmers were ignorant about the scientific duck rearing practices. Extension works, educating the farmers about scientific management practices like disinfection, fumigation, de-worming and record

keeping was essential to improve the productivity and economics of this system. Cheap compounded feed incorporating prawn waste should be formulated to feed the duck during lean periods when FPW was not available. Financial help in the form of capital loans, subsidies and insurance coverage for ducks would promote this highly profitable enterprise.

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GOOSE PRODUCTION FOR RURAL FOOD SECURITY

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Introduction:

Domestic geese Anses Anses (North American and European breeds of domestic geese). Anses Cygnoides (Asian and African breeds of domestic geese) are widely spread all around the world. The goose is undoubtedly the least exploited of all poultry species which suggest scope for development, the constituents 0.2% of poultry population in India. Geese are a type of a water fowl.

China is major producer of geese meat in the world. Goose feathers are a source of extra income, as it is used for bedding and clothing industries. Among the European countries, Mainly France and Poland are specialized for long time in geese production. They can be raised either as broiler with intensive feeding system or in an extensive one owing to their ability to get a large part of their food from grass. Geese are hardy creatures. They are vegetarian in character. Geese is one of the best genetic resources for diversified poultry production system, has tremendous scope and may provide a fascinating and profitable Hobby for any one with adequate pasture, once established are inexpensive to maintain.

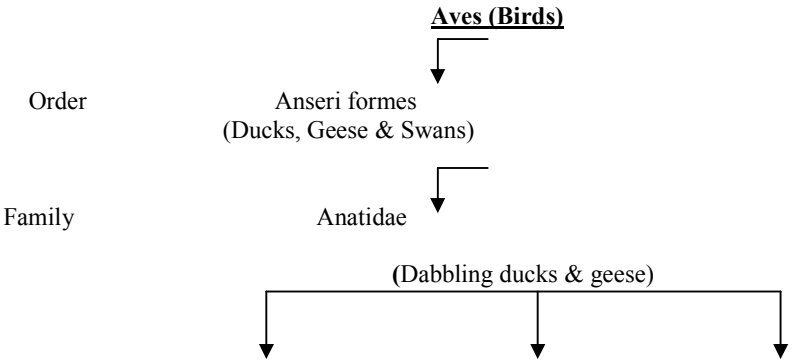
History:

In India wild goose are described as *RAJ HAMSA*. They are monogamous in nature a domesticated bird the goose has a long history, more than 4000 years ago in Egypt it was regarded as a sacred bird. Goose is a social creature, around them has grown a number of legends, superstitions and belief. The first positive evidence of man's control and domestication of geese to be found in Mesopotamia (present day-TRAG). Geese word originated from word gans and English word gos (ges), Geese are domesticated in 2500 B.C. The grey log goose is considered to be chief ancestor of most of the world domesticated breeds of Geese.

Table1. Total poultry meat production in different regions of the world.

Region	Total poultry meat production in million tones	Proportion of different poultry species to the total poultry slaughtering (%)			
		Chicken	Turkey	Ducks	**Geese**
World	78.2	86.57	6.53	4.16	**2.72**
Africa	3.5	94.29	2.00	1.71	**1.71**
N.C.America	22.4	87.95	11.56	0.36	**ns**
S.America	12.7	97.64	2.52	ns	**ns**
Asia	25.8	81.40	0.66	10.23	**7.75**
Europe	12.9	81.40	15.50	3.41	**0.62**

Table 2. CLASSIFICATION.



Genus	Anas	Cairina	Anser
Species	Platyrhyn chos	Moschata	Anser
	Domestic duck	Mascovy duck	Goose

GEESE AS PETS:

Geese have been kept as pets for special purposes. The Egyptians were said to be first to use them as companions in some way as cats. They were also kept for amusement by the Russians. They are very good watch dogs.

Geese are tremendous forgers:

Geese must be allowed to roam around an orchard or even a semi-wood land enclosure. There must be ample grass for the geese to graze. The grass should be the main food, it is cheap and effective. The grass area should be kept clean and short. Pasture for geese must consist of close-growing palatable grass and moving may be necessary before very young gosling is put out. Geese are normally run in flocks over posture. Basically Geese are good grazers. They contribute in improving rough pasture, eliminating weeds, and improving the growth of grass by the natural manuring of the land. Goslings and adult geese will forge for themselves and, therefore, a great deal of food will be obtained from the pasture. Around half-a-acre of grazing land is essential and with a set of 4-5 geese and area of 2-3 acres is advisable. The run area should be surrounded a wire netting of 6feet height.

Geese meat:

Geese are fast growing is 25percent cheaper to produce than beef and is a possible alternative for meat consumers. Geese meat claimed to be good kind of meat for physically active people. Broiler type of geese can marketed at 8-14 weeks of age at the body weight between 4-6 kgs body wt.

Geese and small rural poultry farmers:

Geese were reared entirely by small farmers who kept 10 or at the most 100 birds, as a side line to earn little extra income. A stocking density of 100-125 birds per hector is reasonable. Egypt is one of the leading geese producers, but production carried out extensively by small farmers and is distributed in the middle of the delta. China ranks first in goose meat production, 93 percent of goose meat in the world. The leading goose meat producer after China is Ukraine, Hungary, Egypt and Taiwan, Poland has a long

tradition of goose meat production. It is know based on commercial while kolvda geese. Goose production worldwide expanded by 120 percent between 1993-2003.

Fattening of geese:

They must have access to ad-lip nutritious feed in their first three month of age. Gosling should be given high protein food first few weeks and they run on grass of much of their food. Broiler finisher may be used for fattening, wet mash may be given. The allometric co-efficient show that the growth rate of breast muscles is considerably higher compared to that of body weight in geese (2.43 for geese).

Geese down:

Geese supply profitable high value product like geese down which can sell as much as US$ 75000 per ton is found for its lightness, warmth and used in winter posakas, pullovers bed spreads and comfortable and many other high value textiles. The percentage of down will normally 20 percent of the total weight. While varieties is most popular in all the species of domestic birds the most highly valued with regard to filling power of downs after processing, down of geese superior to ducks, 172 m.m vs. 143m.m of Peking ducks and 133 m.m of muscocy ducks. Plumage color is white, since the white gives the highest commercial value to the feathers/down.

Geese economic viability:

Each parent stock female will-in 5 seasons- produce 125 goslings to rear for feather and meat production. Each bird can be plucked 4 times which gives the farmer 650g feathers and down with 25 percent down . In total we can produce 65-85 kgs feather and down from each parent female.

Suitable varities for indian agro climatic condition:

1. Chinese variety best suited for good number of Eggs (50-60 eggs per year).
2. EMBDEN is prominent meat variety. It is one of the largest birds with males weighing up to 10 kg and female up to 9.0 kg.
3. Toulouse Geese (Grey geese) is commonly used for fat liver production (Foie gras). Force feeding geese done between 9-15 weeks for period of 14 days two times a day morning and evening. During this period weight of liver increases from 80g to 600g. Force feeding is done recently designed equipment called SPRIAL DOSING TANK.

Breeding plan:

A useful commercial goose can be developed by crossing Chinese gander with Embden or Toulouse female Geese should not be bred from until they are at least 3year old. Age at sexual maturity is takes 3-4 years. Gander can be useful for breeding for excluding 10 years under intensive system a mating ratio of 1male to 3females give highest fertility, for commercial exploitation 1:4 may be used. Crossing can increase performance and effectiveness of goose husbandry and also crossing of two dam lines to utilize heterosis for reproduction traits is of major importance in water fowls.

MANAGEMENT TIPS:

Table 3. Common names for the Sex, Young, Grower and Birthing of Water Fowls.

BIRDS	MALE	FEMALE	YOUNG	GROUP	GIVING BIRTH
GOOSE	Gander	Goose	Gosling	Guggle flock	Hatching
DUCK	Drake	Duck	Duckling	Flock	Hatching
SWAN	Coh	Pen	Cygoet	Flock	Hatching

Table 4. Hatching period, Longitivity Slaughter time of Water Fowls.

	DUCKS	GEESE	SWAN
Hatching period	28days(Muscovy-35days)	28-35 days	33-37days
Longitivity	8-10 years	20-26 years	30-50 years
Slaughtering time	Muscovy-12 weeks Pekin-7weeks	8-14weeks	-

Housing:

Only simply housing is needed for breeding geese. Deep litter system 1.0sq.mt of floor space may be given. 10feet by 4feet will suitable house of 8 geese without any over crowding.

Incubation:

28-30 days, on a small scale, eggs can be incubated by a broody hen/small table type hot air incubator may be used.

Adequate water:

Running water or even a pond is not vital, but there should be adequate water for the birds to immerse their heads. A plentiful supply of fresh water is vital. Nipple drinkers can be used for rearing gosling to limit the wastage of feed and water and stimuli the birds to search of feed and important behavioral factor.

Brooding:

Gosling may be reared under infrared bulbs gosling required only 2 weeks brooding period. They are hardy, mature quickly. They may be hand fed with bread and milk, or wet broiler starter must for a week. Gosling can be fed homely food such as, Grounded oats, Barley meal, Boiled rice, Potatoes, Bread soaked in milk/water. A young gosling allowed for following purpose. They may allowed go to pond after 21 days of age.

Nutrition

Metabolic energy and crude protein requirement:

Nutrients	Chicks	Grower	Layer
Energy (kcal ME/kg)	2800	2900	2500
Crude Protein (%)	17.0	11.0	14.8

Laying & lighting period:

Normally laying period starts in February to end of the June. Lay average 50-60 eggs/year. Egg wt. is 100-120g and the egg production being quiet low during the later part of laying period. The incidence of photo-refractions with long light days carries the cessation of egg laying in May\June in geese. Using an 8-10 height-16-14h dark programmers can extent the laying period of geese to more than 6 months.

Swimming:

They should not be alone to swim until till they are about 10 weeks of age.

Handling OF GEESE:

Geese should always be caught by neck to avoid hurting their legs.

Suggesstions:

The experts of waterfall recommended the following areas for further research in Geese:

- China has an abundant and a wide variety of goose resources. The systematic estimation of genetic diversity of Chinese indigenous geese will provide an important scientific basis for the conservation and utilization of the resource all over developing countries.
- Development and application of the out of season laying technique, together with the resultant economic benefits lead to modernization and sustainable development of the goose industry in Guangdong province, China this technique may be used in other developing countries so that goose meat consumption stimulate the market growth and also substantial economic to the farmer.
- Reciprocal crossing of wild Geese with domesticated geese has been performed successfully, further study may be undertaken.
- The Embden is the prominent meat bird in Europe and America it has to popularize even in Asian countries.
- The Toulouse is commonly used for fatty liver production; other breeds need to study for fatty liver production.
- Dr. Molnar and Prof Bogenfurst (Hungary), who observed their behavior with two 2watering systems (Trough and nipple drinkers). Goslings reared to 6 weeks of age in small groups spent less time feeding, drinking and laying and more time sitting. It appeared that nipple drinkers can be used for rearing goslings to limit the wastage of feed and water to stimulate the birds to search for feed an important behavioral factor. The lack of this activity in adult geese reared under intensive system leads to undesirable symptoms of boredom.
- Sex linked crosses. Two pairs of sex-linked genes influencing plumage color among geese are utilized making sex linked crosses. If the white Chinese male crosses with Embden female, the

female progeny will be generally darker than the males. In reverse crosses, the adult male will be light grey and females are white.

Summary:

The principle of management of Geese in respect of nutrition housing, rearing, prevention of diseases and breeding are basically the same as those followed in other poultry. Geese rearing are well adapted to harsh environment of free range and they produce egg, meat, down (which can be used for cottage industries of pillow making). Geese rearing are suitable and sustainable for backyard poultry farming and also unemployed youth and women can earn the livelihood through Geese rearing. Diversified Geese rearing productive system maintains genetic diversity. The integrated and eco-friendly farming system with aquaculture, poultry and water fowls. The Poultry education and Human resource planning for Poultry Sector National Seminar recommended that need to strengthen poultry course by incorporating new branches looking into the present need of globalization or consumers preference. Geese farming for meat and special liver production. The integration of different agricultural and poultry diversification also minimizes the risk besides helping in the effective re-cycling of the organic residues. The system ensures higher productivity per unit and soil integrated farming can augment production of animal protein at reasonable cost, improve rural economy and generate employment opportunities.

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ECONOMICS AND MARKETING OF DUCK IN RURAL CONDITION OF ASSAM

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Abstract

The popularity of raising duck in Assam has been increased in the last two decades. This is due to geographical location (vast surface water in the form of rivers, marshy and waterlogged area), ecological conditions, social structure and tradition stipulate the condition to develop duck farming in Assam, apart from the various advantages of rearing duck over chicken.. The total duck population of Assam is 6.88million (Livestock census, 2003), which constitute about 31.82 % of total poultry population. About 96.47 % ducks are reared in rural areas only and remaining 3.53 % in urban areas. Duck occupy second place after chicken in number and in egg production in Assam although duck has not received adequate attention for its development like that of chicken because of obvious reasons (Poultry Industry Year Book, 2003-04). Farmers of Assam mostly maintain different breeds/types of duck, which differed widely in phenotypes. Although the farmers of Assam rear various breed/types of duck like Pati,Nageswari,Khaki Campbell ,Graded,Charachembelli, Muscovy, Deohanh and Rajhanh(Geese), but from economic point of view mostly farmers rear Khaki Campbell,Pati and their crossbred and Charachembelli(which is introduced by SIRD ,Govt. of Assam few years back, Annual report of SIRD,2007-08). The cost of hatching eggs, feed ,medicine,labour are considered while calculating the economics of rearing ducks in a common group from hatching to 5 months period .The return per duck during this period was found to be Rs.23.29 .The cost of duckling/duck , feed , house ,medicine, vaccine are considered when economics of rearing Khaki Campbell,Pati ,Khaki Campbell X Pati and Pati X Khaki Campbell and CharaChembeli ducks are considered .The profit during growing period(Hatching to 5 months) per duck is found to be Rs.28.80,Rs 22.90,Rs 24.30,Rs 23.10 and Rs 24.70 for Khaki Campbell,Pati ,Khaki Campbell X Pati and Pati Khaki Campbell and CharaChemballi ducks, respectively. The corresponding figures during laying period (From onset of laying to the end of first laying year i.e. 72 weeks) are Rs.65.89, Rs 19.65, Rs 51.45, Rs 39.21 and Rs. 53.79, respectively. The duck farmers of Assam managed their flock with their own finance. The duck egg, drakes and spent ducks are sold out either at the local market or at farmer's doorstep to individuals or to the traders. The farmers in general gets a higher price from sale of duck eggs than that of chicken eggs both in the rural and urban areas. Two types of marketing channels are involved in marketing of duck egg and live ducks in rural areas. They are Producer-Retailer Consumer and Producer-Consumer (Direct Marketing)

Key words: Duck, Geographical location, social structure, Breed, Marketing channel

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Introduction

The Farmers in the rural areas of Assam mostly maintained the different breeds/types of duck, which differed widely in phenotypes. The different breed/types are Pati, Nageswari, Khaki Campbell, Graded, Charachembelli (which is introduced by SIRD, Govt. of Assam few years back, Annual report of SIRD, 2007-08), Muscovy, Deohanh and Rajhanh (Geese) .The so called pati constituted about 86.50 % of total duck population of Assam.

Materials and methods.

The study was conducted in duck populated areas selected randomly from the different agro climatic zones of Assam. The different duck farmers are identified along with the different location with the help of Animal Husbandry and Veterinary officers of the selected villages. After completion of the list of duck farmers in each village, they were selected on the basis of their flock size. A farmer who had a minimum of 10 ducks was considered as a duck farmer for the present study .A total of 110 farmers was selected. The required information was collected by means of questionnaire, personal interview and house hold records. Although the farmers of Assam rear various breed/types of duck like Pati,Nageswari,Khaki Campbell ,Graded,Charachembelli, Muscovy, Deohanh and Rajhanh(Geese), but from economic point of view mostly farmers rear Khaki Campbell,Pati and their crossbred and Charachembelli(which is introduced by SIRD ,Govt. of Assam few years back, Annual report of SIRD,2007-08**)** and hence for the present experiment five different genetic groups of ducks Viz Khaki Campbell, Pati, Khaki Campbell X Pati, Pati X Khaki Campbell and Chara chemballi were considered .A total of 1050 numbers of ducks were considered for the study . Each farmer rear more than one group of

duck and number of ducks varied from farmer to farmer. Information was collected only for those ducks which have been survived till the end of laying period. The information pertaing to socio-economic status of the farmer, economic aspect of rearing duck and marketing and finance were collected.

Results

Socio-economic status of the farmer:

The farmers of Assam considered the duck farming as subsidiary sources of income. People from all sections irrespective of caste, education, religion, occupation and economic conditions are found involved in rearing of duck. However majority of the duck are from the Hindu society who donot have much educational background and cultivation is the major source of income. The remaining portions of the farmers are either service holder or businessmen with some educational background.

Table 1, 2 and 3 depicts the economic aspects of rearing duck in rural situation of Assam.

Table 1: Economics of rearing a unit of 100 ducklings (hatching to 5 months of age) under natural incubation.

A. Cost 1. Cost of 117 hatching eggs to get 100 ducklings (85 % hatchability @ Rs. 3.00 each 2. Feed cost for 10 broody ducks(10 eggs per ducks) a. Cost of paddy @115gms/duck/day for entire incubation period @ Rs 5.10 per Kg b. Cost of rice polish @ 55 gms/duck/day for entire incubation period @ Rs.4.00 per Kg 3. Feed cost of 100 ducklings with 2 Kg Rice polish @ Rs4/Kg and 1 Kg paddy @ Rs 5.10 /Kg for 2 weeks 4.Cost of medicine, vaccine etc. for the flock 5.Cost of one labour for 5 months @Rs 600/month	Rs. 351.00 Rs. 164.22 Rs. 61.60 Rs. 183.40 Rs. 510.00 Rs. 3000.00
Total cost	Rs. 4270.22
B. Income 1. By sale of 88 ducklings (12% mortality) @ Rs. 75.00 per ducklings	Rs.6600.00
C. Gross profit 1. Profit for total unit 2. Profit per duckling	Rs. 2329.78 Rs. 23.29

However Islam (2001) reported a net profit of Rs 22.96 per grower in 20 weeks in rural condition of Assam

Table 2: Cost of production and return from four different genetic groups of ducks (growers)

Items	Khaki Campbell	Pati	Khaki Campbell X Pati	Pati X Khaki Campbell	Chara chemballi
A. Components of expenditure 1.Cost of Ducklings	@Rs.20/duckling for 100 nos. of ducklings= Rs. 2000.00	@ Rs.14/ duckling for 100 nos. of ducklings = Rs 1400.00	@ Rs 18/duckling for 100 nos. of ducklings = Rs 1800.00	@ Rs.18/duck ling for 100 nos. of ducklings = Rs 1800.00	@Rs 20/duckling for 100 nos. of ducklings Rs 2000.00
2.Cost of feed(From hatch till onset of laying i.e. 5 months)	(a)2.5 Kg rice polish /day for 100 nos. of ducklings @ Rs . 4/Kg feed (for 5 months) = Rs 1500.00 (b) 2.0 Kg paddy grain /day for 100 nos. of ducklings@ Rs.5.10 /Kg feed (for 5 months) = Rs. 1530.00	(a) Rs. 1500.00 (b) Rs 1530.00	(a) Rs. 1500.00 (b) Rs. 1530.00	(a)Rs. 1500.00 b) Rs. 1530.00	(a)Rs. 1500.00 b) Rs. 1530.00
3.Labour	Family member	Family member	Family member	Family member	Family member
4.Miscellaneous expenditure(house,medicine,vaccine etc)	Rs. 1060.00	Rs.255.00	Rs.720.00	Rs. 555.00	700.00
Total expenditure for 5 months(20 weeks)	Rs. 6090.00	Rs.4685.00	Rs. 5550.00	Rs. 5385.00	5730.00
B.Return Sale of duck	78 nos. of duck. Mortality percentage = 22 % ,@Rs 115/duck= Rs. 8970.00	93 nos. of duck. Mortality percentage = 7 % ,@Rs 75/duck Rs6975.00	84 nos. of duck. Mortality percentage = 16 %,@ Rs 95/duck Rs. 7980.00	81 nos. of duck. Mortality percentage = 19 % ,@ Rs 95/duck= Rs. 7695.00	82 nos. of duck. Mortality percentage= 18 %,@ Rs100/duck=Rs 8200.00
C.Profit or return (1)Profit for total unit 2) Per duck	Rs. 2880.00 Rs 28.80	Rs.2290.00 Rs 22.90	Rs.2430.00 Rs 24.30	Rs. 2310.00 Rs 23.10	Rs.2470.00 Rs.24.70

Kalita et al (2004 a,b),Kalita and Deka(2005),Mahanta et al (2001) and Saharia (2003) also reported similar findings to the present study.

TABLE 3: Cost of production and return from four different genetic groups of ducks (Adults)

Items	Khaki Campbell	Pati	Khaki Campbell X Pati	Pati X Khaki Campbell	Chara chemballi
A. Cost components 1.Cost of Duck	@Rs. 115/duck for 100 nos. of duck = Rs. 11,500.00	@ Rs. 75/ duck for 100 nos. of duck = Rs 7500.00	@ Rs 95/duck for 100 nos. of duck = Rs 9500.00	@ Rs. 95/duck for 100 nos. of duck = Rs 9500.00	@Rs. 100/duck for 100 nos. of duck=Rs 10000.00
2.Cost of feed(From onset of laying to the end of first laying year i.e. 72 weeks)	(a)Rice polish 4.0 Kg /day for 100 nos. of duck @ Rs . 4/Kg feed (for one year) = Rs 5840.00 (b) Paddy 3.0 Kg /day for 100 nos. of duck @ Rs.5.10 /Kg feed (for one year) = Rs. 5584.50	(a) Rs. 5840.00 (b) Rs 5584.50	(a) Rs. 5840.00 (b) Rs. 5584.50	(a) Rs. 5840. 00 b) Rs. 5584.50	(a)Rs.5 840.00 (b)5584. 50
3.Labour	Family member	Family member	Family member	Family member	Family member
4.Miscellaneous cost(house,medicine, vaccine etc)	Rs. 1296.00	Rs.722.00	Rs.1075.0000	Rs. 894.00	Rs.916.00
Total cost for one year	Rs24221.00	Rs. 19647.50	Rs22000.00	Rs. 21819.00	22341.00
B.Return 1.By sale of eggs @ Rs.2.50/egg 2.By sale of spent duck@ Rs 50/duck	1.138 nos. egg annually/duck. Mortality percentage = 22 % = Rs26910.00 2. Rs. 3900.00	1.75 nos. egg annually/duck. Mortality percentage = 9 % = Rs. 17062.5 2. 4550.00	1.102 nos. egg annually/duck. Mortality percentage = 11 % =Rs. 22685.00 2. Rs 4450.00	1.97 nos. egg annually/duck. Mortality percentage = 12 % = Rs. 21340.00 2.4400.00	1.112 nos.annually /duck. Mortality percentage =16 %=23520.00 2.Rs 4200.00
C.Profit (1)Profit for total unit/year (2) Profit per duck/year	Rs. 6589.00 Rs. 65.89	Rs.1965.00 Rs 19.65	Rs.5145.00 Rs. 51.45	Rs. 3921.00 Rs 39.21	Rs. 5379.00 Rs. 53.79

Kalita et al (2006 a, b) and Sarma (2003) also reported similar findings to the present study.

Marketing and Finance

The duck farmers of Assam managed their flock with their own finance. The duck egg, drakes and spent ducks are sold out either at the local market or at farmer's doorstep to individuals or to the traders. Similar observation also made by Islam (2001).The farmers in general gets a higher price from sale of duck egg than that of chicken eggs in the rural areas. Two types of marketing channels are involved in marketing of duck egg and live duck in rural areas. They are Producer-Retailer - Consumer and Producer-Consumer (Direct Marketing)

Discussion

The differences in genetic makeup are the major cause of profit in one group than the other. Similar result also reported by Barua et al (1992),Das et al (2000),Islam (2001), Islam et al (2002), Sarma (2003) and Saharia (2003). Further these differences were also attributed due to some non-genetic influences like nutrition, agro climatic condition and slight differences in managemental practices

Conclusion.

From the above observation it is opined that the Khaki Campbell ducks appeared to be the best performing genetic group among all the five genetic groups. The performance of reciprocal crosses were also found to be better than that of pati ducks. The egg production was highest in Khaki Campbell and lowest in Pati ducks. Therefore it is suggested that farmer can rear Khaki Campbell for having better performance and economy in their rural conditions. However as the mortality percentage is more in Khaki Campbell ,therefore as a second option they can rear the cross bred progeny between Khaki Campbell X Pati for better economy since introduction of exotic blood improved performance of pati ducks to a large extent. The performance of Charachembelli although better than Graded and pati,but it needs some more time to know its consistence performance both in respect of production and adaptability in the rural situation of Assam. The higher return received in the present study might be due to lesser cost involvement in rearing of ducklings, grower and layer, where the above workers included certain additional expenditure in rearing. It can be concluded that rearing of duck in rural situation under free range is a profitable venture

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A STUDY ON MIGRATORY DUCK FARMING IN DELTA AREAS OF

COASTAL ANDHRA PRADESH- INDIA

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ABSTRACT:

Andhra Pradesh posses about 3.4 lakh ducks supporting ten thousand people which are reared in migratory scavenging production system. Duck farming by scavenging in harvested paddy fields and water bodies is common in Krishna and Godavari delta areas of coastal Andhra, India. The socio-economic condition of duck rearers, existing farming system and package of practices in the above area is discussed. Migratory duck farming in Andhra Pradesh is taken up by Schedule tribe and Backward class communities for generations. They are mostly illiterate, landless and nomadic in nature. Each nucleus family is looking after a flock of about 500-1000 ducks which are procured from local hatcheries. They are reared for egg production up to one or two annual cycles and dispose them in lot before procuring ducklings for next cycle. AFE is about 180 days; egg production is 120-150 eggs/year with 20-30% rat of lay. Supplemental feeding is given only during chick stage and during lean period. Marketing is done through middlemen who lift the eggs from the farm by paying Rs 1.40-1.50/egg and pay weekly once. Adult stock is disposed in whole sale @ Rs 30-40/bird. Health care is not at all followed.

Key Words: Duck farming, Scavenging, Migration, Feeding, Costal and Delta areas

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Introduction:

Andhra Pradesh state located in peninsular India with a long coast line, posses about 3.4 lakh duck population supporting livelihood to nearly ten thousand people under migratory duck farming system. Duck production in this state is concentrated in Krishna and Godavari delta areas adjacent to Kolleru lake, Nellore and Prakasham districts, which are irrigated under Somasila and other minor irrigation projects adjacent to Pulikat lake. Status of duck farming, socio-economic condition of duck rearers, package of practices and constraints faced by the duck farmers are discussed in this article.

Materials and Methods:

For the present study primary data is collected from about 50 duck farmers from Krishna and Godavari delta and Somasila ayacut areas of Andhra Pradesh state. Secondary data pertaining to 18th quinquenial livestock censes is accessed from department of Animal Husbandry department.

Distribution of Duck Production and Agro Climatic condition:

Duck production in Andhra Pradesh is concentrated in south coastal districts. Two-third of total duck population is distributed in about 60 mandals falling under Krishna, and Godavari districts. Duck farming is concentrated in Krishna and Godavari delta areas adjustment to Kolleru lake where paddy is the principle crop grown twice a year. Paddy growing areas in Nellore district adjacent to Pulikat lake is another major duck production center holding one-third of total duck population. These areas experience hot humid climate with an average rainfall of 1000 mm, warm winter and hot humid summer.

Socio-Economic status of Duck farmers:

The duck farmers in Andhra Pradesh are mostly nomadic migrating to various paddy growing areas as per paddy harvesting seasons and come back to their villages and maintain them by grazing in small water bodies, canals or drains when standing paddy crop exists. Among the duck rearers 50% belong to the Schedule Tribe while remaining 50% belongs to various backward caste communities. However, all the farmers took to duck rearing from their ancestors and continue with the same. However Islam *et al* (2002) reported that duck farming is taken up as a subsidiary enterprise by all strata of the society in Assam, while rural poor belonging to Christian community are involved in duck production in Kerala state (Ravindran, 1983). Nearly 56% of the total rearers are illiterate, while 36% belong to read only group. Only 8% of the people have formal school education. Islam *et al* (2002) and Ravindran (1983) reported that most of the duck farmers are illiterate and belong to BPL category in Assam and Kerala states respectively. The duck farmers of Andhra Pradesh have mostly (96%) nucleus families. Women and children are also engaged in the grazing and other activities.

About 80% of the farmers own Kuccha house while 16% are totally nomadic living in make shift houses moving along with flock and 4% live in rented accommodation in slum areas.

Among duck farmers 80% are landless totally depending on duck rearing while 20% are marginal farmers with a land holding of one acre or less. However Islam *et al* (2002) reported that most of the duck farmers have agriculture and duck production is a subsidiary to them. Duck farmers in the region do not keep any other livestock as they are engaged in grazing

from morning 8.00 A.M to sun set. However five rearers also kept 3-8 Aseel birds which are tied near their make shift homes and hand fed.

Flock Size:

The flock size in Andhra Pradesh varied widely ranging from 300 to 9000 adults. About 8%, 52%, 24%, 8% and 8% of the farmers were holding flock size of >500; 501-1000; 1001-1500; 1501-2000 and >2000 ducks respectively. The flock size group of 501-1000 is more predominant which may be due to the convenience of handing up to 1000 ducks by nucleus families without hiring the labor.

Much smaller flock size was reported by Islam *et al* (2002) in Assam as it was taken up as subsidiary enterprise.

Flock size similar to that of present study were reported in Indonesia (400-1000) by Kingston *et al* 1978; in South Vietnam (1000-2000) by Nindad and Tu 1998, while Gajendran *et al.* 1991 reported that flock size ranging between 200-360 in Tamil Nadu - a southern state in India.

Type of Duck Farming:

Duck production in Andhra Pradesh is traditionally in the hands of nomadic tribal community reared by scavenging in paddy fields and foraging in water bodies or net work of canals distributed in Delta areas of two major rivers Krishna and Godavari located in the proximity of Kolleru a fresh water lake. Similar type of duck farming also exist in Nellore region.

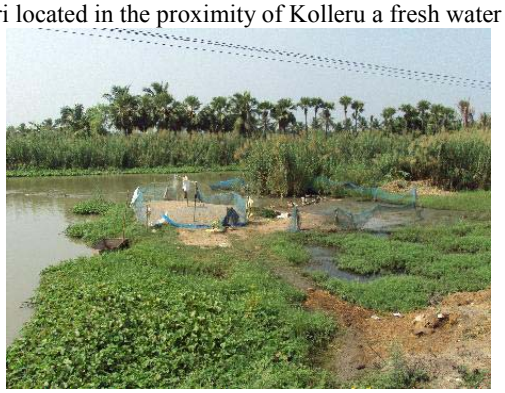

Fig 1: Flock Penning

Fig 2: Make-shift housing

Major Migratory Routes:

Duck producers in Andhra Pradesh mostly depend on harvested paddy fields having lot of fallen grains and insect population which provide enough nutrients for the optimal egg production. Duck farmers of Krishna and Godavari region stay at their native place from February to September, initially foraging in paddy fields followed by migrating to Kolleru region. By the time Karif paddy is harvested, they move to Nagarjunasagar ayacut area of Telangana or Somasila and other minor project ayacuts in Nellore region. They come back home by February by which time paddy crop is harvested in this region.

Sex Ratio:

It is interesting to note that in the present study sex ratio was very vide ranging from 1:7 to 1:57. About 48% farmers maintained the sex ratio between 1:10 to 1:30. The farmers of the study area dispose of the eggs for table purpose. They procure the replacement stock from hatcheries. The non-concern of the farmers to fertility and hatchability may be one reason for vide sex ratio.

Fig 3: Flock on Migration

Fig 4: Temporary Shelter

These farmers migrate from one paddy growing to another paddy growing area in search of feed as time of paddy harvest is different in various regions.

Age at Sexual Maturity:

Most of the farmers have reported that the age at sexual maturity is six months (180 days) which is comparable with that AFE reported by Zaman *et al* (2005) and Islam *et al* (2002) in Nageswari ducks.

Egg Production and Rate of Lay:

Mostly local non-discript ducks are maintained by the farmers. Annual egg production ranged between 100 to 150 eggs, which is comparable with the annual egg production reported by Sharma *et al.,* 2003 (100-120) and Islam *et al.,* 2002 (140-150) in local or Nageswari breed of ducks in Assam; Mahanta *et al* (1998) in Chara and Chemballi ducks in Kerala. The vide difference in egg production reported by the responding farmers may be due to vide difference in the availability of grain, worm and snail population and also seasonal influence on egg production.

The rate of lay ranged between 19% to 52%, with maximum frequency (52%) falling in the class interval of 20-30%.

Marketing of eggs:

Eggs produced are mostly marketed through middle men (84%). The cost per egg ranged between Rs 1.40 to 1.50/egg. Middle men generally pay once in a week. However 16% if respondents informed that they dispose the eggs in weekly shandies and realize higher rate Rs 2.0/egg. It is not possible with majority of rearers as nobody is available to look after the flock in their absence.

Procurement of Replacement Stock:

The duck rearers in the study area maintain the flock of uniform age and dispose the old stock as one lot before procuring ducklings from hatchery for replacement. In a way it is similar to all in-all-out method. Ducklings procured from hatcheries are initially reared in an enclosure made of thatch roof or plastic sheet roof and surrounded by plastic net for about 4-6 weeks. During this period they offer broken rice and DOB to ducklings. After this the flock is taken to nearby water bodies or harvested paddy fields.

Disposal of Old Stock:

The flocks are maintained for one to two annual cycles of egg production and then dispose in whole sale to middle men. Approximately Rs 30-50/- per bird is realized for spent stock.

Feeding Practices:

Duck farming in the study area is completely under extensive system of rearing**.** Supplementation of feed is not followed except during first one month of duckling stage and when there is no scope for

migration before paddy crop is harvested. During this period only broken rice and DOB is offered to them. Feeding of fortified concentrates during brooding and growing stage is another area which require intervention programme.

Fig 5: Feeding in Water body

Fig 6: Foraging in Paddy fields

Fig 7: Supplemental Feeding

Health Care:

The duck rearers in the state are totally unaware of health care. They do not follow any vaccination or deworming schedules. The ducklings are vaccinated only for duck plague. All the respondents have informed that neither they approach any veterinarian nor veterinarian comes to them for health care activities. It is found to be a big gap for which government intervention is very essential.

Areas which requires intervention:

1. Total lack of information on major health issues and prevention is the most important gap. It is very essential to identify important diseases of ducks in the region and plan for their control and prevention.
2. Feeding during chick and grower stage and during lean season was found to be taxing for duck rearers. Preparation of low cost feeds with locally available unconventional feed ingredients will help to reduce feed cost and increase the growth, production and general health of the flock.
3. Cost of duckling which is about Rs. 12/duckling is one of the major costs. It can be reduced if steps are taken to hatch their own eggs on payment by setting up hatcheries in the vicinity. By this duckling cost can be reduced to half.
4. Farmers face harassment during transportation of ducks by trucks to far of migrating places. The regular migratory routes can be identified, notified and issue of transport permits through department of Animal Husbandry can avoid the problem.
5. A detailed survey on the incidence of major duck diseases and development of epidemiological maps will help the government to tackle existing and emerging avian diseases.

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DUCK PRODUCTION SYSTEMS IN KASHMIR

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INTRODUCTION

In Kashmir, duck production is geographically concentrated near the water bodies of rural and urban centers, with low density of bird populations within households. Chickens and ducks are the dominant species raised across the state which has an important role in maintaining social relations, cultural traditions, religious events, wellbeing of children (duck derived income is often spent on food, medicine, clothes, education) and women's economic empowerment and sense of ownership.

PRODUCTION SYSTEMS

State has two systems of duck production: (1) Traditional extensive backyard/household duck production system and (2) semi intensive, small scale market oriented production (including Government duck farm, Sumbal, Ganderbal). Traditional extensive backyard/household duck production: This production system is by far the most common production system in rural Kashmir, where duck is raised in backyards, gardens, courtyards, orchards and often free to range on neighboring land. In this system the flock size is less than 30-50 ducks per house hold.

FEEDING MANAGEMENT

In traditional extensive backyard/household duck production system, ducks drives large part of their diet from free scavenging. Apart from scavenging ducks are also given some locally available feeds and supplemented with limited amount of home produced grains such as rice or maize and kitchen wastes. This supplementary feed given to birds not based on production efficiency, but depends heavily on availability of grains that farmers have in storage for personal consumption, as seeds for next planting season and needs of their animals.

In semi intensive, small scale market oriented production system ducks are kept in enclosed area and for some times allowed for free scavenging in backyards or orchards or the ducks are allowed to scavenge without enclosure. The ducks are also supplemented with locally available feed stuffs or commercial feed. As mostly progressive farmers are keeping the ducks for market oriented production, the feeding practice they (farmers) followed is based on production requirement of the ducks.

HOUSING MANAGEMENT

The duck farmer of the Kashmir mostly used cement concrete floor with gabled type roof to protect the duck from rain and snow fall. Some times the farmers construct slatted cage type house with gabled roof using locally available timber. The cages vary from permanent to makeshift enclosures made from locally available materials such as tree branches or bamboo. The duck are allowed to scavenge during day time in apple, walnut, pear gardens which are fenced with netting or bamboos. The shelter is provided only during night time and at the time of snow fall. During winter shed type of house with completely covered brick walls, cement concrete floor with wood-ash, wood shaving, saw dust or rice husk used as litter material.

BREEDING REPLACEMENT STOCK

Ducklings are generally hatched from own stock eggs, but sometimes farmers buy replacements from local market and/or neighbors to complement their flocks. The majority of the farmers also keep a

certain number of laying hens to produce chicks for fattening and for hatching of duck eggs. From hatching to one month of age (30d), ducklings are brood with hens. The hatchability of duck eggs found more (60-65%) when hen are used compared to duck it self(40-50%) but the incubation period is found more with hens about 40 days compared to 28-30 days when ducks are used. Egg production usually ranges between 80-100 eggs/ laying season. Most small and medium scale farmers keep duck all year round and sell their bird assets as need arises.

SOCIO- ECONOMIC STATUS OF DUCK KEEPERS

Usually poultry derived income is destined to buy clothes, pay for children education and purchase food. Most of the households engaged in a traditional extensive poultry production, with an average flock size of 32 birds, representing around 94% of all poultry producers. Since it is considered as sideline activity, attention to bird safety and health is limited and mortalities can be high in bad weather conditions as high as 30-40%. Mostly local duck breeds are raised in valley and some parts of Jammu province. These local breeds are of low productivity but have characteristic white–brown greenish featherings and dark skin colour features that are favoured by consumers in both rural and urban areas particularly for traditional festivals, family gifts, marriages and for religious offerings.

Duck rearing along with chickens considered a supplemental activity, depending on income status of individual producer households. Household members are also engaged in other farming activities like cropping, raising other livestock or off-farm employment. No record is available about the number of households that are currently engaged in this mode of poultry and duck production.

MARKETING

The majority of semi-intensive farmers also keep a certain number of laying hens to produce chicks from fattening. This system has production cycles for meat birds of about 70 to 90 days, with intermediate mortality rates and efficiency levels. These outputs are mostly utilized for family need or sometimes sold to different buyers such as wholesalers and various consumers or in Saturday market because local poultry varieties still form an important share of stock of these producers, quality of meat and eggs are seen as similar to that of household/subsistence producers they are suitable to both urban and local consumers and for sale into traditional event and festival.

Poultry keeping is an integral part of rural households' livelihood strategies and has been so for thousands of years and remains in the hands of poor. In India duck enjoys the second position after poultry as far as their population is concerned. West Bengal ranks first in terms of duck (Production) population, followed by Assam, Tamil Nadu, Andra Pradesh, Bihar, Orissa and Kerala. Even though duck keeping is confined to a limited area of the country, it contributes about crores of rupees to the national income and provides employment to about two to three lakh rural families. The poultry population which was 17.05 lakhs (including duck in 1972) has increased to 54.99 lakh (2003 census) with an average annual growth rate of 2.5%. Any effort to improve the duck farming by the state government will have a great impact on the lives of these farmers and will create the job opportunity for many others and it is desirable that the poultry production should now be diversified. Characterization of water fowl production systems in Kashmir helps government and the public to better understand this agricultural sector and in doing so, they can coalesce with industry participants to derive the most benefits out of this activity.

A STUDY ON DUCK FARMING SYSTEMS IN CAUVERY DELTA REGION OF TAMIL NADU

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A pilot study was conducted to analyse duck production systems under field conditions in Cauvery delta region of Tamil Nadu. A total number of 25 duck farmers and their ducks formed the study subject. The data on socio-economic status, flock details, selection criteria, housing methods, production, reproductive traits, marketing channels, health care and constraints in duck rearing were collected by using a structured and pre-tested interview schedule and personal observation.

The average age of duck rearers were 47.00±2.41 years. The number of members in the family engaged in duck keeping was 5.49±0.39. The main occupation was duck rearing only. The average flock sizes of the ducks were 1800±278.38 with male female ratio of 1:12. Desi breed of ducks formed the flock in the study area. Selection of ducks for parent stocks was mainly based on higher body weight. The average distance covered in the migratory system was observed to be 6.87±0.64 km per day. In addition to grazing farmers supplemented paddy grain. The body weight of adult ducks at 21st week was 1.20±0.06 kg. The age at maturity was reported to be 21.20±0.64 weeks. Peak production, Hen day egg production and laying period were reported to be 40.00±2.43 weeks, 68.00±2.91 per cent and 1.87±0.05 years respectively. Traders played a major role in egg marketing. The average unit sale price of an egg was Rs.2.91±0.03 and that of duck meat was Rs.59.75±0.82 per kg. Vaccination against Ranikhet disease was carried out by all farmers and deworming by 32 per cent of duck farmers in the study area.

Non availability of hybrid ducks, high mortality, disease outbreaks, non availability of vaccines and poor credit support were reported to be the main constraints in duck rearing. The results of the study reflect the existing scenario of duck rearing in delta region from which scope for future development can be looked into.

Key words: Duck farming, Cauvery delta, Tamil Nadu

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Introduction

Duck rearing is the one of the important occupation for socially and economically backward sector in India including Tamil Nadu state. Duck play an important role in livelihood and economy of landless community. River deltas play an important role in the

historical development of the duck industry. Even now traditional duck activity shows the importance of rivers. In India most of the duck farms are situated on the eastern sea board from Assam to Tamil Nadu and other important sites in Kerala, Andra Pradesh and Tripura. The duck industry rearing is closely associated with rice cultivation in Asia. They found the rice grain spilled during harvest as feed and convert in to protein in the form of duck eggs and meat. Information about the existing duck production system and various management practices adopted by the farmer is necessary to identify the opportunities for future policy reforms and innovation that would promote sustainable duck production. Keeping the above factors in view the present study was undertaken to document existing husbandry practices and production parameters of duck maintaineds in Cauvery delta region of Tamil Nadu.

Materials and Methods

The study was conducted purposively in the villages around the Cauvery delta of Trichy, Tanjore, Thiruvarur and Nagapattinam districts in Tamil Nadu state. A total number of twenty five duck farmers and their flock formed the study subject. The data on socio economic status, flock details, husbandry practices, production performance parameters, marketing channels and health cover details in duck rearing was collected by using a structured and pre-tested interview schedule and by personnel observation. The data collected were analysed by standard statistical methods.

Results and Discussion

Socio-economic status

All the duck farmers surveyed were literates and among them 68.75 per cent were primary school drop outs and 31.25 per cent were reported to complete their secondary school education. Majority of the duck farmers (68%) were Hindus. Earlier

study by Ravindran (1983) in Kerala showed that only 2 per cent of duck farmers were illiterates and mostly Christians were involved in the duck farming. The average age of duck farmers was 47.00±2.41 years which was similar to that reported by Rithamber *et al.,* (1986) in Andhra Pradesh. The nomadic nature of the profession which demands continuous travel might be the reason for middle aged group to involve in duck rearing. The average family size of duck farmers and number of persons in a family engaged in duck keeping in the study area were 5.49±0.39 and 2.56±0.27 respectively. All of them had more than a decade experience in duck farming. Economic strategy of duck farmers revealed that 12.5 per cent were poor 37.5 per cent were marginal income group and 50 percent were middle income group. Similar findings were reported by Rithamber *et al.,* (1986). Among the duck farmers 56.5 per cent were reported to be indebted to local money lenders.

Husbandry practices

The duck farmers were purchased the adult duck at six months age from Andhra Pradesh (Telungana and Coastal Andra region) and Kerala (Allepey and Kottayam) at the rate of Rs.100 per bird. All the farmers maintained only local (Desi) breeds and they are not aware about exotic breeds of ducks. The farmers interviewed maintained an average flock size of 1800±278.38 with male: female ratio of 1:10 in 37.5 per cent of flock and 1:12 in 62.5 per cent flocks. In comparison much wider sex ratio of 1:10 or 1:30 has been recorded in previous reports, (Ramachandran and Ramakrishnan 1982; Rithamber *et al.,* 1986 and Nind and Tu, 1998). The duck farmers in Cauvery Delta not only move within the state but also take their stock to neighboring states of Karnataka and Andhra Pradesh. The ducks were flocked together in a slightly elevated place on the bunds of fields and fences with a circular wire net enclosure during night and the owner or his agent keep watch on the birds. The average distance covered in the migratory system was observed to be 6.87±0.64 km per day. If the grazing is not sufficient the farmers provided about of 40 gm of paddy grains per day per bird.

Production performance

The data revealed that the average age at sexual maturity of ducks was 21.20±0.64 weeks. This is in agreement with the findings of earlier workers (Baruah *et al.,* 1991, Eswaran *et al*., 1984, Rithanber *et al.,* 1986 and Mahanta *et al.,* 2001).The average body weight at 21 weeks was 1.20±0.06 kg. This correlated with the findings of Rithamber *et al., (1986).* The peak egg production was reported at 40.00±2.43 weeks which were similar to the findings of Rithamber *et al*., (1986). In the present study the average hen day egg production was 68.00±2.91 per cent and the laying period was 1.87±0.05 years.

Marketing

The Cauvery delta farmers reared ducks only for egg production. The table egg production was the primary purpose of duck raising in Kerala and Andra Pradesh (Reddy, 1987). The eggs were sold to egg traders. Eggs were stored for not more than one week at room temperature before sending them to the market. Nearly 87.5 per cent of the farmers sold their eggs to the traders and 12.5 per cent of the farmers directly to shop keepers. The unit sale price of an egg was Rs.2.91±0.03 and the duck meat was Rs.59.75±0.82 per kg.

Heath

In the present study 18.75 per cent farmers were utilizing the veterinary services and all the farmers vaccinated against Ranikhet disease and duck plague. This finding correlelated with that of Ramachandran and Ramakrishnan (1982) in Kerala. Only 54 per cent of the farmers surveyed practiced regular deworming in their flocks. Mortality was

reported to be high in summer months which might be due to water scarcity and heat stress.

Constraints

Non availability of hybrid ducks, high mortality, disease outbreaks, difficulty in availability of vaccines and poor credit support were reported to be the main constraints in duck rearing.

Conclusion

The results of the study reflected the existing scenario of duck rearing in delta region. Duck production can be improved by extension activities through training on scientific management practices in duck farms for adoption in the study area.

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IMPROVEMENT OF RURAL LIVELIHOOD THROUGH REARING OF CHARA- CHEMBALLI DUCKS IN ASSAM

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A study was made to understand the impact of the projects for rearing of Chara- Chemballi Ducks implemented by SIRD, Assam of Kerala. A total of about 24055 (2352 SHGs) women beneficiaries have been maintaining this type of native ducks of Kerela under the agro climatic condition of Assam since the year 2003. The paper is based on the empirical findings from the visits 19 Districts covering 60 villages to study the impact of rearing Chara Chemballi duck by rural women in backward condition. Different indicators have been studied. It is found that the project for rearing of Chara- Chemballi Ducks has been transforming the lives of the poor and other sociological dimensions.

Introduction:

Since time immemorial, Assam has been, still continues to be and will remain in foreseeable future, a land of village communities. No strategy of socio-economic development in Assam that neglects the rural people and the rural areas can be successful. Assam is famous for the different groups of indigenous ducks reared by farmers under traditional system (Islam *et al*. , 2002). Earlier surveys (Mahanta *et al*., 2001 & Islam *et al*.,2002) had shown that the so called Pati (85.6%) constitute the major duck population of the state of Assam. These Desi ducks (Pati) are poor in egg production with an annual egg production record of 80-90 per duck (Islam *et al*., 2002). In order to improve egg production and profitability from duck farming, a field study was conducted in association with Centre for Advance Studies in Poultry Science, Kerala Agricultural University about the Duck Production in Kerala. After the study, Chara-CHemballi ducks from Kerala were introduced by the State Institute of Rural Development (SIRD), Govt. of Assam in the year 2003 for feasibility studies and performance evaluation under range condition of Assam. The studies showed that the agro-climatic condition of Assam is most suitable for rearing of Chara- Chemballi Ducks. SIRD, Assam has implemented a special project under SGSY for rearing of Chara-Chemballi ducks by the SHGs specially the women in different district of Assam. 1600 SHGs has been assisted under this project. The project was implemented in collaboration with Kerala Agricultural University, Mannuthy. This special project showed a revolution specially in empowering rural women. Following the successful implementation of the special SGSY project for rearing of Chara- Cemballi Duck, Govt. of Assam has also sponsored a special project for rearing of Chara-Chemballi Ducks by the women SHGs in clusters in different districts of Assam since 2006-07. The overall objectives of the projects are to *"improve the socio-economic condition of rural women by adding value to one of their traditional income generating"*.

The projects of rearing chara- chemballi Ducks in Assam has already assisted 2352 SHGs directly benefiting 24055 nos. of rural families covering 19 districts of Assam.

Methodology of Assessment:

The mission collected two types of data; one is secondary data in the form of records, registers etc. maintained by the members of the SHGs and the primary information were collected by direct interaction with the leaders of the SHGs, NGO partners and Village Heads.

The methods adopted and used for collecting of primary data from the field are group discussion, semi structured interview method and informal discussions. The information gathered from both secondary and primary sources has been compiled and interpreted in the form of a sociological analysis.

Building of Social Capital by Mobilizing Rural Women of Assam:

Social mobilization provides a suitable framework for development, by catering the needs and aspirations of the poor as well as engineering social change for their self reliance. A large numbers of the SHGs in rural areas of Assam have been developed through social mobilization process. Social capital so built has created an enabling environment for socio economic development of rural women in Assam. Rural women have been closely involved in economic, social, cultural and political processes having direct bearing on their life.

Women for the first time in the State have come out in large number to build their own organization for development. Visible changes have been observed in socio economic status of rural women by organized participation in development

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process through SHGs. SHGs have become platform for women for human resource development including overall personality development.

Coverage under the Projects for rearing of Chara- Chemablli Ducks:

Since time immemorial Ducks have been playing an important role in the socio economic sphere of the rural people of Assam. Ducks are seen almost all the villages of Assam because of its suitability for rearing in the backyard. The unique ability of the bird to utilize low quality food that normally go unharvested is a most important quality which helps the women to rear the Chara Chemballi ducks with minimum cost. Understanding the feasibility in rearing ducks in scientific manner, SIRD, Assam has introduced the Chara- Chemballi Ducks of Kerala in association with Kerala Agricultural University, Mannuthy in Assam. 2352 numbers of SHGs covering 24055 numbers of families have been assisted under different projects for rearing of Chara- Chemballi Ducks. Till date a total of 101 nos. of Clusters under 20 Districts have been covered under the projects for raring of Chara- Chemballi Ducks(Tab.1).

Table:1: District wise distribution of SHGs for rearing of Chara- Chemballi Ducks under different projects…

Sl. No.	Name of the District	No. of Clustered Developed	No. of SHGs developed/ assisted
1	Sonitpur	7	313
2	Jorhat	5	214
3	Nagaon	4	157
4	Kamrup	25	493
5	Lakhimpur	4	83
6	Tinsukia	5	96
7	Udalguri	3	40
8	Golaghat	3	65
9	Darrang	7	192
10	Dibrugarh	5	75
11	Sibsagar	3	62
12	Goalpara	4	59
13	Nalbari	7	128
14	Morigaon	4	92
15	Karbi Anglong	1	5
16	Cachar	2	22
17	Barpeta	5	90
18	Dhemaji	3	56
19	Baska	1	20
20	Chirang	3	90
Total		**101**	**2352**

Preference for Chara Chemballi ducks:

Rearing of ducks in backyard condition is a traditional income generating activity of the rural households of Assam. The climatic and natural topography are congenial for rearing of Ducks in Assam. Duck meat is also popular in Assam. Studies (Mahanta et al.,2001 & Islam et al., 2002) revealed that Pati (85.6%) constitute major duck population of the state of Assaam. These Pati ducks are poor in egg production with an average annual egg production record of 80-90 per duck (Islam et al. 2002). Comparing to these the average egg production of Chara- Chemballi Ducks are much higher (Jalaludeen et al., 2004). Therefore there is a shift in preference for rearing of Chara –Chemballi Ducks from local Pati Ducks among the rural people in Assam.

Performance and Highlights of the Project:

SIRD, Assam has established linkages with Centre for Advance Studies in Poultry Science, College of Veterinary & Animal Sciences, Kerala Agricultural University, Mannuthy for supplying of inputs like Chara - Chemballi Ducklings and Hatching eggs. At the initial stage of the project Chara- Chemballi ducklings were brought from Kerala, the SIRD established 20 units (1 setter+ 1 hatcher= 1 unit) of Hatcheries under the project. After establishment of the hatcheries, the SIRD started bringing eggs from Kerala instead of ducks. The eggs hatched out from these hatcheries were supplied directly to the members of the SHGs selected under the projects. Initially the selected SHGs had received 200 ducklings and 100 kg commercial duck feed in two phases. After receiving the initial support the SHGs has been linked up with Bank Loan of Rs. 30,000.00 per SHG with Rs. 15,000.00 as back ended subsidy as per the provision of the project. Each SHG had been supplied with minimum 300 ducklings against Bank Loan.

The SIRD also purchase fertile eggs from the clusters for hatching in the hatcheries. Each egg is purchased at a cost of Rs. 4.50 out of this Rs. 0.50 paise per egg go to the egg collector.

Fig : 1: Flock Management of Chara – Chemballi Ducks in rural Household in Assam

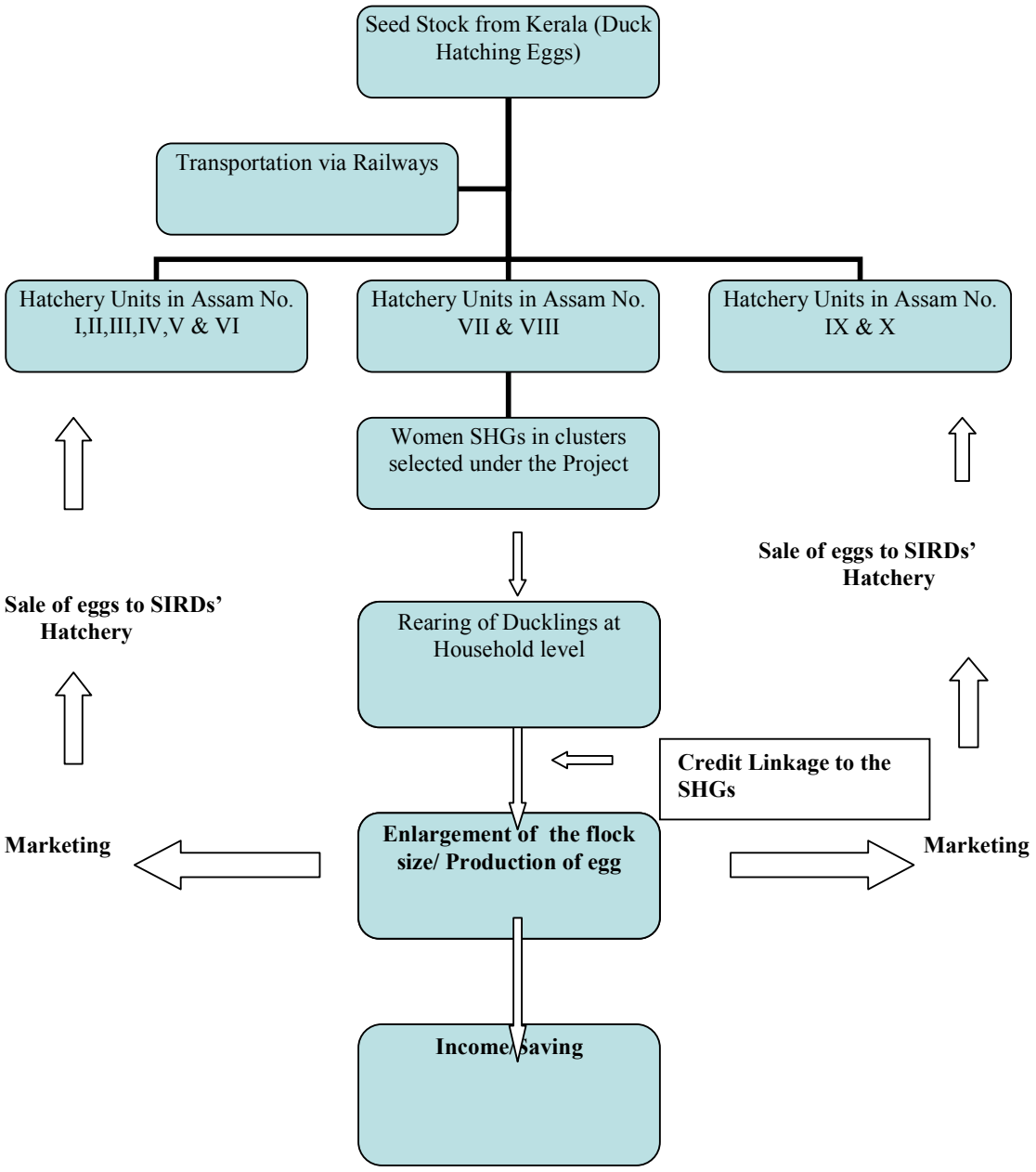

Fig. 2 : Organizational Chart showing the Steps in Implementation of the Projects for rearing of Chara- Chemballi Ducks in Assam

Impact of the Projects:

A gradual transformation has been noticed among the villagers which can be better understood by comparing some of the indicators before implementation and after implementation of the project.

Income generation for the rural people: The members of the SHGs has been maintaining the Chara- Chemballi ducklings in an unit size ranging from 15-35 in an average. The average annual income of a farmer from a flock of 15-35 Chara- Chemballi Ducks were calculated to be Rs. 15000/- with a range of Rs. 10000/- to Rs. 20000/- by selling the eggs. Thus rearing of Chara- Chemballi ducks is a remunerative enterprise for the women SHGs. The women have also been earning by selling excess male ducks. This has also enabled the women in the villages to earn on their own. The women spend their earning in

health care, education of their children and their own requirements besides regular saving. The income found in the present study was much higher than those reported in the findings of Ravindran (1983) , Rithamber *et.al.* (1986), Reddy (1987), Islam *et.al.* (2002) and Zaman *et.al.* (2005). Selling of ducklings hatched out through indigenous method has become a lucrative business. It can be better understood in the words of Mrs Barnali Baruah of Lozora Village , Deomornoi of Darrang District " *We have started propagating the duck flock by natural incubation. Last month we have sold 100 male ducks @ Rs. 100/- per Duck. We have been supplying growing ducklings of 15-20 days of age at the rate of Rs. 70 /- per pair to the other village people. I feel proud to have opened an RD account in the Bank. With the income getting out of the production from duck I am now able to send my elder son to tuition who is reading in class IX. I was working as a maid servant, as good income has started flowing from the Duck flock I have stopped working as maid servant*". This is a classic example of the socio-economic changes that are taking place with the introduction of the Chara- Chemballi Ducks in the villages of Assam.

Nutritional Security: Assam is dependent on other states for egg. Study revealed that after introduction of Chara-Chemballi Ducks , the additional egg production from Chara-Chemballi Ducks per day accounts to 1.39 lakhs (from 17360 families), *Anon 2005-2006*. Which in turn shows an increase of 10% of total egg production. Besides selling the additional amount of eggs, the families are also getting proper nutrition by taking egg in their meal especially the women and children. There is a reduction in the gap between production and demand of eggs in the clusters after implementation of the project for rearing of Chara- Chemballi Ducks.

Means of Self Employment and Gender Equity: Income through rearing of Chara- Chemballi Ducks has brought gender equity. The women who have always remained dependent on their men folk and never had any penny of their own, are now entrepreneurs in their own right. The activity of rearing of Chara- Chemballi Ducks under the project has become source of regular income to around 23000 rural households. With the women contributing to the household income significantly, they have been able taken part in the decision making process of the households.

Social Upliftment: Enhanced income has solved indebtedness as many households made themselves free from old loans taken from local moneylenders. Many families got back cultivable land given on mortgage. Many of them have started other activities like opening of PCOs, Grocery Shops, Tailoring, other livestock farming out of the income from saling of Chara-Chemballi Drake and Eggs. Mrs. Riju Deka of Gumoria Village of Kamrup District of Assam has expressed her acknowledgement "*Our Gumoria village was very poor. Now the women are organized in Self Help Groups and are very busy with their income generating activity of rearing Chara Chemballi in backyard condition. We can make transaction with the Banks. Some of our members have purchased knitting machines and some have purchased domestic animals like cows, goats etc. out of the sale proceeds of eggs and male ducks. They have admitted their childrens even in English medium schools. I too have sent my eldest son to Guwahati to study Bachelors of .Business Administration and the other son has been admitted to degree course. They have been able to pursue their studies without any difficulties because of our income from Chara Chemballi ducks."*

Fig.3: A beneficiary assisted under the Projects of rearing of Chara- Chemballi Ducks is now a proud owner of a Grocery Shop also.

The Red Letter Day:

His Excellency Dr. A.P.J. Abdul Kalam the then President of India visited the cluster and interacted with the women members of the Self Help groups of Gumoria Village in Kamrup District of Assam to know about the transformation in their lives through rearing of Chara Chemballi Ducks on 17th October,2006. One of the women members of SHG Mrs. Tulika Deka explain her accomplishment with the following words *"Previously the financial condition of my family was very bad. We used gunny bags to get rid of cold. Now I can run the home comfortably. We are now in a position to purchase blanket in winter."*

After his visit to the village, the then President of India referred to the economic empowerment of the rural women through rearing of Chara Chemballi ducks from kerala in Gumoria village of Assam in National Conferences as follows:

ADDRESS OF HIS EXCELLENCY PRESIDENT OF INDIA, DR. APJ ABDUL KALAM, AT THE DEDICATION OF THE LABORATORY FOR THE CONSERVATION OF ENDANGERED SPECIES (LaCONES), HYDERABAD 01-02-2007

My Experience in Gumoria Village

"When I think of Genetic research, I am reminded of my visit to Gumoria village in Assam where the self help groups members are developing duck rearing practices based on inputs from agricultural specialists from Kerala and with the initiative of the Assam Government. This has resulted in improving the economic conditions of the whole village by improving the duck productivity substantially."

ADDRESS OF HIS EXCELLENCY PRESIDENT OF INDIA DR. APJ ABDUL KALAM at the Summit of the Powerless, New Delhi, 20 November 2006

"In Gumoria village in Assam, the self help groups are developing duck rearing practices based on inputs from agricultural specialists from Kerala with the initiative of the Assam Government. Pride was writ large on the women as they explained their accomplishments".

Fig.4: Visit of His Excellency the Then President of India Dr. A.P.J. Abdul Kalam to Gumoria Village of Kamrup District in Assam

Income Exceeded the Investment:

A study of 1600 SHGs developed and assisted under special SGSY (from 2003 to 2005) revealed the total income of all the SHGs a exceeded the Project cost of Rs. 8.025 Crores. (Poultry component only)

$ Taking into consideration that the lowest average income of a member of the SHG is Rs. 500.00 per month.

$ Average lowest income of a 10 members SHG is Rs. 5000.00.
$ Monthly income of 1600 SHGs is Rs. 80.00 Lacs.
$ Annual income of 1600 SHGs is 9.60 Crores.
$ Project cost Rs. 8.025 Crores. (Poultry components only)
$ 1400 SHGs received credit support of Rs. 416.50 Lacs under the project.

(Anon. 2005-06)

Concluding Remarks:

It is difficult to draw any conclusion on a project related to livestock. But it is very clear from what we have observed in the field that social transformation is taking place gradually. The project has infused confidence among the women that they can reduce poverty and change their quality of lives for better through such activity. Whatever may be the intrastate cultural differences, the overall impact of the project is very much visible and encouraging, which made the activity a demand driven one with active and voluntary participation of the women in the activity.

The unique nature of the project is that the members of the SHGs are maintaining the Chara- Chemballi Duck flock at household level. Each of the members of SHG have a separate duck unit of her own. The average flock size maintained by each member of the SHGs ranges from 15-35 laying Ducks per household. The SHGs have been expanding the activity with help of Bank Loan supported by Government subsidy. Although they are maintaining the Duck flocks at house hold level, the repayment of the Bank loan and other activities are going on in the Groups.

Formation of SHGs among the women members of the Villages has significantly transformed lives and relationships. Quality of the life in the households has been moving for better and one can see these changes in the villages. But there is a need for systematic and pragmatic approach in ensuring sustainability of the ongoing activities.

Acknowledgement:

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PRESUMED REASONS FOR TRANSIT SOJOURN OF MIGRATORY WATER FOWLS IN KARAIKAL REGION OF U.T. OF PUDUCHERRY, SOUTH INDIA

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ABSTRACT

Pandit Jawaharlal Nehru College of Agriculture and Research Institute campus, Karaikal in the Union Territory of Puducherry is located 10 º55' N Latitude, 79 º52' E Longitude and with 4m MSL altitude. Every year in the North-East monsoon season (October- November) Migratory Waterfowls like Paddy Bird (Ardeola grayii), Cattle Egret (Bubulcus ibis), Herons (Nycticorax nicticorax), White Ibis (Threskiornis aethiopica), Redwattled Lapwing (Vanellus indicus), Blackwinged Stilt (Himantopus himantopus), etc. take a transit sojourn in a confined area of the campus which is marshy and swampy in nature with varied flora and fauna that provide sufficient feeding ground for the fowls. The presumed reasons for their arrival to this particular place are 1) sufficient water bodies to provide feeding with fishes, snails, worms, etc. 2) Tree canopy around those water bodies that favour them for nesting as well as to do their other natural activities. 3) These confined areas are with restricted human interference and no noise pollution 4) This area is located exactly on the migratory track to Kodiakarai (Migratory birds' Sanctuary and breeding site) which is 40 km from this place.

Key words: migratory waterfowls, transit sojourn, Karaikal, South India.

Pandit Jawaharlal Nehru College of Agriculture and Research Institute campus, Karaikal in the Union Territory of Puducherry is located 10 º55' N Latitude, 79 º52' E Longitude and with 4m MSL altitude at the tail end of Cavery river delta. Every year in the North-East monsoon season (October- November) many migratory Waterfowls visit this campus and crowd here to take a transit sojourn in a confined area of the campus. The mentioned area is marshy and swampy in nature with varied flora which consists of many water weeds and fauna like snails, fishes, worms etc. that provide sufficient feeding ground for these fowls.. These migratory birds includes Paddy Bird (Ardeola grayii), Cattle Egret (Bubulcus ibis), Herons (Nycticorax nicticorax), White Ibis (Threskiornis aethiopica), Redwattled Lapwing (Vanellus indicus), Blackwinged Stilt (Himantopus himantopus), etc.

Paddy bird (Ardeola grayii) :

This bird belongs to the Order- Ciconiiformes, Family- Ardeidae. Ardeola is a genus of small herons, typically 40-50cm long with 80-100cm wingspan. These are stocky species with a short neck, short thick bill, typically buff or brownish back, and coloured or streaked fore neck and breast. Their breeding habitat is marshy wetlands. They nest in small colonies, often with other wading birds, usually on platforms of sticks in trees or shrubs. 2-5 eggs are laid. They feed on insects, fish and amphibians. They are often found on small ponds.

Cattle Egret (Bubulcus ibis) :

This bird belongs to the Order- Ciconiiformes, Family- Ardeidae. The Cattle Egret is a stocky heron with a 88–96cm wingspan; it is 46–56 cm in length and weighs 270–512 grams . It has a relatively short thick neck, sturdy bill, and a hunched posture. The Cattle Egret feeds on a wide range of prey, particularly insects, especially grasshoppers, crickets, flies (adults and maggots), moths, spiders, frogs, and earthworms. The species is usually found with cattle and other large grazing and browsing animals, and catches small creatures disturbed by the mammals.

Herons (Nycticorax nicticorax) :

This bird belongs to the Order- Ciconiiformes, Family- Ardeidae. Although they resemble birds in some other families, such as the storks, ibises and spoonbills, they differ from these in flying with their necks retracted, not outstretched. Some members of this group nest colonially in trees; others, notably the bitterns, use reed beds. The member of this family are mostly associated with wetlands, and prey on fish, frog, invertebrates and snakes.

White Ibis (Threskiornis aethiopica) :

This bird belongs to the Order- Ciconiiformes, Family- Threskiornithidae. The White Ibis is a wading bird of the ibis family Threskiornithidae, also known as the "Sheep bird".

The White Ibis is around 65–75cm long and has a bald black head and neck and a long black down curved beak, measuring over 16.7cm in the male, and under in the female. The body plumage is white with some black feathers near the tail, although it may become brown-stained. The upper tail becomes yellow when the bird is breeding. The legs and feet are dark and red skin is visible on the underside of the wing. Immature birds have shorter bills. The head and neck are feathered in juveniles. This ibis feeds on various fishes, frogs and other water creatures and also insects and garbage.

Redwattled Lapwing (Vanellus indicus) :

This bird belongs to the Order- Charadriiformes and Family- Charadriidae. Red-wattled Lapwings are large waders, about 35cm long legs. The wings and back are light brown with a purple sheen, but head and chest and front part of neck are black. Prominently white patch runs between these two colours, from belly and tail, flanking the neck to the sides of crown. Short tail is tipped black. A red fleshy wattle in front of each eye, black-tipped red bill, and the long legs are yellow. In flight, prominent white wing bars formed by the white on the secondary coverts.

It usually keeps in pairs or trios in well-watered open country, ploughed fields, grazing land, and margins and dry beds of tanks and puddles. They occasionally form large flocks, ranging from 26 to 200 birds. It is also found in forest clearings around rain-filled depressions. It runs about in short spurts and dips forward obliquely (with unflexed legs) to pick up food in a typical plover manner. For food, ants, beetles, caterpillars, insects, snails and other invertebrates, mostly picked from the ground and a quantity of vegetable matter. It feeds in the day as well as night

Blackwinged Stilt (Himantopus himantopus) :

This bird belongs to the Order- Charadriiformes and Family- Recurvirostridae.The Black-winged Stilt (Himantopus himantopus) is a widely distributed very long-legged wader. Adults are 33—36 cm long. They have long pink legs, a long thin black bill and are blackish above and white below, with a white head and neck with a varying amount of black. Males have a black back, often with greenish gloss. Females' backs have a brown hue, contrasting with the black remiges. Immature birds are grey instead of black and have a markedly sandy hue on the wings, with light feather fringes appearing as a whitish line in flight. These birds pick up their food from sand or water. They mainly eat insects and crustaceans.

Presumed reasons for their transit sojourn to this particular campus are :

Campus with sufficient water bodies to provide feeding: The 225 acres campus area has five ponds of varying sizes sufficient to provide the feeding material relished by these birds. These feeding materials consist of fishes, prawns, snails, worms, crabs, insects, snakes etc.

Tree canopy around the water bodies: These water bodies in their boundaries have nice tree canopies from the trees like Gulmour, Rain-tree, Neem, Spathodia, Pongamia, etc. This favours them for nesting as well as to do their other normal natural activities.

Restricted human interference: These confined areas are well protected with minimum or no human intervention. So, these birds are not at all disturbed in their natural habitat.

No noise pollution: Absolutely this place is free from any noise pollution to interfere with their natural behavior. These birds are shy in nature and behavior and avoid their presence in noisy environments.

Location on the migratory track: This area is located exactly on the migratory route to Kodiakarai (Migratory birds' Sanctuary and breeding site) which is 40 km from this campus. Point Calimere Wildlife & Bird Sanctuary is a wetland jutting out into the Palk Straits, which separate India and Sri Lanka. In winter (November to January) every year; these wetlands is full of birds. The call of a thousand birds fill the air, as these birds nosily go about their business of setting up nests and raising families.

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EBENEZER DUCK FARM-A SUCCESS STORY IN COMMERCIAL BROILER DUCK PRODUCTION AND MARKETING

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Ducks occupy an important position next to chicken farming in India. The traditional duck rearing practice in Kerala is the migratory and scavenging type which is closely associated with paddy cultivation seasons. This extensive system of duck rearing is mainly meant for egg production purpose. The source of duck meat is either male or spent female ducks. As the demand for duck meat increases, the farmers started rearing meat type ducks intensively and exclusively for meat production. The Ebenezer duck farm is such a successful venture owned by a young entrepreneur Jomy K. K., Kaiparambat, Athani, Ernakulam. Jomy, a vocational higher secondary certificate holder in poultry science started broiler chicken farming at small scale for self employment. But the setbacks faced by that industry made him to shift to broiler duck farming. He started this venture in 2001 by procuring VIGOVA SUPER-M ducks from Central Poultry Development Organisation, Bangalore. Now he is marketing through his own channels an average 2000 Kg duck meat / weak. The prize of eggs, which are brought from Bangalore and hatching charges at a private hatchery, is costing him an average of Rs.11/chick. The average hatchability of 50% is obtained. He is rearing at a time about 8000 Vigova ducks at different stages of growth. The intensive type of rearing requires about 16,000 square feet area for accommodating the above capacity. He is providing an average ½ to 31/2 square feet area/duck from day old to marketing age of 50-55 days. The chicks weighing an average body weight of 46 gram reaches an average of 370 grams at 2 weeks of age. Much care is needed at the time of brooding and special designing of feeders and waterers required. The broiler ducks reaches an average body weight of 2.5 Kg between 50-55 days of age. The observed dressing percentage is 70-75%. The feed conversion ratio obtained here is 2.4- 2.6. The dressing of ducks also requires much attention including steps like defeathering and singeing. The market rate for broiler duck is Rs. 120 / Kg live weight. Jomy uses his own marketing outlets for reaching the markets. This new venture has made him one of the leading players in duck meat industry in India.

Key words: Broiler duck, Vigova super-M, Duck meat, Commercial duck production.w

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Introduction

Ducks occupy an important position in the rural economy of Kerala. The geographical peculiarities of this state is also considered to be ideal for duck farming. The traditional duck farming system in kerala is closely associated with paddy cultivation. The unique nomadic system of duck rearing

is the peculiarity of our duck production system. This system make it's route depending upon the paddy cultivation seasons. In addition to this small household units of duck rearing are also prevalent. All these systems are aimed for the egg production. The males and spent females are utilised for meat purpose. As the demand for duck meat is growing,farmers started to concentrate on meat production also. Instead of Desi/ Kuttanadan ducks which are mainly used for egg production, the progreesive farmers are using meat variety ducks for commercial duck meat production. The White Pekin ducks are generally used for this purpose. The story of Mr. Jomy K.K,Athani, Ernakulam, an enthusiastic young entrepreneur shows the scope of commercial broiler duck farming in Kerala. He brings Vigova Super-M ducks from Central poultry Development Organisation (CPDO), Bangalore for running his business.

Background

After completing the certificate course in poultry science ,Mr. Jomy started rearing broiler chicken in the premises of his house for supporting his family. This business was growing until 2001, when the broiler poultry industry faced a setback which led to closure of many farms. This was the phase of the life, Jomy came to know about the broiler ducks available from Bangalore. He started the Ebenezer duck farm, which was probably the first attempt in Kerala to rear the ducks for commercial meat production. The first problem faced by him initially was the difficulty in marketing the broiler duck meat, as nobody was much aware of such product. He had to go for many attempts to popularise this ducks. He made many advertisements in print and visual media to seell broiler ducks.His efforts were fruitful as gradually the demand was increasing day by day ,many times Jomy was not able to meet the demand. Ebenzer duck farm faced another difficulty when there was a threat of Bird Flu outbreak in many parts of the country. The people were reluctant to buy duck meat also. Anyway now the Ebenezer duck farm is the largest broiler duck rearing unit in Kerala marketing about 2000Kgs of broiler duck meat per week.

Broiler duck- VIGOVA SUPER-M

The source of vigova ducks is CPDO, Bangalore, a Central Government of India organisation. The Vigova Super duck were developed in Vietnam using White Pekin and Aylesberry ducks. The Ebenezer duk farm brings fertile eggs from Bangalore by train route. It will cost an average of Rs.8/ egg to reach here. The eggs are being hatched at a private hatchery . The hatching charge per egg is Rs. 2.50. The average hatchability obtained here is 50%. So the total cost of a duckling will reach upto Rs.11per duckling. After hatching the ducklings were moved to brooding and rearing sheds which is situated at another place.

Housing and Rearing

The average housing capacity of Ebenezer duck farm is 16,000 square feet shed. This include brooding ,growing and finishing areas. An average of 8000 ducks at different stages of growth are being growon at this farm at a time. The sheds are typical poultry sheds having roof of either tiles or GI sheets. The concreted flooring is covered with litter materials. The sides of the shed are covered with wire nets. The major difference in the housing of ducks adopted here is the arrangement of waterers and feeders. Utmost care has been for providing clean drinking water all the time especially at the time of feeding. Care has been taken to provide automated water channels at the sides of the shed to avoid water from the drinker wetting the litter. The feeding vessels are designed such a way to avoid wastage. The space provided here for ducks ranges from ½ square feet/duckling to 3 ½ square feet/ duck at the time of marke The chicks weighing an average body weight of 46 gram at day old age reaches an average of 370 grams at 2 weeks of age at Ebenezer farm. Much care is needed at the time of brooding and special designing of feeders and waterers required. The broiler ducks in this farm reaches an average body weight of 2.5 Kg between 50-55 days of age. The observed dressing percentage ranges from70% to75%. The feed conversion ratio obtained here ranges from 2.4 to2.6. The ducklings are fed broiler chiken starter feed upto an age of 28 days and broiler finisher feed thereafter.

The experience in this farm shows low incidence of disease problems.

Marketing

The Ebenzer duck farm uses it's own retail shop and marketing channels for marketing the entire farm stock. The dressing of ducks also requires much attention including steps like defeathering and singeing. The labourers are employed for dressing the meat with skin and packing it. In addition to retail selling,the duck meat is being demanded by hotels and catering units. In this area the broiler duck meat is being served at marriage functions also.The market rate for broiler duck meat is now Rs. 120/ Kg live weight. The direct marketing system enables this farm to obtain maximum profit from this enterprise.

Conclusion

The success story of Jomy and his Ebenezer duck farm shows the high demand for duck meat in many parts of Kerala. The duck varieties exclusively used for meat purose with high growth rate,feed conversion efficiency and meat qualities are well accepted by the farmers. The problem faced by Ebenezer farm is now is that they are not able to meet the demand especially during festival seasons especially Christmas and Easter. So there is a need to establish a breeding farm units having parent stocks of meat type ducks. This only will meet the growing demand for ducklings. In addition the poultry development schemes of the governments should also include broiler duck farming projects. There should be concerted effort to exploit the incresing demand for meat including duck meat. The future plan of the Ebenezer farm is to establish a breeding farm and also to increase the infrastructures for the storage of dressed meat.

DUCK PRODUCTION FOR RURAL LIVELIHOOD

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In alternate poultry farming, duck rearing plays a vital role and is being practised in India, especially in Tamilnadu as a traditional system by the rural farmers. Even though, the duck production and genetic potential of indigenous ducks are being untapped by Government or other organized private sectors, still it is continued as the livelihood preposition of several poor rural farmers from time immemorial. The local or indigenous ducks constitute over 92 per cent of the duck population and are mainly distributed in the rice cultivating areas. The extensive water shed areas like ponds, lakes and rivers in Tamilnadu provide excellent natural habitats of ducks. In northern districts of the state, the local duck varieties like *Arni* and *Sanyasi* are very popular and reared under backyard and extensive water range system.

The size of the duck flock varies from 10 to 25 dozens; mainly thriving on waste grains from harvested paddy fields and aquatic organisms from water ways. Traditional hatching is carried out by few farmers seasonally, synchronized with rice harvesting, with average hatchability of above 60%. Most of the other managemental practices are done under nil-input system except during lean season when the hand feeding of ducks with locally available low cost broken rice, rice bran, palm pith, etc. The marketing of duck eggs is unorganized as the duck farmers are sticking on to the loan lenders who support them financially. Further, the marketing of duck eggs and duck for meat purpose is mainly based on the Kerala market, because the popularity of duck eggs and meat are still in primitive stage in the state.

Therefore, the ducks are exclusively maintained for eggs. Duck meat production as an avocation is non-existent as only spent ducks and drakes contribute to the duck meat. Since ducks are moving from rice field to rice field, canal to canal, pond to pond, etc, sometimes covering many kilometers in search of food which mainly consists of fallen paddy grains, shrimps, snails, small fishes, tadpoles, earth worms, water weeds, insects, etc, the overheads are low and the cost of production becomes negligible. It is therefore imperative to raise the contribution from this unexplored species of waterfowls – ducks – to the natural supply of animal proteins which would automatically uplift the livelihood of the poorest among the rural poor sustainably.

Keywords: Duck, livelihood, Tamilnadu

The traditional backyard poultry was metamorphosed in to poultry industry during the last three decades. This poultry industry concentrates only on chicken to improve its production potential and to meet the demand only by chicken and its products. The duck farming, an alternate to chicken farming, was neglected by many researchers, Government and other organized private sectors inspite of its better production potentiality. But duck farming is being practiced as vital farming system especially in Tamilnadu by the rural farmers as their livelihood preposition. Still the duck production is in the hands of the rural population and is not being undergone any process of industrialization so far as in chicken. Duck production in the country in general and in Tamilnadu specific is in the hands of the rural poor landless agricultural farmers for their livelihood preposition. Moreover, only indigenous varieties of duck are being maintained by the farmers as a traditional system through their ancestors. Hence, the paper discuss the indigenous duck varieties, management practices, marketing of duck egg and meat and the status of duck farmers in the state of Tamilnadu.

Population and distribution

The local or indigenous ducks constitute over 92 per cent of the duck population. Based on the 17th Livestock census (2003), the total duck population in Tamilnadu was 2,46,960 which is only 0.29 per cent of the total poultry population. In Tamilnadu duck farming is predominant in the Northern districts and in other parts, where water sources are available duck farming is practiced. Among the Northern districts, Vellore, Thiruvallur, Villupuram and Kancheepuram dominated with duck population (19.94, 16.93, 14.72 and 9.67 per cent over total population). In these areas the local duck varieties of *Arni* and *Sanyasi* ducks are very popular. These local ducks are being reared under backyard management with extensive water range system. In these parts mostly duck farming carried out by the illiterate agricultural farmers as traditional practice. It is in accordance with the reports of Ravindran (1983) and Gajendran et al. (1991).

Rearing and Management

The duck population are mainly distributed in the rice cultivating areas. The extensive water shed areas like river, lakes and ponds in Tamilnadu provide excellent natural habitat for ducks. Ducks are allowed in the harvested paddy fields/ water ways for foraging during day time. These ducks are being maintained mainly for their egg production and meat being a by-product. Ducks are reared under extensive systems of management mainly on the water ways as described by Sivalsem and Prabhakaram (1986).

Flock size

The size of duck flock usually refers in dozens (12 Nos./dozen). The common size of flock is 15 ranging from 10-25 dozens. (Gajendran et al. 1991). The duck are allowed in the harvested paddy fields and water ways for foraging. During lean seasons ducks are hard fed with locally available cheap ingredients such as paddy, rice gruel, cholam etc. The drake and duck ratio was 1:12 which is in accordance with the reports of Ramachandran and Ramakrishnan (1982), Bulbule (1985) and Rithamber et al (1986).

Incubation

The ducks are usually start laying eggs from mid night to sun rise. Eggs are being collected in the early hours of the day. The eggs intended for hatching collected clean and without contamination and sold at 8-10% extra cost (Ramakrishnan 1996). The selection of hatching eggs carried out mainly based on the size and weight of eggs.

Duck farmers in Tamilnadu are utilizing broody hens for hatching duck eggs acting as “live incubators”. The average no. of duck eggs set under each broody hen ranges from the 15-18 Nos. This is in concurrence with the reports of Gajendran et al. (1991). Mud pots and bamboo baskets are used for hatching purpose with paddy straw as bedding material. Few duck farmers practicing the process of candling the hatching eggs on fifth day of incubation using kerosene lamps. This is in accordance with the observations of Reddy (1987).

Some times the process of custom hatching is also being practiced by the middle man or the wholesale duck vendors. Hatching of duck eggs is synchronized with rice harvesting and it is seasonal, occurs during October – November and January-February. Gajendran et. al. (2005) reported that hatching operating carried out from July to March. The hatchability parent of more than 60 is being obtained by the farmers ranging from 60.5 to 62.5. This is in accordance with the findings of Ravindran et. al. (1984).

Management practices

Reports on practicing artificial brooding are very scanty. Usually the ducklings are removed in second day from broody hen and maintained in a temporary confined sheds up to 7 days with hand feeding of broken rice, grains and rice bran. Some farmers are practicing brooding of duckling in a lorry

tyre enclosure as reported by Gajendran et. al. (2005). After 7 days , the ducklings are allowed in the water ways for swimming in nearby ponds (or) canals and after a month they allowed for foraging in the paddy fields or water ways along with their mother. Since they are prolifie egg producers no artificial lighting is provided for brooding or for production as reported by Lewis and Perry (1995). The same practise of raising duckling was reported in Kerala by Ravindran (1983). Most of the other management practice are carried out with nil-input system under free range foraging in water ways and harvested paddy fields for grains. During lean season, the ducks are hand fed with locally available low cost broken rice, rice brain, cholam, palm pith etc.

Marketing

Ducks are maintained exclusively for the eggs. The drakes and spent ducks contribute the meat products. The consumption of duck egg and meat is still in primitive stage in the state of Tamilnadu. Marketing of duck egg and meat is mainly based on the Kerala market. Since, duck rearing is followed by the poor landless agricultural farmers, they depend on the middle men or loan vendors for financing the duck rearing. Moreover marketing of duck eggs is in unorganized manner, the middleman are fixing the prices for duck eggs and ducks marketed for meat and transporting to the neighbouring states. Thus the marketing of duck egg and meat in Tamilnadu is considered as pure competitive market as described by K.Gajendran and G.Kathiravan (2008).

Conclusion

The indigenous ducks of Tamilnadu are maintained under free range system in the rice cultivated fields and other water ways for foraging with nil-input system of management and these ducks are having the potential of producing sufficient eggs of good quality. Duck rearing in Tamilnadu is still in the hands of poor and landless agricultural farmers for their livelihood preposition.

It is therefore imperative to raise the contribution form this unexplored species of water fowls-ducks to the natural supply of animal proteins which would automatically uplift the livelihood of the poorest among the rural poor for their sustainability.

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WATER FOWLS: PROMISING ENTERPRISE FOR FUTURE

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Besides poultry industry meeting the ever growing demand of the human population, the farming pattern with water fowls can be a successful alternative. In India, under the category of water fowls, duck farming ranks first, then geese. The swans and others are being reared only for ornamental purpose especially by the bird lovers. Ducks contribute 6.13 per cent of total poultry population in the country. Nine million duck population in 1972 had increased slowly to ten millions in 1984 and profusely to about 29.96 millions in 2003. The state of Tamilnadu occupies a significant position in duck population in the country with indigenous ducks distributed very widely in all districts. Therefore the economic contribution from this increased duck population to the poultry sector can not be ignored. The indigenous duck varieties available in Tamilnadu are capable of laying 180-200 eggs per annum with an average egg weight ranging from 60-64 g with no additional or special feeding management. This average potential from ducks is certainly higher than the production from the backyard chicken. The duck is very prolific, hardy and quite promising among indigenous poultry species because of their rapid growth rate and dressed weight of drakes. The advantage of integrating ducks with fish rearing as well as paddy cultivation is one of the promising upcoming fields in the animal husbandry sector.

Next to duck is the 'geese' which are found all over the world; but at present goose farming is economically important only in Asia and central Europe and well-suited to aquatic areas and marshlands and are completely at home in warm, shallow waterways. Some European breeds, such as the Embden and Toulouse, have been introduced into tropical developing countries with notable success and promising enterprise for smallholders. Geese are among the fastest-growing avian species commonly raised for meat. It is a multipurpose animal supplying nutritious meat, huge eggs and rich fat for cooking as well as soft down feathers for bedding and clothing which make them particularly appropriate for providing farmers with a supplementary income.

Thus, the abundant duck and geese population are promising genetic resources available in India which can be better exploited with scientific management without making any genetic dilution. In addition, shrinkage of lands and agricultural fields warrants the integrated approach with water fowls, livestock, fishery and agriculture as a viable option for the better future.

Keywords: Waterfowls, ducks, geese, integrated farming

HOUSING & MANAGEMENT

MEAT DUCK - BREEDER MANAGEMENT

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Abstract

Until Twentieth Century, Ducks were kept in small flocks by small holders, Farmers and Estate Owners, many places in India and Asia. Ducks are allowed access to open water during day and are housed only at nights.

There is a great variety of system in use around the world for keeping Breeding Ducks.

Keeping breeder Duck Management in view present authorities wants give some important aspects of breeder meat ducks managements in the area of environment, nutrition, controlling egg weight housing equipments and other routine husbandry practices under Indian conditions which can be widely adopted in India.

Key words - Breeder Duck, Nutrition Indian condition
Access to open water.

Introduction

The production of good quality parent breeding stock begins with the arrival of day old ducklings. Ducklings to be handled carefully and to be placed them in the brooding area, with access to water as quickly as possible after arrival. Suitable housing system, adequate heat, balanced diet, sufficient food and feed trough space to be provided.

In terms of ultimate performance, a high standard of management and husbandry is required to maintain the flock in good conditions with special attention to the application of the controlled feeding programme. Accurate body weight and feed control is crucial to achieve good results.

Environment:

Comfortable environment is essential to achieve optimum breeding performance. Ducks can tolerate a wide range of temperature. However, mature breeding ducks comfortable between 6°C to 30°C. Increasing ambient temperature above 30°C reduces feed and nutrient intake and this begins to affect the rate of lay. This is the point where laying/breeder ducks start panting (using latent heat exchange via respiration to achieve sufficient heat loss to maintain homeostasis). Again this panting depends on body weight, feathering, composition of litter temperature, access to swimming water and relative humidity.

When temperature raises beyond 30° C, (panting threshold) - Birds expose and extend their legs and wings and open their feathers to encourage sensible heat loss, and ducks tries to rest on slats and shaded areas. Ducks spend lot of time drinking, preening and socializing, resting and loafing around, usually close to water source. Birds avoid resting in direct sunlight where radiant temperature can exceed 50° C. Evaporative cooling systems at high ambient temperature showed that it is possible to reduce average day temperature by about 5° C and 8° C by fogging the atmosphere. Providing bathing water can help to maintain laying performance at high ambient temperature.

Housing:

Duck breeding houses to be constructed with 35' to 40' width with 6' – 8' over hang. This over hang will prevent direct sunlight entering into the open side walls. Ducks choose to avoid direct sunlight in hot weather hence, providing shade at water channel is a must for them during the day. Slat system of

housing widely used because they provide ventilation, however due to foot problem, slat area is restricted to 35% of the floor area. Deep litter sheds with water channel outside the shed or at the border of semi
range are very popular in India. EC sheds also are popular in USA and Europe for breeders in order to avoid the risks from transmission of diseases from migratory, wild and water fowls.

Birds housed intensively without access to outside pens require about 5 sq.ft. per bird. Then the drinkers should be placed over a drainage pit located at least 1 ft. above the floor. Pit should be covered with plastic slats or plastic coated weld mesh.

Floor space:

Ducklings should be placed in a brooding circle which is used for the first week in order to keep them close to the source of heat. In each brooder for 300 ducklings the circle should be 9' diameter with the height of 12" to 18". Young ducklings should be protected from floor draught. From 3rd day, the brooder circle should be made slightly larger each day with additional flexible brooding guard. After 7 days brooder circle can be removed allowing the ducklings access to the whole pen area with 0.5 sq.ft floor area per duckling. Around 300 ducklings are advised to keep in one pen. Again after 22 days the floor area per duckling should be increased to 2.25 sq.ft. per duckling inside the shed and 4.95 sq.ft per duckling with

run space /semi range space up to 20 weeks of age. 20 weeks to 66 weeks of age, the floor space of 3 to 3.25 sq.ft inside the shed and about 6 sq.ft./bird including run/semi range space should be maintained.

Brooding temperature / heat:

The brooding temperature levels and duration depend upon ambient temperature. However, young ducklings must be kept warm for the first 7 days, especially for first 3 days. Normally the required brooding temperature is as follows: 1-3 days 35° C, 4-7 days 34° C – 30° C and 7-14 days it is 29° C - 24° C. In areas with high ambient temperature, take great care not to over heat the ducklings during brooding.

Water:

First 3 days water plus a vitamin and mineral preparations should be provided in Chick drinkers in order to help the ducklings to recover from traveling stress. Ducks should be provided with an easily accessible clean drinking water at all times. The floor area must be kept dry.

When chicks are access to an outside run which incorporates a swimming channel then ensure that there is a steady flow of fresh water through the channel at all times. Empty and clean water channels at least twice in a week. If there is no flow of water, empty and clean the channels everyday.

Lighting:

Provide 23 hrs of light each day from 0-3 wks. One hour darkness during this period ensures that the ducks are accustomed to darkness. From 3 - 66 weeks of age provide 17 hrs of light each day. It is very important that lighting programme is not disturbed as this will reduce egg production. The light intensity required is 5 to 10 lux. This level can be achieved by providing 5 watts incandescent light bulbs per sq.mt.

Rearing system of breeder stock:

Accurate control of body weight during rearing period is vitally important to achieve optimum breeding performance. Males are genetically selected for their carcass characteristics and females are selected for their productive and reproductive traits. Hence, they differ in body weights and growth pattern. For this reason sex separate rearing is very important.

FEEDING /NUTRITION TABLE (Day old to 28 days of Age):

Type of feed and method of feeding are significant factors in determining the breeder production performance. If the feeding levels and target body weights are not accurately controlled, egg production and hatchability will be adversely affected.

Feeding levels in hot climates: (Table-1)

Age days	Males g/day/duckling	Females g/day/duckling	Age days	Males g/day/duckling	Females g/day/duckling
1	2.4	2.3	15	71.6	68.2
2	7.2	6.8	16	76.3	72.8
3	10.7	10.2	17	81.1	77.3
4	14.3	13.6	18	85.9	81.9
5	17.9	17.1	19	90.0	85.5
6	21.5	20.5	20	94.0	89.0
7	25.0	23.9	21	97.5	92.5
8	30.5	29.1	22	101.0	96.0
9	36.5	34.8	23	104.5	99.5
10	42.9	40.9	24	108.0	103.0
11	49.9	47.5	25	111.5	106.0
12	57.2	54.6	26	114.5	109.0
13	62.0	59.1	27	117.5	112.0
14	66.8	63.7	28	120.0	115.0

During this period the objective is to keep the flock growing along the growth as mentioned below:

Age in weeks	Male body wt.	Female body wt.	Age in weeks	Male body wt.	Female body wt.
4	1200	1050	15	3200	2750
5	1550	1350	16	3300	2850
6	1900	1600	17	3380	2920
7	2200	1800	18	3450	3000
8	2400	2000	19	3520	3050
9	2550	2150	20	3600	3100
10	2650	2300	21	3680	3150
11	2750	2400	22	3720	3180
12	2850	2500	23	3750	3200
13	3000	2600	24	3750	3200
14	3100	2680			

The control of body weight is achieved by accurate control of the daily feeding quantity.

Feeding/ nutrition:

There are variations in estimates of the nutritional requirements of breeding and laying ducks, Dean (1985) and Scott and Dean (1991) and also recommended by the ARC (UK) NRC (USA), Central Duck Breeding Farm, Vigova Super M (Parent Stock Management manual) and other commercial breeding companies. In these varied estimates, the protein requirement is 15 – 19.5%, lysine is 0.6 to

1.1% and Methionine is 0.5 to 0.68%. These variations may be partially due to differences in genotype and climate.

Controlling growth can be achieved by restricting feed and thus energy intake using diets formulated to provide sufficient intake of other nutrients to support limited but healthy growth to maturity. During feed restriction/controlled growth birds should be allowed to get an equal opportunity to obtain a fair share of the valuable feed.

Table : NUTRIENT COMPOSITION SUITABLE FOR DUCK BREEDERS *(Hot humid climate)*

NUTRIENT	**STARTER 0 – 5 wks**	**GROWER 6 – 20 wks**	**ADULTS Above 20 wks**
Pellet Diameter (mm)	3	4	5
Energy Kcal/kg	2900	2850	2700
Protein (%)	22	15.5	19.5
Available lysine %	1.2	0.70	1.1
Available Methionine %	0.4	0.3	0.31
Available Methionine + Cystine %	0.8	0.55	0.68
Calcium %	1.0	0.9	3.50
Available Phosphorus %	0.50	0.40	0.45
Linoleic acid % min	0.75	0.75	1.1
Sodium min.	0.18	0.18	0.18
Fibre %	3.5	4.5	4.0

In three large scale trials, (data from cherry, 1993) growth was controlled to give live weight at 20 weeks in a range of 2.5 to 4 Kg, which is about 50 - 80 % of ad-libitum feeding weight.

As per as production is concerned, birds were under restricted feed to achieve 70 and 75% of ad-libitum mature weight at point of lay were able to produce 173 to 211 eggs in 60 weeks of age, compared to 110 – 140 eggs in ad-libitum fed group of birds at the same weeks of age. It is very much essential to keep close to the target body weight curve throughout rearing period. Much deviations above or below will affect the age at sexual maturity, the number of eggs produced, egg size, fertility, hatchability etc.,

On 29th day before feeding 10% of female and male birds should be weighed randomly. Average body weights to be calculated and compared with standard target weights. If the average weights are below standard, feed little more / or 5th week feed level. If the average weights are above standard, feed the same quantity i.e. 28th days feed level.

Weigh birds every week and adjust the feeding level after each weighing so as to ensure that the weights follow the target levels. Adjust / increase the feeding only by 5 – 10 gm /duck /day.

Grading:

Maintenance of flock uniformity during growing period is very important to achieve uniform body weight and egg size. The flock should be segregated three times during growing period. 100% birds should be weighed and segregated into 3 or 4 groups based on their body weight. Lower body weight birds should be given 5-10 gms. more feed. The objective of good growing is to have uniform body weight and skeletal frame. In a uniform flock, majority of the birds will have similar physiological state. Such birds will attain maturity at the right time and give consistently good performance. To have a uniform flock, controlled growth along with target weights for age are necessary as mentioned early in Table – I & II, following restricted feeding, growth control is achieved. However, restricted feeding may result in competition for feed consumption which leads to variation in body weight in flocks. In other words it disturbs uniformity. Other reasons for poor uniformity are improper feed distribution, too much

feed restriction, poor feed quality, over crowding, inadequate feeding space, improper brooding, faulty debeaking, vaccination reactions, disease conditions etc.,

As a thumb rule, whenever flock uniformity goes below 75% that flock should be graded /segregated into different groups. This should be done at least three times during 6^{th} – 12^{th} and 18^{th} weeks of age. This should be done by weighing all the 100% birds.

At 20 weeks of age:

Change feed from developer to breeder ration. Mix males with females at the ratio of 1:5 (1 Male : 5 females) and feed them the same level. From 20^{th} – 22 week, give daily feed increments by 3 grams per duck per day in order to achieve a gradual increase to ad-libitum feeding at 22 weeks of age. From 22 weeks to 66 weeks of age provide free access to feed hoppers throughout the laying period, feed hoppers should be cleaned everyday. During laying period, there is no feed restriction.

Controlling egg weight:

To achieve good hatchability in temperate climates from genotype selected for rapid growth, egg weight must be limited to about 93 gms. by restricting energy intake through either quantitative or time feeding. Though age affects the egg weight, it is important to encourage feed intake when birds are coming into lay to achieve maximum egg weight in early stages. Genotypes which are selected for rapid growth to control egg weight after 30 weeks of age can some times affect post peak production. Hence, a sensible approach to be applied for moderate feed restriction by allowing birds between 6 and 8 hour feeding from about 23 weeks and then gradually reduce feeding time or feed quantity as egg weight approach 90 gm. However, increasing in environment temperature also reduces feed intake and subsequent egg weight, which means that during summer birds must be allowed more feeding time. To control egg weight by restricting energy intake but to maintain layer performance it is essential to provide a diet formulated to allow birds to achieve their requirements for other nutritients. While formulating duck breeder diets, it is desirable to know both feed intake and environment temperature. Controlling /reducing feed intake by 12 gm. or 130 KJ. Per day, average 2 gm. of egg weight can be reduced. But genotype, mature weight and dietary energy can alter the pattern of response to some extent (Cherry, 1993). Egg weight should be maintained between 88 – 92 gms. However, controlling egg weight is as much as skill as a science, requiring experience in the effect of genotype, age, environmental temperature and nutrient composition upon food intake, rate of lay and egg weight.

Litter management, nest box and egg collection:

Litter use for floor and nest boxes must always be clean, dry and free from mould in order to keep ducks and more importantly eggs clean. The spores from the mould can be easily carried into the hatchery where they grow and spread quickly causing high level of infections.

Nest boxes:

Nest boxes are essential to ensure the majority of the eggs are laid in clean conditions. The cleaner the nest box litters, the cleaner the eggs and hence hatchability is better.

Place nest boxes around the perimeter of the pen when the ducks reach 22 weeks of age so that birds get used to enter the boxes and lay eggs in the next boxes. The size of the nest box is 40 cm x 40 cm x 40 cm. This one cubicle is recommended for 4 birds.

Egg collection:

Egg collection must be the first job of the day. To avoid cracking eggs and the spread of the bacteria from shell to shell, eggs should be collected on plastic egg trays (which can be washed with

disinfectants everyday and plastic trays support each egg individually). Avoid always eggs from rain and extremes of climate and direct Sunlight.

Egg washing:

Ducks lay most of the eggs on floor , they tend to be contaminated with bacteria even with good nest material. Hence, it is essential to wash eggs in order to achieve high levels of hatchability. Inadequate egg washing can reduce hatchability levels as much as 10-15%.

Washing chemicals : Chlorine Based
Washing time - 10 minutes
Washing Temperature – 35° C
Washed eggs should be allowed dry before storage.

Egg storage:

After washing eggs, eggs should be moved directly to the egg store room. Good egg storage is especially important in hot climate or during hot period of the year. This is to synchronize the hatch and to have high levels of hatchability.

Storage temperature:

In temperate regions 13° – 15° C and in hot humid region 18°C should be maintained. Relative humidity of 75 to 80% is to be maintained in order to reduce the evaporations from the eggs.

Storage time:

The optimum storage period of duck hatching eggs is 2 – 4 days. If the storage time increases, the hatchability will decline very fast. Egg store room and its area should be washed and disinfectant once in a week. Egg store must be kept clean and dry in order to minimize the opportunity of the eggs to be recontaminated with bacteria.

Records:

Complete records including rearing, body weights, uniformity charts, feeding and laying should be accurate, comprehensive and regularly reviewed. By keeping complete records for each flock the flock performance can be assessed in relation to its history. Records should be kept in numeric and graphic form.

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PRESENT STATUS OF DUCK FARMING IN ASSAM

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Abstract

Duck production is an integral part of the socio-economic life of rural people of Assam. This paper describes briefly about the different breeds and breeding, incubation, management, housing and equipments, nutrition and feedstuffs, production performance, incidence of diseases, mortality pattern , marketing and areas of future research for duck in Assam. The different breeds and types of duck found in the State of Assam are Pati (Desi), Nageswari, Sylhet mete, Muscovy, Khaki Campbell, charachemballi, Vigova super M etc .Most of the duck eggs in this region are hatched under broody hen/duck (natural incubation) with a hatchability percentage of above 60.

There are two systems of duck production–back yard system and improved system which is practised in Government farms only. In rural condition during the first 10-14 days ducklings are kept in clean baskets. From about 2-4 weeks the ducklings are kept on rice husk or straw in a corner of the house with plenty of fresh air and sunlight. The flock size averages 8-20 ducks normally in rural areas with a range of 8 –200 ducks.Farmers spent very little amount for housing of the ducks. Ducklings are fed in the beginning with boiled rice, broken rice, rice bran, chopped earth worms/snails, small fishes, green vegetables etc. Every morning ducks were given some feed and after which the ducks are allowed to go for foraging .In organized farms, ducks are given a balanced diet. Feed is provided once in morning and once in afternoon comprising a total quantity of 150 grams per duck per day. In rural condition of Assam the age at sexual maturity ranges from 220-235 days in Pati, 170-205 days in Nageswari, 185-220 days in Khaki Campbell,190-230 days in Graded (Khaki Campbell X Pati),200-235 days in Graded(Pati X Khaki Campbell),290-325 days in Muscovy, 320-355 days in Rajhanh(Geese) and 185-225 days in Charachemballi . The annual egg production per duck recorded for Pati 70-95 eggs, Nageswari 130-160 eggs, Khaki Campbell 135-150 eggs, Graded (Khaki Campbell X Pati) 90-130 eggs, Graded (Pati X Khaki Campbell) 80-120 eggs, Muscovy 45-65 eggs, Rajhanh 25-35 eggs and 110-135 eggs in Charachemballi. The most common diseases in ducks are duck plague, duck cholera, hepatitis and aflatoxicosis in different ages of ducks. Ducks eggs, yearling duck and spent ducks are marketed in rural areas as well as in cities. Although limited research has been undertaken in different aspect of duck production, plan for intensive research should be undertaken by Assam Agricultural University and other research organization in Assam.

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Key word: Duck, incubation, foraging, aflatoxicosis

Introduction

The popularity of duck raising in Assam has been increased in the last two decades. This is due the availability of abundance surface water like river, beels, ponds, marshy and water logging areas with varieties of aquatic insects, weeds, snails, small fishes, earth worm and algae, the social structure and tradition stipulate the suitable condition for duck rearing in this region , apart from the various advantages

of rearing duck over chicken. The total duck population in Assam is 6.88million (Livestock census, 2003), which constitute 31.82 % of total poultry population. The 85.6 per cent of the duck in Assam are
desi (Sarma, 2003).About 96.47 % ducks are reared in rural areas only and remaining 3.53 % in urban areas. Duck occupy second place after chicken in number and in egg production in Assam although duck has not received adequate attention for its development like that of chicken till date (Poultry Industry Year book 2003-04).

Materials and methods:

The present investigation was conducted in duck populated areas selected randomly from the different agro climatic zones of Assam. The different duck farmers are identified along with the different location with the help of Animal Husbandry and Veterinary officers of the selected villages on the basis of their flock strength. A farmer who had a minimum of 10 ducks was considered as a duck farmer for the present study .A total of 110 farmers was selected. The required information was collected by means of questionnaire, personal interview and house hold records. Although there are many breed/types of ducks

reared in the village of Assam ,considering the economic aspect of production of duck and population status of duck for the proposed study five different genetic groups of ducks Viz Khaki Campbell, Pati, Khaki Campbell X Pati, Pati X Khaki Campbell and Chara chemballi were considered .The present investigation involved a total of 1050 numbers of ducks belongings to five different genetic groups of 210 numbers of ducks in each group. Each farmer rear more than on group of duck and number of ducks varied from farmer to farmer. Ducks with incomplete records were not included in this investigation. The information pertaing to different breeds/types, incubation, housing and management, nutrition, productive and reproductive performance, incidences of diseases and health coverage, mortality pattern and marketing were recorded**.**

Results

Breeds and Breeding:

The different breeds/types of duck found in the State of Assam are Pati (Desi), Nageswari, Sylhet mete, Muscovy, Khaki Campbell, Charachembelli, Deohanh, Rajhanh (Geese) Vigova super M etc. In most of the villages of Upper Assam Muscovy duck is known as "China hanh", "Bor china", "Bhatt china" etc. A wild variety of duck known as "Deo hanh" is very much popular in Upper Assam due to its delicious meat quality. Few years back the State Institute of Rural Development (SIRD), Govt. of Assam introduces the charachemballi, an indigenous layer breed of Kerala in various places of Assam through different self-help group for economic upliftment of rural women (Annual Report SIRD, 2007-08). It is also reported that already more than 4 lakhs charachemballi ducks have been made available to the different self-help groups of various parts of Assam. Further the State Institute of Rural Development also introduces Vigova super M a meat type duck in certain pockets of Assam. Many unemployed youth have started the rearing of this meat type duck in different parts of Assam for income generation. The production potential of the desi ducks widely known as "Pati hanh" are very poor. They are good forager, hardy with higher survivability rate in rural condition. However, their legs are so short that their bodies almost touch the ground and it is difficult for them to travel long distance. The govt. of Assam brought long back a suitable parent flock of pure Khaki Campbell duckling as a base stock at Kaliabor and Hajo. The local breeds in selected pockets of Assam were upgraded with pure Khaki Campbell males through various block and community development center under the Department of Animal Husbandry and Veterinary, Govt. of Assam. The graded duck with 50% Khaki Campbell inheritance were claimed to have exhibited better performance and survivability rate at rural situation as compare to the purebred Khaki Campbell ducks. But in course of time the pure Khaki Campbell were reduced in size due to unplanned breeding and lack of quality inputs. In Tripura, there is a big state central duck breeding farm, which maintains pure Khaki Campbell duck in semi intensive system. The farm earned good repute

initially but experienced certain problem later on in maintaining the better production performance and survivability rate due to multifarious problem.

Incubation:

Most of the duck eggs in this region are hatched under broody hen/duck (natural incubation). About 15-18 eggs are hatched under each broody ducks with a hatchability of above 60 per cent. However, for large scale hatching on a well-organized farm incubators designs for chicken eggs are used (Artificial incubation) with slight modification in the egg holding trays to properly accommodate duck eggs and obtain satisfactory hatchability. Normally farmers claimed a hatchability of 70-80% on total egg set basis in artificial incubation. Hatching is synchronized with rice harvesting, which is seasonal and occurs in October – November, January – February and April – May.

Management, housing and equipments

There are two systems of duck production–back yard system and improved system which is practiced in Government farms only. The most favorable time for rearing duckling is during the rainy season. Ducklings in organized farms are brooded for 2-3 weeks indoor. Fishing nets are sometimes hung in surrounding areas to prevent predators from attacking the ducklings. Simple nest, open type with partitions is provided 4-6 weeks before lay in some progressive farms. However, some of the farmers allow ducks to lay on litters. Some farmers provide 16-18 hours light for duck during laying period. But most of the farmers provide very deem light from a hurricane lamp. In rural condition during the first 10-14 days duckling are kept in clean baskets with about 5 cm of rice husk or straw in the bottom of the basket. This is changed frequently to keep the ducklings dry and comfortable. The basket is also covered with a piece of loosely woven jute bags to protect the ducklings from the cold. Duckling starts eating one day after hatching and they grow rapidly. From about 2-4 weeks the ducklings are kept on rice husk or straw in a corner of the house with plenty of fresh air and sunlight. Although the older ducks enjoy the rain, the younger duckling is protected from storms. Little money is spent on housing and equipment of duck except for a 60-90 cm height split bamboo enclosure in rural condition to keep the ducks during night time. On well-organized farm with improved varieties of duck intensive or semi intensive system with gable type houses and asbestos sheets as roofing materials are considered. Wire floor are used for duckling upto 3-4 weeks of age. In semi intensive systems the watering arrangement is

located at the end of the house. Normally a continuous water trough 50 cm wide and 15-20 cm deep constructed running parallel to the rearing or layer house wall on both sides. Long round feeder/simple bamboo container sufficient to store large quantity of feed are used. The flock size averages 8-20 ducks normally in rural areas with a range of 8 –200 ducks.

Nutrition and feedstuffs:

Although no attention is given to nutrient requirement of duck in back yard system of rearing but ducklings are fed in the beginning with boiled rice, broken rice, rice bran, chopped earth worms/snails, fish, green vegetables etc. Every morning (after the eggs are collected) ducks were given some feed and after which the ducks are allowed to go to beels for foraging where they search for natural feed such as earthworm, snails, small fish and plant material. Ducks are brought back to their houses before dark. A small quantity of feed is given before putting them into the house. This encourages the ducks to return home promptly at the end of each day. On organized farms, ducks are given a balanced diet (starter 0-6 weeks, grower 6-16 weeks and layer beyond 16 weeks) as a wet mash. Ingredients included rice bran, wheat, soyabean meal, fish meal, bone meal, sesame cake, shell grit, mineral and vitamin premix. Feed is provided once in morning and once in evening comprising a total quantity of 150 grams per duck per day.

Production performance

In rural condition of Assam the age at sexual maturity ranges from 220-235 days in Pati, 170-205 days in Nageswari, 185-220 days in Khaki Campbell, 190-230 days in Graded(Khaki Campbell X Pati),200-235 days in Graded(Pati X Khaki Campbell), 290-325 days in Muscovy, 320-355 days in Rajhanh(Geese) and 185-225 days in Charachemballi . However, Mahanta et al (2001) reported that age at sexual maturity to be 240 days in pati ducks in Assam. Islam (2002) also made similar observation.

The annual egg production per duck recorded for pati 70-95 eggs, Nageswari 130-160 eggs, Khaki Campbell 135-150eggs,Graded(Khaki Campbell X pati) 90-130 eggs, Graded (Pati X Khaki Campbell) 80-120 eggs, Muscovy 45-65 eggs, Rajhanh 25-35 and 110-135 eggs in Charachemballi . Further Barua et al 1992, Das et al 2000, Kalita et al 2004(a,b),Kalita et al 2005,Kalita 2006, Sarma 2003 and Saharia 2003 reported that the Khaki Campbell duck found to be superior for all the productive traits like age at sexual maturity, body weight, egg production, egg weight etc. than the pati ducks. However it is observed that the crossbred progeny of Khaki Campbell and Pati perform well for almost all the traits than the pati duck in the climatic condition of Assam.

Incidence of diseases, mortality pattern and health maintenance:

The most common diseases in the Assam occurs in ducks are duck plague, duck cholera, hepatitis and Aflatoxicosis in different ages of ducks.

The ducks are vaccinated against duck plague. In addition the ducks are treated with different antibiotics, potash solution, local vodka and black pepper depending upon different outbreak. Mortality was found to be highest in Khaki Campbell and lowest in Pati ducks.

Marketing:

Ducks eggs and spent ducks are marketed in rural areas as well as in cities. In non duck-producing areas, there is consumer resistance to pati ducks egg and meat. It is claimed that these products have an unpleasant odour due to perhaps the feed they scavenge and their housing condition. This consumer resistance is not found for egg and meat from ducks raised on well organized duck farms where good management is practiced thereby encouraging the producer to rear the ducks in intensive/semi-intensive system. Egg is usually transported in this region in egg trays and card board boxes. Each box contains 7 trays, each of which accommodates 30 eggs and totally 210 eggs per box. Normally duck's egg in Assam fetches a high price (50 paisa to one rupee) than the chicken eggs, which is indicative of popularision of duck farming in Assam.

Discussion:

The differences between the different genetic groups in regards to different traits perhaps due to the different genetic makeup genetic .Further these differences were also attributed due to some non-genetic influences like nutrition, agro climatic condition and slight differences in managemental practices. Further the average value observed for different groups in the present study were slightly differ than those reported by many authors(Kalita et al 2004,Kalita and Deka,2005,Kalita,2006(a) and Kalita,2006(b)), which might be due to poor nutrition and poor managemental practices because in the present experiment ducks are reared under semi-scavenging condition with little supplementation of ration However Similar values are also reporetd by Mahanta et al.(2001),Barua et al (1992),Das et al (2000) and Saharia (2003)

Areas of future research:

Although limited research has been undertaken in different aspect of duck production, intensive research by Assam Agricultural University and other research organization in Assam should be undertaken in the following areas.

1. Adaptability of exotic breeds and varieties of duck to local condition of Assam.

2. Technology to improve productivity of local (indigenous) stock by appropriate short term and long term proposal.

3. To investigate the economic implication of confinement of duck and to identify a suitable breed to this system.

4. To find out the reaction of duck to different microclimatic environments so as to ultimately recommend the optimum condition for economic production.

5. To investigate the effect of different housing system on duck production to suggest a low cost diet appropriate to the system of management.

6. Improved marketing channels should be developed for selling the table eggs and duck meat from village to the cities and towns

7. Disease diagnostic laboratories and vaccine producing center should be equipped with modern facilities so that villagers can obtain information and assistance.

8. Several feed mills need to be established in different locations where farmers can purchase balanced diet for their ducks.

Conclusion:

The development of duck industry depends with the economic progress of other industry. Procurement of improved genetic stock, adoption of better management system, providing qualities ration to the ducks and increased knowledge and application of disease control, have an important role for popularization and further development of duck farming in this region. The present study suggests the suitability of rearing crossbred ducks over Khaki Campbell and pati, as they are more resistant to adverse climatic condition of Assam than Khaki Campbell and also production performance of cross bred ducks were better than that of pati ducks. However, in general performance of khaki Campbell ducks is better than other four groups of ducks for almost all the traits followed by Charachembelli, Khaki Campbell X Pati, Pati x Khaki Campbell and Pati ducks. The performance of Charachembelli although comparable to Khaki Campbell and better than Graded and pati,but it needs another few generations to study its consistence performance both in respect of production and adaptability in the State of Assam. Mortality percentage is more in Khaki Campbell ducks and lowest in Pati ducks

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(5)Preferred Session : Housing and Management

(6) Category : Research Article

BIOSECURITY

COMPARISON OF OMPH GENES OF *PASTEURELLA MULTOCIDA* ISOLATED FROMDUCKS AND FOWL IN KERALA

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Summary

Several studies have been carried out on the outer-membrane protein (OMP) genes of Pasteurella multocida isolated from chicken but reports on research on OMP genes of *P.multocida* is scanty. In this study primers were designed to amplify the ompH genes of *P.multocida* isolated from ducks. The amplified PCR products were subjected to restriction enzyme digestion. *Hinf* I digested PCR product revealed fragments of sizes 821, 107 and 72 base pairs. While *Dra* I digestion generated four fragments of sizes 346, 314, 209 and 131 base pairs. Similar digestion patterns were obtained for all the 25 isolates from ducks as well as the fowl isolate FP 1 and the reference Poultry strain LKO. The amplified PCR product was sequenced. A 994 bp sequence was submitted to the Genbank and was assigned an accession number of AY606823. Sequence similarity searches were performed with Basic Local Alignment Search Tool (BLAST) provided by the National Centre for Biotechnology Information (NCBI). The sequence had 98 per cent identity with *P. multocida* strain X-73 outer membrane protein (*OmpH*) gene (Accession No U50907).

Key words: PCR, OmpH, *P.multocida*, Restriction enzyme analysis and sequencing

Introduction

The outer membranes of Gram-negative bacteria form an interface between the bacteria and the host environment. It harbours various molecules like proteins, polysaccharides and lipids, which are surface-exposed or embedded in the membrane. These components are presently being investigated for their role in pathogenicity and ability to elicit a protective immune response.

Luo *et al.* (1997) cloned and characterized the major outer membrane protein gene of *P. multocida* X-73 (serotype A:1). They designated this gene as *OmpH* gene as it encoded major outer membrane protein OmpH. This gene was distributed in all the 15 serotypes of *P. multocida* . Purified X-73 ompH protein induced 100 per cent protection in chicks, confirming its protective nature. Report of work related to OMPH genes of *P. multocida* isolated from ducks is scanty. Hence the present study was undertaken.

Materials and Mmethods

Twenty five strains of *P.multocida* isolated from ducks (labeled DP1 to DP 25) and a fowl isolate of *P.multocida* were used in the study. A reference strain (LKO) of *P. multocida*, obtained from Indian Veterinary Research Institute, Izatnagar, was used for comparison. All the isolates were characterized up to the species level as *P.multocida*. All the 25 isolates from ducks, the fowl isolate FP1 and the standard

reference strain LKO when subjected to specific amplification by PM-PCR (Townsend *et al*. 1998) were found to be PM-PCR positive.

Primers for OmpH-PCR

Two oligonucleotides based on the sequence of *P. multocida* X-73 *ompH* gene, Accession No. U50907 (Luo *et al*., 1997) were designed using Primer3 software. The primers were custom synthesized by M/s Bangalore Genei India.

The sequences of the two primers were as follows:

OmpH F5'-GCG TTT CAT TCA AAG CAT CTC-3' - 21 mer
OmpH R 5'-ATG ACC GCG TAA CGA CTT TC -3' - 20 mer

Culture lysates were used as template DNA in PCR. The 50ul reaction mixture The reaction contained: 5 µl of template DNA, 40 pmol each Primer, OmpH 1and OmpH R, 5 µl of 10x PCR buffer, 2 units *Taq* DNA polymerase, 2 µl dNTP mix. The following programme was used - initial denaturation at 94°C for 5 min, followed by 35 cycles of denaturation at 94°C for 15 sec, annealing at 56°C for 1 min, extension at 72°C for 1 min and a final extension at 72°C for 10 min. The template DNA used was bacterial culture lysate. The product was analysed on 1.5% agarose gel containing ethidium bromide. Standard molecular size marker low range DNA ruler with fragments 3000, 2500, 2000, 1500, 1000, 600, 300 and 100 bp was used as DNA molecular size markers to ascertain the size of the amplified PCR product. Electrophoresis was carried out at

5V/cm for one hour (or) until the bromophenol blue dye migrated more than two-third of the length of the gel. The gel was visualized under UV transilluminator (Hoefer, USA) and the images were documented in a gel documentation system (Bio-Rad Laboratories, USA).

Restriction Enzyme Analysis Of Omph-PCR Product

Two restriction enzymes viz., *Dra I* and *Hinf I* were used in this study. The enzymes were obtained from Bangalore Genei Pvt. Limited, Bangalore.

The restriction digestion mixture was prepared in thin walled PCR tubes. The reaction mixture contained 10 µl amplified PCR product, 2 µl of 10x RE buffer, 1 µl (10 units) of Restriction enzym and distilled water to make up the volume to 20µl. Restriction enzyme digestion was performed in Eppendorf Master Cycler, (Germany). The digestion was carried out at 37°C for two hours, followed by inactivation of the enzyme at 80°C for 20 min. The restriction fragments were analysed on eight per cent acrylamide gels (DNA-PAGE). Five microlitres of the amplified PCR product digested with restriction enzyme was mixed with one microlitre of 6x gel loading buffer and carefully loaded in the wells under the buffer column. In one of the wells undigested amplified PCR product was added. Electrophoresis was carried out at 70 V till the bromophenol blue dye reached the bottom of the gel. At the end of the electrophoresis, the glass plates were dismantled and the gel was stained with ethidium bromide. The gels were viewed on a transilluminator and photographed using a gel documentation system.

Sequencing of PCR Product

The purified PCR product was directly sequenced by Sanger' dideoxy-chain termination method using ABI PRISM Model 310 version 3.4.1. Primers OmpH 1 and OmpH 2 were used as sequencing primers. Sequencing was carried out at the School of Biotechnology, Madurai Kamaraj University, Madurai, Tamil Nadu.

Sequence similarity search was performed using Basic Local Alignment Search Tool (BLAST) network provided by the National Centre for Biotechnology Information (NCBI).

Results and Discussion

The primer pairs OmpH 1 and OmpH 2, designed to amplify the *OmpH* gene of *P. multocida* successfully amplified the *OmpH* gene of all the 25 isolates from ducks, fowl isolate FP1 and the reference strain LKO. (Fig 1). The amplified product had a size of approximately 1000bp. Primer pairs OmpH 1 and OmpH 2 did not amplify the DNA prepared from unrelated bacterial species such as

Streptococcus zooepidemicus, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Leptospira* serogroup *canicola* serovar *canicola*. Similar results were reported by Luo *et al.* (1999) who

had reported successful amplification of *OmpH* genes of the serotypes 1, 3 and 4 to 16 of *P. multocida* and the product had an approximate size of 1 kilo-base pairs.

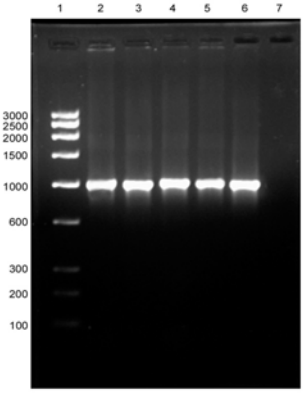

Fig. 1 Amplification of *OmpH* gene of *P. multocida*

Lane 1 : Low range DNA marker
Lane 2-3 : LKO & FP 1
Lane 4 -6 : DP 1 , DP 10 & DP 25
Lane 7 : Negative control

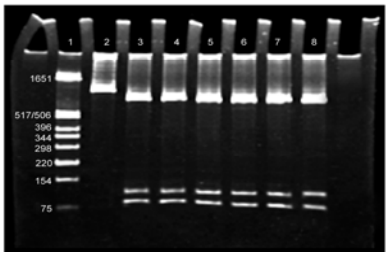

Fig. 2 REA of OmpH-PCR product of avian isolates with *Hinf* I
Lane 1 pBR 322 DNA/*Hinf* I digest marker
Lane 2 Undigested OmpH-PCR product
Lane 3-8 LKO, FP 1, DP 1, DP 8, DP 15 & DP 25

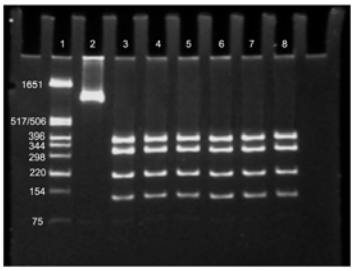

Fig. 3 REA of OmpH-PCR product of avian isolates with *Dra* I
Lane 1 pBR 322 DNA/*Hinf* I digest marker
Lane 2 Undigested OmpH-PCR product
Lane 3-8 LKO, FP 1, DP 1, DP 8, DP 15 & DP 25

Analysis of *Hinf* I digested PCR product revealed fragments of sizes 821, 107 and 72 base pairs (Fig. 2).While *Dra* I digestion generated four fragments of sizes 346, 314, 209 and 131 base pairs. (Fig 3). Similar digestion patterns were obtained for all the 25 isolates from ducks as well as the fowl isolate FP 1 and the reference strain LKO. Thus the PCR-RFLP of OmpH-PCR products with the two restriction endonucleases viz., *Dra* I and *Hinf* I could not reveal any polymorphism or heterogeneity within or between the duck and fowl isolates of *P. multocida.* This indicates a high level of homogeneity amongst the amplified region of the isolates.

Eight duck isolates (DP1 to DP8) and fowl isolate (FP1) of P. multocida were serotyed as A:1 by the division of Bacteriology an Mycology IVRI, Izatnagar. This further indicates the high level of homogeneity between the duck and the fowl isolates of *P. multocida* isolated from Kerala. This finding could be of epidemiological significance, indicating that fowl isolates could readily infect ducks and vice-versa. The pathogenicity studies also seemed to support this finding. Muhairwa *et al.* (2001) showed that strains of *P. multocida* isolated from chicken and ducks in the same area were identical by phenotypic markers and ribotyping. They suggested that the isolates of chicken and ducks from the same area were closely related and have the potential to adapt to different hosts. The authors also stressed the importance of dogs acting as a transient carrier of *P. multocida* and transmitting the disease to other flocks by moving carcasses. A similar scenario is seen in the villages of Kerala where ducks and fowl are kept in close proximity and an ever-increasing population of stray dogs may help in the transmission of the disease between the species.

Sequencing revealed the presence of 994 base pairs. The sequence has been submitted to the GenBank and has been assigned the accession No AY606823. Sequence similarity searches were performed with Basic Local Alignment Search Tool (BLAST) provided by the National Centre for Biotechnology Information (NCBI). The sequence had 98 per cent identity with *P. multocida* strain X-73 outer membrane protein (*OmpH*) gene (Accession No U50907). These findings are in accordance with that of Luo *et al.* (1999) who analyzed the DNA sequence of *OmpH* genes of *P. multocida* serotypes 4-16. The PCR products were purified and directly sequenced. Their study revealed a high degree of homology among different serotypes. The present investigation indicates that *P. multocida* serotype A:1 is prevalent in Kerala and there is little variation between the isolates from ducks and chicken. However, continuous monitoring of the field situation for emergence of new serotypes is a must for effective control of the disease.

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IMMUNOMODULATORY ACTIVITY OF ETHANOLIC EXTRACT OF *CURCUMA MANGGA*VAL. RHIZOME IN DUCKS-TREATED WITH H5N1 VACCINE

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Abstract

Immunized avian by vaccine, produces specific antibody in the serum as well as in the egg yolk. *Curcuma mangga* Val. rhizome, contains some chemical compounds such as essential oil, curcumin, amylum, tannin and saccharide. It could enhance the lymphocyte proliferation and specific antibody production, due to the activity of curcumin. The aim of this study was to evaluate the capability of the ethanolic extract of *Curcuma mangga* Val. rhizome in enhancing the specific antibody (IgY) production in ducks-treated with H5N1 vaccine. Groups I, II, III, IV and V (@ 5 ducks) of ducks-treated with the vaccine by intramuscular injection after 7 days being acclimatized. Group of I, II, III, and IV were oral administered once a day with ethanolic extract of *Curcuma mangga* Val. rhizome (prepared in capsules) on dosis of 17.43 mg; 34.87 mg; 69.73 mg; and 139.47 mg/kg duck body weight (BW) respectively through out of the study, and group V as a control. The eggs were collected on day 12, 15 and 18 while the serum on day 15, 31 and 42. Isolateion of IgY was performed by repeated polyethylene glycol 6000 (PEG-6000) precipitation steps and then the pellets were weighed. The serum was tested for the specific antibody against the influenza H5N1 virus by hemagglutinin-inhibition (HI) method and then analyzed by indirect ELISA method and S/P ratio was then calculated. The result of this study showed that ethanolic extract of *Curcuma mangga*, Val. rhizome had a capability to enhance the production of specific antibody against H5N1 vaccine, with significantly ($p<0.05$) highest of the dose of 139.47 mg/kg duck B.W. in comparation to the control.

Keywords: Duck, Antibody, Ethanolic extract, *Curcuma mangga*, Val. rhizome, H5N1 vaccine

Introduction

Various herbal preparations have been reported to show an immunomodulatory effect. The used of herbal immunomodulators perhaps might be helpful in the future (Sakure *et al*., 2008). With the herbal immunomodulators as adjuvant, the vaccine induced protective antibody levels against the original H5N1 strain, including when used at low doses (Stephenson *et al*., 2003). *Curcuma mangga* Val., has been used as a herbal medicine. *Curcuma mangga* Val. rhizome, contains some chemical compounds such as essential oil, curcumin, amylum, tannin and saccharide (Anonymous, 1988). Curcumin is a principal yellow pigment present in the rhizome of *Curcuma longa* L and other related spesies. Several studies due to curcumin as immunomodulator have been done. Only few studied have shown the stimulatory effect of curcumin, comparation with the suppressor effect of curcumin. For example, curcumin has been reported to show the stimulatory effect of antibody production from splenocytes and natural killer cell activity in vivo (South *et al*., 1997 in Yadav *et al*., 2001). However, curcumin has been reported from the in vitro study of curcumin by Yadav *et al*. (2001), that it inhibits PHA-induced T-cell proliferation. and cytokine production. In this study, we have evaluated the immunomodulatory as an immunostimulatory activity of ethanolic extract of *Curcuma mangga* Val. rhizome in ducks which were treated with H5N1 vaccine.

Materials and Methods

Materials

Curcuma mangga Val. rhizome was collected from Kulonprogo Distric of Yogyakarta at the end of dry season. Ducks (5 months of age), weighing about 1.4 kg were obtained from Klaten Distric of Central Java. H5N1 vaccine was purchased from Medion company, Bandung, West Java and inactive antigen subtype H5N1 from Pusvetma (Surabaya, East Java). ELISA kit from Sigma company.

Preparation Ethanolic Extract of *Curcuma mangga* Val. Rhizome

The *Curcuma mangga* rhizome were washed, sliced, dried in oven 45^{o}C, powdered. About 2 kg of dried powder, was macerated for 5 days with 70% of ethanol. The 70% ethanolic supernatant was filtered and evaporated under vaccum condition

until it was given viscous mass. The viscous mass obtained was then mixed with pollard powder to get doses of 17.43 mg/kg BW; 34.87 mg/kg BW; 69.73 mg/kg BW; and 139.47 mg/kg BW/capsul. The placebo capsules were prepared by filling capsules with pollard powder.

Experimental Design

The ducks were divided into 5 groups (@ 5 ducks). Group I as the negative control (+vaccine+placebo capsul); group II, group III, group IV and V (+vaccine+17.43 mg/kg BW; 34.87 mg/kg BW; 69.73 mg/kg BW; and 139.47 mg/kg duck BW of ethanolic extract of *Curcuma mangga* Val.rhizome in capsules respectively). After acclimatized (7 days), all ducks were given one intramuscular shot with 0.5 mL of H5N1 vaccine/duck. Eggs were collected on day 12, 15 and 18 while the serum was collected on day 15, 31 and 42. Isolation of IgY was performed by repeated polyethylene glycol 6000 precipitation steps (Gassmann *et al.* 1990). IgY obtained was analyzed by indirect ELISA method. The IgG serum was tested for antibody specificity against inactive antigen subtype H5N1 by HI (hemagglutinin-inhibition) method (Beard, 1989).

Statistical Analysis

The data expressed as means ± SEM were statistically analyzed with Split plot variance, followed by DMRT (Duncan's multiple range test) and Tukey test, using a significance level of $P<0.05$.

Results

The Weighing (g) of Imunoglobulin Yolk Isolated from Eggs

Isolated imunoglobulin yolk from the eggs which were collected on the day 12, 15 and 18 as a response to ethanolic extract of *Curcuma mangga* Val. rhizome
treatment after being given H5N1 vaccine is shown in Table 1.

Table 1. The Weighing (g) of Imunoglobulin Yolk Isolated from Eggs

Day	Control	The dose of Ethanolic Extract			
		17.43 mg/kg BW	34.87 mg/kg BW	69.73 mg/kg BW	139.47 mg/kg BW
12	0.485	0.597	0.926	1.121	1.228
15	0.178	0.758	1.200	1.286	1.305
18	0.236	1.451	0.761	0.273	1.244
Means ± SEM	0.256 ± 0.08	0.773 ± 0.246	0.772 ± 0.211	0.746 ± 0.267	1.025 ± 0.235

The Titer of Antibody

The serum antibody's titer on day 15, 31 and 42 as a response to ethanolic extract of *Curcuma mangga* Val. rhizome treatment after being given H5N1 vaccine
which was measured by using the method of hemagglutinin-inhibition (HI) is shown in Table 2.

Table 2. The titer of antibody against H5N1 vaccine in the serum

The Titer,s Antibody Day of	Control	The dose of Ethanolic Extract			
		17.43 mg/kg BB	34.87 mg/kg BB	69.73 mg/kg BB	139.47 mg/kg BB
15	128	64	64	128	64
31	64	128	128	128	128
42	64	128	128	128	128

Note: Non-vaccinated standard titer is 64 (when it should be negative), in this case there was a big possibility that the standard ducks were already infected by virus or AI vaccine.

S/P ratio values of Immunoglobulin Yolk (IgY)

Absorbancy level gained from ELISA Reader's result in wavelength of 650 nm can be used to determine the S/P ratio value (Standard/Positive sample comparation). S/P ratio indicated whether the immunoglobulin yolk (IgY) is high or low. This value also indicates, the precence or absence of specific antibody against H5N1 virus. The S/P ratio values is given in Table 3

Table 3. The S/P ratio values of control and sample in response of different doses of ethanolic extract of *Curcuma mangga* Val. rhizome

Day of	Control	The Dose of Ethanolic Extract			
		17.43 mg/kg BB	34.87 mg/kg BB	69.73 mg/kg BB	139.47 mg/kg BB
12	1.31	4.39	3.85	1.93	5.12
15	0.89	2.95	1.51	2.16	2.27
18	0.83	4.04	1.58	3.53	4.57
Means ± SEM	0.96 ± 0.118	3.28* ± 0,6	2.10 ± 0.585	2.55 ± 0.353	3.83* ± 0.638

Note: * shows significant difference ($p < 0,05$).
The S/P ratio ≤ 0.5 is indicated negative and it is indicated positive when the S/P Ratio ≥ 0.5.

Discussion

The weighing of the sample could also be used to quantify isolated polyclonal immunoglobulin yielded. Table 1 shows different results between control and treatments. The heaviest sample treated with dose of 139.47 mg/kg duck BW. The sample produces not-so pure IgY isolated with the possibility of the presence of protein with higher molecular weight. Therefore, the more effective and efficient immunoglobulin yolk isolation method is needed, with purer result. Detection of antigen infection from AI vaccine which was measured with the method of HI shows a positive effect. According to Tian *et al*. (2005), when SPF chickens were inoculated with 0.3 ml of H5N1-inactivated vaccine, the hemagglutinin-inhibition (HI) antibody became detectable at 1 week post-vaccination (p.v.) and reached a peak at 6 weeks p.v., whereas ducks and geese were completely protected from highly pathogenic H5N1 virus challenge 3 weeks p.v. In our study, eggs were collected on day of 12, 15 and 18 and serum were collected on the day of 15, 31 and 42. From data in Table 1 is shown the weight of antibody isolated from the eggs give the highest value on day 15 and on day 15 the serum also give the highest titer value. This result indicated that duck is able to produce antibody earlier and then reached a peak at 2 weeks p.v. because of the addition of ethanolic extract of *Curcuma mangga* Val. rhizome. Titer gained for control and treatment groups show variation results between 64 and 128. It might be because of the infection at acute or recovery phase. But, titer gained for duck's serum without any treatments (general standard duck at the market) indicated that the ducks were highly possible already infected by AI virus because it gave positive result. This phenomenon can be proven that domestic waterfowl (duck for example) is a potential intermediate host in zoonotic transmission and these duck usually do not show any disease sign, even when they carry viruses that are highly pathogenic for chickens (Alexander *et al.* 1986; Chen *et al.* 2004; Perkins and Swayne, 2002; Webster *et al*. 2002 in Tian *et al*. 2005). The result from HI test gives a very important information before ELISA test done. The data obtained from HI test could be assumed that there is a specific antibody against H5N1 virus on eggs. Beside indicating the presence or absence of specific antibody against H5N1 virus, S/P ratio also gives information of high or low of immunoglobulin yolk related to the isolate degree after vaccination. The S/P ratio control value is 0.96 while at 139.47mg/kg BW and 17.43 mg/kg BW dose groups show S/P ratio as 3.88 and 3.28. Statistical analysis in both treatments shows a significant different compared to the control group ($P<0.05$). From this phenomenon it could be assumed that the ethanolic extract of *Curcuma mangga* Val. rhizome is proven to give non-direct effect to enhance the specific antibody against H5N1 virus production. It stimulates the lymphocyte cells proliferation and produce higher antibody through a series of immunological reactions as a response of the antigen presentation. This research opens a new horizon to the rise of IgY specific against H5N1 production by adding ethanolic extract of *Curcuma mangga* Val.rhizome as an adjuvant to the H5N1 vaccine which is given in duck.

Conclusion

The result of this study showed that ethanolic extract of *Curcuma mangga*, Val. rhizome had a capability to stimulate specific antibody against H5N1 virus production in duck-treated with H5N1 vaccine, with significantly ($p<0.05$) highest of the dose 139.47 mg/kg duck B.W. in comparation to the control.

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PATHOLOGY OF WATERFOWL DISEASES PERTINENT TO KERALA, INDIA - A STUDY REPORT

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Diseases of birds are serious cause of alarm in view of the emerging pandemics. Waterfowls also root serious concern in this aspect since they have more rooms for spreading the infectious agents through water bodies. A retrospective study conducted over a period of two years brought valuable information on the common diseases in water fowls including ducks and geese. Out of five hundred cases examined the various lesions encountered were hepatosis, enteritis, pulmonary congestion, oophoritis, salpingitis, sinusitis, airsacculitis, epicardial hemorrhage, pericarditis, perihepatitis alone or together with others lesions. Field cases were mostly pasteurellosis, colibacillosis and salmonellosis. This points the fingers towards the major infectious causes as Pasteurella spp., Salmonella spp. and coliforms along with many other infectious agents. There could also be viral agents which could not be diagnosed affirmatively. Incidence of parasitic infestations both internal and external were negligible or nil. The carcasses were brought from different parts of the state. This paper details those diseases which are very much pertinent to present situations in Kerala based on gross and histopathological observations and the methods to prevent these menaces which cause severe head ache to the farmers.

(**Key words**: waterfowls, postmortem observation, lesions, control measures)

Introduction

Waterfowl rearing is traditionally associated with paddy cultivation in general and more so in Kerala. The shrinkage of paddy fields by about ten per cent every year along with occurrence of various diseases has adversely affected the waterfowl production in the state. The common diseases of water fowls in Kerala can be classified as, pasteurellosis, colibacillosis, salmonellosis, mycotoxicosis, viral enteritis and viral hepatitis. Some of the disease conditions showed multiple etiologies. The postmortem observations give the first hand information about the illness of birds and this help the clinician to treat affected birds and prevent the disease from entering other unaffected ones. So the farmers are benefited profusely by just bringing the dead bird for post mortem before it gets decomposed. Many diseases if detected and treated at early stage can be eliminated easily. Stringent biosecurity measures, proper immunization programmes and adequate stress management are some key factors that can direct the farmers to healthy waterfowl production.

Materials and methods

Around five hundred carcasses of waterfowls (white pekin duck, flying ducks, desi cross and muscovy ducks) brought to the Department of Veterinary Pathology over a period of two years from September 2007 to September 2009 were analyzed based on postmortem observations. The carcasses were brought by individual owners from near by areas and recognized farms. Standard post mortem techniques were carried out and tissues were collected for routine histopathological examination. Bacteriological examination was limited to staining the blood and tissue impression smears for morphological identification of the organisms. Intestinal scrapings were collected for microscopical detection of ova or oocysts of parasites.

Results

Condition of the carcass

The specimens examined included carcass of all age groups. Adult birds were brought in single or duplicate where as ducklings of less than one week old were brought in groups of two to eight. Among the carcasses brought for post mortem examination, condition of the carcass was good in 98 per cent of

the cases. Two per cent were mutilated or decomposed. Dehydration, loss of weight, lacrimation with or without purulent discharge, sinusitis with purulent exudates from the nostrils, blood stained or soiled vent were detected on external examination.

Gross pathology

The important gross lesions involved organs like liver, heart, kidney, lungs, air sacs, intestine, and spleen, ovary, oviduct in adult and growing birds and mostly yolk sac in ducklings. Out of five hundred birds examined as much as forty five per cent (225n) of the carcasses showed prominent liver lesions. Enlarged, pale friable liver (Fig. 1), swollen and mottled liver with or without pin point hemorrhage or hemorrhagic streaks and grayish white necrotic foci were the common lesions. Paleness in certain cases extended to yellowing and glistening of the entire liver indicating fatty changes. Pin point hemorrhage in the liver

of four ducklings of 2-3 weeks old was characteristically noted. Perihepatitis was observed in 10 per cent of the carcasses. Thick fibrinous membrane covered the liver in a few cases. Gall bladder was found to be distended in five per cent birds. Color and consistency of bile varied from watery pale yellow to thick greenish. Wall of the gall bladder was thickened with its contents gaining thick, oily greenish consistency in two to three per cent of the birds. Bile imbibition was a common post mortem change.

Pulmonary edema and congestion were noted in ten per cent (50n) of the birds (Fig. 2) Presence of milky white exudates in the thoracic cavity, lungs and air sac was observed in one duck of one year old. One duckling of 2 weeks age showed, slightly hardened cheesy exudates rolled into folds in the air sacs. Sinusitis with mucopurulent or caseous exudates, fibrinopurulent perihepatitis, peritonitis and air sacculitis were concomitantly observed in 10 to15 growing birds.

Cardiac lesions were standing out in 19 per cent (95n) of the carcasses and varied from prominent hemorrhage in the epicardium and endocardium (Figs. 7&8), myocardial degeneration, hydro pericardium, fibrinous pericarditis to ascitis. Considreable hypertrophy in the ventricular wall was a common finding. Focal pale infarcts were noticed in the myocardium of three or four bids. Epicardial hemorrhage was striking in different age groups as pin point focal or diffuse streaks of reddish areas.

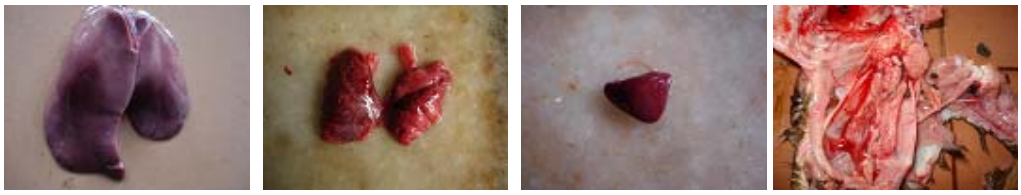

Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figures. 1. Multiple white necrotic foci on dorsal surface with mild perihepatitis. 2. Bilateral pulmonary congestion and edema. 3. Splenomegaly with congestion. 4. Pale swollen kidney.

Only three per cent (15n) of birds demonstrated notable renal lesions. Enlargement in the anterior lobes of the kidney which became pale and swollen (Fig. 4) was characteristic observation in two birds. Entire kidney lobes were swollen, grayish and mottled in five birds. Dark and congested kidney was observed in seven cases.

Though subserosal edema was seen in many cases in the proventriculus, pin point hemorrhage at the tip of the proventricular glands were noticed only in four cases. Striking lesion in the intestine was presence of mucous to hemorrhagic exudates and focal petecheal hemorrhage (Fig. 6) in the serosa of duodenum and jejunum. The ceca were filled with watery contents in most of the birds. Moderate splenomegaly, congestion and mottling of the spleen were noticed in four or five birds.

Seven laying ducks out of 12 had shown caseous deposit in the oviduct, ruptured ova and yolk fluid spilled in the abdominal cavity (Fig. 5). The rest of five birds were presented with hepatosis and enteritis. Out of 105, two to five day old ducklings, 50 per cent (52n) had unabsorbed yolk material with putrid

odor and yolk often ruptured leading to peritonitis. The rest of the ducklings showed pale and friable liver with enteritis.

Fig. 5 Fig. 6 Fig. 7 Fig. 8

Figures: 5. swollen, congested and ruptured ova. 6. Petecheal hemorrhage in duodenum 7. Hemorrhage on coronary arteries. 8. Epicardial hemorrhage

One white pekin duckling of one month old suspected for feed toxicity showed subserosal edema in intestinal tract, catarrhal to hemorrhagic enteritis diffuse hemorrhage in the proventriculus, erosion and ulceration in the gizzard, nephrosis and hepatosis (Fig. 9 to 12). History indicated death of three other birds of same flock which had taken the same feed. Removal of the feed stopped death rate spontaneously.




Fig. 9 Fig. 10 Fig. 11 Fig. 12

Figures: Gross lesion seen in one month old duckling suspected for feed toxicity. 9. Erosion in the serosa of gizzard, subserosal edema and hemorrhage in proventriculus. 10. Focal ulceration in gizzard. 11. Dark red congested kidney 12. Pale yellowish friable fatty liver with distended gall bladder.

Histopathology

Histopathological observations varied from cloudy swelling, vacuolar degenerations, necrosis of hepatic cells, congestion and infiltration of heterophils in the hepatic parenchyma. Hyperplastic changes in the bile duct epithelium noted in some birds. Lung showed congestion and presence of serous exudates with vacuolated macrophages and infiltration of mononuclear cell in the air vesicles. Some birds also showed heterophilic, mononuclear and plasma cell infiltration. Hemorrhage in the duodenum and jejunum with degeneration and sloughing of the villi, reduced number of goblet cells, detachment of cells from the lamina propria and infiltration of heterophils and lymphocytes were the microscopical findings noticed in the intestine. Heart showed degeneration and breaks in the myocardial fibres, myocarditis, hemorrhage and lymphocyte infiltration in the epicardium and endocardium. Renal lesions included degeneration of the tubules with infiltration of mono and polymorpho nuclear cells. Congestion and hemorrhage noted in renal parenchyma. The gross and microscopic lesions suggestive of pasteurellosis, salmonellosis and colibacillosis, were supported by bacteriological examination.

Discussion

Out of five hundred carcasses of water fowls (ducks, geese and swan) examined, most of them showed lesions of infectious nature. During this two years time serious challenges were attributed to Pasteurellosis. Hirsh *et al*. (2004) reported *Reimerella anatipestifer* causing contagious septicemic disease in ducklings, termed as "new duck disease" or duck septicemia. An emerging form of duck disease was reported in Kerala with perihepatitis, pericarditis, air sacculitis and enteric infection with isolation and identification of *R. anatipestifer* (Priya *et al*, 2008) from the infected birds. The present observations also emphasized the incidence of Pasteurellosis in different parts of the state. Smears from lesions of extensive hemorrhage in the epicardium, liver and intestine were subjected to microbiological examination and revealed presence of bipolar Gram negative coccobacilli.

Salmonella infection was reported to be common in duck farms especially in the younger birds in which affected birds showed necrotic foci in liver, lungs and gizzard with catarrhal enteritis (Yu *et al*, 2008). Different serotypes of salmonella have been identified from both adult and younger birds. Salmonellosis also bears certain zoonotic significance, so need to be given public health importance. Coli septicemia in ducks is characterized by curd like exudates of variable thickness causing pericarditis, perihepatitis and airsacculitis with distinct odor during necropsy (Barnes and Gross, 2003). Data from many birds of growing age had shown typical lesions of colibacillosis and is considered to be a common disease in organized duck farms in the state.

Viral diseases may be prevalent which can also be the primary cause of mortality in many birds. But no attempt had been taken to diagnose such condition confirmatively. Parasitic infestation was seen only in very few cases of intestinal coccidiosis, might have been missed to detect in other cases. Lesions suggestive of internal parasites were generally absent.

Mycotoxicosis plays a significant role in development of lesions in ducks. Ducks have more susceptibility to aflatoxins due to the higher production of liver microsomal enzymes which metabolise aflatoxins into toxic products leading to acute toxicity. The factors that affect toxicity are interaction of the toxin with pathogens, genetic variability, environmental conditions and nutritional status (Wylle and Morehouse, 1992). Though specific etiology as aflatoxicosis had not been identified in this study, hepatic lesions in many birds suggest feed toxicity consequently leading to bacterial and viral infections taking upper hand in such immunocompromised birds causing heavy mortality.

Prevention and Control

The aim of studying a disease is to formulate the prevention and control methods for the disease. It has additional magnitude in case of poultry and more so in water fowls. Prevalence of diseases and their mode of perpetuation in these birds require specific attention. Diagnosis of disease should be tried just at the beginning of symptoms and treated with specific drugs well in advance. It is difficult to control disease in water fowls because of persistence of infection in the environment. Regular monitoring and early detection of die offs, and collection and incineration of dead birds are very important. Control of scavenging birds, drainage of the water bodies, and disinfection of water should be attempted as much as possible.

Depopulation may be done as the ultimate step to control the disease. Selection and preference of these methods depend on the nature of the disease, number of birds affected and condition of the environment. Proper immunization procedures and adequate stress management are essential for the effective prevention of diseases.

Conclusion

Duck population in the state was estimated as 0.85 million (3.6 % of country's duck population) in 1994. It has been reduced considerably due to many reasons some of which were unavoidable as nature's way of selection procedure. Occurrence of diseases was considered as a major factor attributing to this. Present study is only a pilot venture to analyze the common gross and histopathological lesions in water fowls and it requires further investigation utilizing latest molecular diagnostic methods to confirm the etiological entities associated with each case. Still it is undoubtedly proved that postmortem observations, gross and histopathological findings lead to presumptive diagnosis of many diseases which can be a cause of heavy mortality in the flock. There fore further investigations are required for confirmatory diagnosis of specific diseases in waterfowls in the state.

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FIELD INVESTIGATION ON THE PREVALENCE OF AVIAN INFLUENZA VIRUS INFECTION IN SOME LOCALITIES IN SAUDI ARABIA

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Abstract

The objective of this study was to find out prevalence and types of avian influenza virus (AIV) among broiler, native chickens, ducks and pigeons. Field investigation was carried out in four localities including Al-Qassim Hail, Aljouf, and Northern Borders.

Serum sample, tracheal and cloacal swabs were collected from broilers (1561 samples), layers (988 samples), ducks (329 samples), and pigeons (450 samples) from these localities and were tested for three different avian influenza viruses (H9, H5 and H3) using Enzyme linked immunosorbent (ELISA) test, hamagglutination inhibition (HI test) and polymerase chain reaction (PCR).

All tested samples were negative for H5 and H3 viruses. In contrast, all positive results were found to be for H9 AI virus using PCR, ELISA and HI test. All tested samples were collected during 2006-2007 which is before the AIV H5 was isolated in Saudi Arabia. It was found that 118 of tested samples (94 chicken samples and 24 duck samples) were positive by using PCR. 529 chicken samples out of 2118 examined samples were positive by ELISA test and 93 duck samples out of 259 examined samples were positive by HI using AIV H9 antigen. All tested pigeons samples were negative for the three virus serotypes concerned in the study HI tests.

Introduction

A non-pathogenic strain of avian influenza virus (AIV) has been encountered among poultry flocks in Saudi Arabia. The continuation of importing the live poultry and their products from continents that could have virulent strain(s) of the AIV requires special attention. In addition, the virus ability to change through mutation and antigenic drift and shift increases the potential of emerging virulent strain of AIV. These scary waves of the AIV infection in birds and human enhanced serious interest from the Saudi authorities to build up a prophylactic plan against AIV epidemics. This is to put a forward plan to avoid any possible catastrophe like those in the south east of Asia with their consequent human infection.

It is important to start investigation of the extent of dissemination of the non pathogenic or pathogenic AIV infection in domestic and wild birds in Saudi Arabia. Therefore, the overall objective of this project was to investigate the presence of the 3 most common AIV (H3, H5 and H9) among different avian species including ducks, chickens and pigeons.

Materials and methods

Serum samples

Serum samples were collected from chickens, pigeons and ducks in four different localities in Saudia Arabia from 2006- 2007 including Qassim, Hail, Aljouf and Northern Borders. Blood samples were collected from wing vein and kept at 4°C for an overnight after which serum was separated by centrifugation at 900 xg. Collected serum samples were aliquoted and kept frozen until needed.

Swabs

Faecal and tracheal swabs were collected from live, dead and slaughtered birds. Alive birds included both apparent healthy and diseased birds showing respiratory signs or other symptoms. Swabs were collected using sterile cotton swabs which were dipped in sterile Hanks balanced salt solution (HBSS) and taken in a cold box directly to the laboratory for extraction of the RNA required for PCR identification.

Haemagglutination inhibition (HI) test

This assay was used for duck and pigeon samples. Variations in the procedures of HI test are practiced in different laboratories. A microassay using U-bottomed 96-well plates was employed. The reagents required for these tests were PBS (0.01 M), pH 7.0–7.2, and red blood cells (RBCs) taken from a minimum of three chickens and pooled in an equal volume of Alsever's solution. Cells were washed three

times in PBS before use as a 1% (packed cell v/v) suspension. Allantoic fluid of eggs inoculated with H9 (local Isolate) was titrated by HA and used as an antigen for the HI test. Positive and negative antisera were run with each test, as appropriate. PBS was distributed (25 µl) into each well of the microtitre plate. Twenty five microlitres of each serum sample were delivered into the first well of a corresponding row in the plate. Serum samples were twofold serially-diluted using the multichannel pipette. Four haemagglutinating units (HAU) of antigen in 25 µl were delivered into each well followed by incubation for 30 minutes at room temperature or 60 minutes at 4°C. After incubation, 25 µl of 1% (v/v) chicken RBCs were added to each well. After gentle mixing, the RBCs were allowed to settle for about 40 minutes at room temperature or for 60 minutes at 4°C, by which time control RBCs should be settled to a distinct button. The HI titre was expressed as the highest dilution of serum causing complete inhibition of 4 HAU of antigen. The validity of results was assessed against a negative control serum, which gave a titre >1/4 (>2^2 or >$\log_2$ when expressed as the reciprocal), and a positive control serum for which the titre should be within one dilution of the known titre. HI titres were regarded as being positive if there was inhibition at a serum dilution of 1/16 (2^4 or $\log_2$ 4 when expressed as the reciprocal) or more against 4 HAU of antigen. Before testing samples, 25 µl of packed chicken RBCs to each 0.5 ml of antisera, shaking gently and leaving for at least 30 minutes. The RBCs were then pelleted by centrifugation at 800 ***g*** for 2–5 minutes and the adsorbed sera were decanted. For duck sample, RBCs of ducks under investigation was used.

Enzyme linked immunosorbent assay (ELISA)

Indirect ELISA kits (FlockCheck*Avian Influenza Antibody Test Kit, Idexx Laboratories, Main, USA) was used for detection and measurement of antibody to avian influenza virus (AIV) in chicken serum. ELISA was done following strictly the instructions supplied by the company with kit components.

Upon reaching to the laboratories, swabs were squeezed several times on the tube wall to get as much as possible of the sample. RNA was extracted from the samples using Trizol and chloroform/ isoamyl alcohol method as described by Sambrook et al. (1989). In brief, 0.1 ml of swab extract was mixed with 1 ml of Trizol reagent (Life Technology, Gaithersburg, MD). After mixing completely and being kept at room temperature for 5 min, the mixture was extracted with 0.18 ml chloroform/isoamylalcohol (24:1). After centrifugation at 10 000×g for 15 min, the RNA in the aqueous solution was precipitated by adding an equal volume of isopropanol. The RNA precipitate was collected by centrifugation at 10 000×g for 20 min, washed by 75% ethanol and dissolved in 50 µl of RNase-free water.

Once obtained, the RNA pellet was dissolved in depec water (free from RNase) and reverse transcribed directly to complementary DNA (cDNA) using the reverse transcriptase enzyme and primer specific for the eight RNA segments of the influenza viruses at 42ºC for 1 hour after initial denaturation at 72ºC in the presence of transcription buffer and depec water **(Horimoto and Kawaoka, 1995).** Transcribed cDNA was frozen at -20ºC until needed for polymerase chain reaction.

In addition to the above mentioned method, Qiagen RNeasy Mini Kit (QIAGEN GmbH, Germany, Catalog #74104)) was used to extract the virus RNA (WHO, 2002).

Polymerase chain reaction (PCR)

For each reaction, 1.5 µl of the cDNA synthesized were mixed with 48.5 µl of the master mix in a 0.5 ml PCR tube.

The PCR master mix recipe (for one sample):

- 5 µl PCR buffer
- 38.65 µl ultrapure water
- 1 µl 10 mM dNTP mix
- 3 µl 25 mM $MgCl_2$
- 0.25 µl Taq DNA polymerase
- 0.3 µl forward primer

- 0.3 µl reverse primer

The mixture was spin briefly and a drop of sterile mineral oil was added to the top of the PCR tube which was then placed in the thermocycler. The PCR condition for the amplification of NP and H3 was 95°C for 3 min, 35 cycles of 95°C for 30 seconds (denaturation), 55°C for 40 seconds (annealing) and 72°C for 40 seconds (extension), followed by 72°C for 10 min (final extension). The PCR condition for the amplification of H5 and H9 was the same as above, except that the annealing temperature was reduced to 50°C (Figure).

Results and discussion

The overall objective of the present study was to find out the prevalence of avian influenza viruses (AIVs) among domestic birds in four localities in Saudi Arabia (Al-Qassim, Hail, Aljouf and Northern Borders). In addition, it was important to identify the most prevalent AIV strains. Therefore, blood samples and swabs were collected from broiler, native chickens, ducks and pigeons.

Health statues of the birds from which the samples were collected vary from apparent healthy to sick birds.

Indirect ELISA was the test of choice to test chicken samples for many advantages of which specificity, sensitivity and direct typing was the most important (Alexander, 1996). Also, it was safe to deal with such a test as it detects antibodies and it contains already coated plate with no or minimum hazards. Concerning birds other than chickens, their serum samples were screened by HI test using the allantoic fluid of eggs inoculated with the same isolate as antigen. Selection of HI tests was due to lack of ELISA kits specific for such birds.

Number of samples collected from different birds from four different areas in Saudi Arabia during period 2006-2007 was shown in table (1).

Results of serological test on chicken sera samples using ELISA test were summarized in table (3). It was found that in Al-Qassim region, out of 1230 examined serum samples collected from 15 broiler and layer flocks, 295 samples were positive (23.98%). In Hail region, out of 339 chicken serum samples, 71samples were positive (20.94%) and in Aljouf, Out of 205 serum samples, 61 samples were positive (29.65%) while in Northern Borders region, Out of 344 tested samples , 102 were positive (45.71%).

These ELISA results indicated that, Northern Borders had the highest prevalence of AIV antibodies followed by Aljouf, Qassim and Hail. This means that the higher prevalence in the border regions than Hail and Al-Qassim regions which focuses on the probable exogenous sources of the AIV cases and foci reported in the rest of the Kingdom. Migratory birds or free uncontrolled in and out movements across the borders can be blamed with the spread of infection on the borders and from there to the other regions. Being prevalence was less in Hail than Al-Qassim, this can be attributed to that

flocks in Hail were almost under closed system of rearing while many flocks in Al-Qassim were native and kept free in the backyards. Therefore, it is recommended that closed rearing is safer than free living rearing to avoid catastrophes of AIV infections in birds and humans. Fortunately, ELISA test was able to identify that most of positive cases were for H9N2 serotype of AIV which is known to be endemic and of low danger in the Kingdom.

From results shown in table (3), it was found that out of 47 ducks serum samples from 3 farms in Al-Qassim, 15 samples were positive (31.91%) for AIV antibodies as tested by the for both AGID and HI tests and out of 55duck sera from 3 flocks in Hail region, 19 samples were positive (34.54%) while 22 samples and 37 samples were positive out of 68 and 89 duck sera from flocks in Aljouf and Northern Borders regions, respectively (32.35% and 41.57%) . These results clear out the role of ducks as being reservoir for the AIV and indicated that special attention must be directed towards this host. It has been well known that ducks have a major role in the spread of epidemics in the severely affected parts of the world *(*Cox *et al., 1994)*. However, duck samples tested in the present study were randomly collected and the antigen used with HI test was originated from H9 local isolate.

It was very important to detect viral components using a safe way other than isolation of the virus that needs at least a biosafety level 3 laboratory. Detection of the viral RNA in the clinical samples has been routinely applied to detect RNAs of different AIV serotypes (WHO, 2002). Therefore, RNA was extracted from tracheal and cloacal swabs collected from chickens, ducks and pigeons. Then RNA was transcribed into complementary DNA (cDNA) using the enzyme reverse transcriptase (WHO, 2002). This was followed by amplification of the possibly present AIV cDNA using two universal primers (Lee et al., 2001). Furthermore, positive samples were tested for amplification using three pairs of primers specific for H3, H5 and H9 AIV serotypes (WHO, 2002; Lee et al., 2001). Positive PCR product was obtained only with the AIV H9-specific primers from samples of the four different study regions. The obtained amplified size was consistent with the suspected size (488 bp) of the target sequence of the viral cDNA.

When RNA was extracted from 282 chickens farms and flocks in Al-Qassim, PCR amplification resulted in 53 positive samples (19.30%) for AIV H9 (Table 2). Out Of 65 chicken swabs from Hail, 11 samples were PCR-positive (16.69%), and out of 58 samples from Aljouf, 14 samples were PCR-positive (24.13%), while 16 out of 35 swabs from Northern Borders were PCR-positive (45.71%). All positive cases were found to be H9. The highest positive samples were observed in Northern Borders indicating that ELISA is correlated with that of PCR concerning prevalence of AIV serotype H9.

Concerning duck swabs, 7, 10 and 7 samples were positive out of 21, 25 and 24 samples from Al-Qassim, Hail and Aljouf (33.33%, 40% and 29.16%), respectively (Table 2).

No swabs from chickens or ducks were positive with primers of either H3 or H5 AIV serotype. All samples were collected before the AIV H5 was isolated in Saudi Arabia. This comes in agreement with previous findings in many regions of Saudi Arabia (Ministry of agriculture).

Collectively, a total number of 3328 birds were sampled. These birds come from forty four farms distributed on the four regions as listed in (table 1). Four different kinds of birds were examined, broilers (1561), layers (988), pigeons (450) and ducks (329).

In AlQassim region there were total of 370 positive samples. 53 chicken samples and 15 duck samples were detected by PCR (table 2) from the swabs specimen and 295 chicken serum samples were detected using the ELISA test and 15 duck samples were detected by HI test (table 3) . A total of 111 positive samples were found in Hail region. 11 chicken samples and 10 duck samples were detected by PCR (table 2) and 71 chicken samples were detected using the ELISA and 19 duck samples were detected by HI test (table 3).

In Aljouf region there were 104 positive samples, 14 chicken samples and 7 duck samples were detected by PCR (table 2) and 61 chicken serum samples were detected using the ELISA and 22 duck samples were detected by HI test (table 3). The total positive samples from Northern border region were 155 samples, 16chicken samples were detected by PCR (table 2) and 102 chicken serum samples were detected using the ELISA and 37 duck samples were detected by HI test (table 3). The total number of positive samples was 740 samples, 94 chicken samples and 24 duck samples were positive by using PCR (table 2) and 529 chicken samples were positive by ELISA and 93 duck samples were positive by HI test (table 3). Concerning samples of pigeons (n = 450), serum samples were negative with HI tests. In addition, RNA extracted from tracheal or cloacal swabs was negative with PCR using the three sets of primers employed in these studies.

Table (1): Number and species of birds tested for AIV in four different localities in Saudi Arabia using PCR, ELISA and HI tests.

Bird species	AlQassim	Hail	AlJouf	N. Border	Total
Broilers	906	250	178	227	1561
Layers	597	154	85	152	988
Ducks	68	80	92	89	329
Pigeons	150	100	100	100	450
Total	1721	584	455	568	3328

Table (2): Results of PCR test for detection of AIV in Chicken and duck tracheal and cloacal swabs collected from four different localities in Saudi Arabia

Locality	Ducks		Chickens	
	# of tested samples	# of positive samples	# of tested samples	# of positive samples
AlQassim	21	7 (33.33%)	273	53 (19.30%)
Hail	25	10 (40.00%)	65	11 (16.69%)
AlJouf	24	7 (29.16%)	58	14 (24.13%)
N. Border	-	-	35	16 (45.71%)
Total	70	24 (34.28%)	440	94

Table (3): Results of ELISA and HI for detection of antibodies against AIV in chicken and duck sera samples collected from four different localities in Saudi Arabia

Locality	Ducks / HI test		Chickens/ ELISA	
	# of tested samples	# of positive samples	# of tested samples	# of positive samples
AlQassim	47	15 (31.91%)	1230	295 (23.98%)
Hail	55	19 (34.54%)	339	71 (20.94%)
AlJouf	68	22 (32.35%)	205	61 (29.65%)
N. Border	89	37 (41.57%)	344	102 (45.71%)
Total	259	93 (35.90%)	2118	529 (24.97%)

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PHYTOCHEMICAL ANALYSIS AND *IN VITRO* STUDIES OF DIFFERENT EXTRACTS OF *POLYALTHIA LONGIFOLIA* LEAVES AGAINST DUCK PASTEURELLOSIS

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The outbreaks of duck pasteurellosis which occur during monsoon period, caused by avian strains of *Pasteurella multocida*, is a serious problem with high mortality and morbidity affecting younger age groups. *Polyalthia longifolia* (*P. longifolia*) leaves which had antibacterial action, was tested for its efficacy against *Pasteurella multocida* by *in vitro* methods. The successive extracts of the plant materials were tested for its antibacterial effect using microtitre plate technique (to estimate the minimum inhibitory concentration, MIC) and disc diffusion method was performed to estimate the zone of inhibition. Microtitre plate technique was assayed by dissolving the plant extracts in sterile DMSO except the aqueous extracts which were dissolved in sterile distilled water. Various concentrations, 200 µg, 500 µg and 1 mg/well, of successive extracts of *P. longifolia* were used to find out the MIC. Disc diffusion method was performed with successive extracts of *P. longifolia* leaves at 200 µg, 500 µg and 1 mg concentrations. The results from the above *in vitro* assay revealed the efficacy of acetonic extract of *P. longifolia* leaves against duck pasteurellosis. The acetonic extract was further subjected to spectrophotometric, thin layer chromatography and high performance thin layer chromatographic analysis. The results of the present study could describe the antipasteurellosis activity of *P. longifolia* leaves.

Keywords – *Pasteurella multocida*, *Polyalthia longifolia*, microtitre plate dilution method, disc diffusion method, phytochemical analysis

Introduction

Ducks provides an excellent economy for the socio-economic uplifment of the rural masses in Kerala. Duck pasteurellosis caused by avian strains of *Pasteurella multocida* with high mortality and morbidity has become a major menace in the burgeoning of the poultry industry. The disease outbreaks occur more frequently during monsoon period affecting younger age groups (Devi *et al.,* 2000). Eventhough antibiotics are available for its treatment, the indiscriminate use and side effects of these antibiotics along with the multiple drug resistance by the pathogenic organisms have created the necessity for thinking an alternative for its treatment.

Polyalthia longifolia (Sonn.) Thwaites (Order: Magnoliales; Family Annonaceae) commonly known as Ashok tree, is an evergreen ornamental plant. The antibacterial reported (Faizi *et al*., 2003, Murthy *et al.*, 2005, Nair *et al*., 2005) and antifungal properties (Nair *et al.*, 2006, Shivpuri *et al.*, 1997) of *P. longifolia* are well documented. The demand of plant based therapeutics is increasing in both developed and developing countries due to recognition that they are natural products, non narcotic, easily biodegradable producing minimum environment hazards (Ghosh *et al.*, 2008). India is the largest producer of medicinal herbs and traditional practitioners of this country use more than 6,000 medicinal plants in the primary health care (Shariff *et al.*, 2006). Hence the present study was aimed at testing the efficacy of *Polyalthia longifolia* (*P. longifolia*) leaves against *Pasteurella multocida* by *in vitro* methods.

Materials and Methods

CHEMICALS

Tryptone soya agar and reagents for biochemical tests were purchased from Hi-media, Mumbai. 3-(4,5-dimethylthiazol-2-yl)2,5-diphenyl-2H-tetrazoliumbromide (MTT) was obtained from Fischer Scientific Worldwide Company, Hong Kong, and all other reagents were purchased from Merck India Ltd, Mumbai. The standard reference drug, Co-trimoxazole (sulpha trimethoprim combination), was purchased from Pathoteq biological laboratories, Gujarat, India.

BACTERIAL STRAINS

The *Pasteurella multocida* A: 1 strain (DP1) isolated from Niranam Duck farm (Pathanamthitta district), serotyped at IVRI, Izatnagar and maintained in the Department of Veterinary Microbiology, College of Veterinary and Animal Sciences, Mannuthy was used for the entire study. Purity of the isolate was checked based on morphology, cultural and biochemical characteristics as described by Barrow and Feltham (1993).

PREPARATION OF THE EXTRACTS

Polyalthia longifolia leaves obtained from College of Veterinary and Animal Sciences, Mannuthy campus, were air-dried at room temperature, coarsely powdered using an electrical pulverizer and successive extractions were carried out with

petroleum benzine, choloroform, acetone, and methanol using Soxhlet apparatus. The extracts were evaporated in a rotary vacuum flash evaporator. The aqueous extract was prepared by taking the 100g of the powdered leaves in five litres of water subjected to boiling with constant stirring. The extracts were filtered through a muslin cloth. All the extracts were kept under refrigeration for the complete evaporation of the solvents. The yield of the extracts was 3.898, 6.438, 2.084, 7.503, 4.906 per cent respectively.

ANTIBACTERIAL ACTIVITY

Antibacterial activity was determined using microtitre plate dilution method and disc diffusion method

MICROTITRE PLATE DILUTION METHOD

Microtitre plate dilution technique was performed as per the method of Sheena *et al.*, 2003. The plant extracts were dissolved in sterile Dimethy sulfoxide (DMSO) to make a total volume of 20 µl and filtered through sterile Whatman syringe filter (0.45 µm). DMSO was selected as the vehicle by disc diffusion method because it showed no inhibitory action up to 400 µl and showed more diffusion power than other vehicles like petroleum benzene, chloroform, acetone, methanol, Tween 80 and gum acacia. Aqueous extracts were dissolved in sterile distilled water and prepared as above. Various concentrations (200 µg, 500 µg and 1 mg/well) of successive extracts of *Polyalthia longifolia* leaves were mixed with 0.05 ml each of bacterial culture (inoculum of 50% transmission at 530 nm in normal saline) and tryptone soya broth to make a volume of 0.18 ml in a 96-well microtitre plate. The plate was incubated at 37º C for 24 hours. After the incubation, 0.02 ml of MTT (5mg/ml) was added into each well and incubated for 30 min at 37º C. After the incubation period, the inhibition of the growth was detected as colourless wells. The lowest concentration of the extracts that completely inhibited the bacterial growth was assumed as minimum inhibitory concentration (MIC). The experiment was repeated thrice.

DISC DIFFUSION METHOD

Disc diffusion method was performed to determine the zone of inhibition as per the method of Bauer *et al.*, 1966. Five millilitre of overnight incubated *P. multocida* culture in tryptone soya broth adjusted with half the concentration of No.1 Mc farland Nephelometer standard (0.5 ml of 1 per cent barium chloride to 99.5 ml of one per cent sulphuric acid (0.36N) was used for the test. The *P. multocida* broth suspension was streaked evenly in three planes onto the surface of the medium with cotton swab. Surplus suspension was removed from the swab by being rotted against the side of the tube before the plates are seeded. After the inoculum had dried, kept sterile plain antibiotic disc on the surface of agar with flamed forceps. 200 µg, 500 µg and 1 mg concentrations of the plant extracts were added

separatedly to sterile antibiotic discs. The reference drug disc (25 µg/disc) was also placed on the surface of the agar. The plates were incubated at 37º C for 24 hours. The plates were examined thereafter, clear zones of inhibiton formed around the discs were measured and antibiotic sensitivity was assayed from the diameter of the clear zone of inhibition (in mm). The experiment was repeated thrice.

PHYTOCHEMICAL ANALYSIS

PRELIMINARY QUALITATIVE ANALYSIS OF THE PLANT EXTRACTS

The plant extracts obtained with petroleum benzine, choloroform, acetone, methanol and water were tested for the presence of various active chemical constituents namely steroids, alkaloids, tannins, phenolic compounds, flavonoids, glycosides, diterpenes, triterpenes and saponins as per the procedure quoted by Harborne (1991). Based on the above results of *in vitro* assay, the acetonic extract of *Polyalthia longifolia* leaves were quantitatively analysed using spectrophotometric method by "ARJUNA NATURAL EXTRACTS LTD – LAB EDAYAR", Ernakulam, Kerala, India. The extracts were taken in methanol and scanned in the UV/Vis Spectrophotometer, within the range 200 – 800 nm to obtain the spectrums. Phytochemical analysis of the acetonic extract was carried out by Thin Layer Chromatography (TLC) using Ethyl acetate : Methanol : Water (7:2:1) solvent system with 10% concentrated sulphuric acid in water which was used as spray reagent. High Performance Thin Layer Chromatography (HPTLC) method were performed in five solvent systems qualitatively and two by quantitatively.

Results and Discussion

BACTERIAL STRAINS

The isolate produced typical colonies on blood agar which were smooth, convex, translucent, and butyraceous and one to three millimetres in diameter, after 18 to 24 h of incubation. Gram's staining revealed Gram negative coccobacillary organisms arranged singly or in pairs. The isolate grew aerobically and anaerobically, did not grow on Mac Conkey's agar, was non-haemolytic on blood agar and non motile. Results of the biochemical tests and sugar analysis for the confirmation of *Pasteurella* culture are presented in the Table 1 and 2. The reactions given by the *Pasteurella* culture were in accordance with findings of Barrow and Feltham (1993), Buxton and Fraser (1977) and Heddleston (1976).

ANTIBACTERIAL ACTIVITY OF THE EXTRACTS BY MICROTITRE PLATE DILUTION TECHNIQUE

All the successive extracts of *Polyalthia longifolia* leaves showed inhibition of bacterial growth. The Minimum Inhibitory Concentration (MIC) of petroleum benzene, chloroform, acetone and aqueous extracts were 200 µg/well. However, the methanolic extract showed minimum inhibitory concentration of 500 µg/well.

ANTIBACTERIAL ACTIVITY BY DISC DIFFUSION METHOD

Acetonic extract of *Polyalthia longifolia* leaves showed antipasteurellosis activity and the extract showed a measureable zone of inhibition at 1 mg and 500 µg concentrations. The zones of inhibition of the extract at 1 mg and 500 µg

concentrations were 12.00 and 9.00 mm respectively. All the other successive extracts did not show any zone of inhibition. The standard drug (25 µg/disc) showed zone of inhibition at 33.2 mm. The zone of inhibition shown by the acetonic extract was not up to the level of standard drug meanwhile it exhibits some antipasteurellosis activity in *in vitro* analysis. This necessitates further *in vivo* study of these plant extracts.

PHYTOCHEMICAL ANALYSIS

The results of phytochemical screening of successive plant extracts are furnished in Table.3. Petroleum benzene, chloroform and acetonic extracts showed the presence of only flavonoids. The methanolic extracts indicted the presence of tannins, flavonoids, diterpenes, triterpenes and saponins while the aqueous extracts showed the presence of steroids, phenolic compounds, tannins, diterpenes and

saponins. Spectrometric analysis of the acetonic extract of *Polyalthia longifolia* yielded 10.50% flavonoids. Other active principles in the plant extract were not analysed since they were not detected in the qualitative analysis. The absorbance values of the acetonic extract were 2.153 (235 nm), 0.854 (306 nm) and 0.877 (323nm). Phytochemical analysis of the acetonic extract of *Polyalthia longifolia* leaves showed the presence of flavonoids. Diterpenes, identified in *P. longifolia* leaves by thin layer chromatographic method, appeared as a spot with Ethyl acetate : Methanol : Water (7:2:1) solvent system. The HPTLC profile also indicted the presence of diterpenes.

Table 1. Biochemical tests performed for the identification of *Pasteurella* culture

Biochemical tests	Results
Motility test	Non motile
Indole test	positive
Citrate utilization test	negative
Oxidase test	positive
Catalase test	positive
Growth on Mc Conkey agar	No colony formation
Urease test	Negative
MRVP	negative
H_2S production test	positive
Nitrate reduction test	positive

Table 2. Sugar analysis performed for the identification of *Pasteurella* culture

Sugars	Results
Arabinose	negative
Mannitol	positive
Mannose	positive
Galactose	positive
Sucrose	positive
Sorbitol	positive
Maltose	negative
Lactose	negative
Inositol	negative
Trehalose	positive
Salicin	negative
Xylose	negative
Dulcitol	negative

Many plants have been used because of their antimicrobial properties, which are due to phytocompounds present in them such as phenls (Kazmi *et al.*, 1994), essential oils (Daferera *et al.*, 2003), terpenoids (Taylor *et al.*, 1996), alkaloids (Omulokoli etal., 1997) and flavonoids (Batista *et al.*, 1994). Preliminary phytochemical analysis during the present study also ascertains the presence of biologically active phytochemical constituents.

Antibiotics, in purified or chemically modified form, are currently used in the treatment of duck pasteurellosis. The indiscriminate use of these antibiotics has created resistance and none of the commonly used antibiotics against duck pasteurellosis become effective. The objective of using ethnoveterinary medicine comes into effect in this situation. *In vitro* studies with different extracts of *Polyalthia longifolia* leaves showed antibacterial activity against *P. multocida*. But the acetonic extract of

Polyalthia longifolia leaves showed antipasteurellosis activity as evident from microtitre plate dilution technique and disc diffusion method. Other successive extracts showed the antibacterial property only in microtitre plate dilution technique. The

acetonic extract of *Polyalthia longifolia* leaves showed more antipasteurellosis activity at higher concentrations. Thus the results of the present investigation revealed the antipasteurellosis activity of acetonic extract of *Polyalthia longifolia* leaves.

Table 3. Phytochemical screening of successive extracts of Polyalthia longifolia leaves

Phytochemical constituents	Successive extracts of *P. longofolia* leaves				
	Petroleum benzine	chloroform	Acetone	Methanol	Aqueous
Steroids	-	-	-	-	+
Alkaloids	-	-	-	-	-
Phenolic compounds	-	-	-	-	+
Tannins	-	-	-	+	+
Flavonoids	+	+	+-	+	-
Glycosides	-	-	-	-	-
Diterpenes	-	-	-	+	+
Triterpenes	-	-	-	+	-
Saponins	-	-	-	+	+

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PASTEURELLOSIS IN A MUSCOVY DUCK

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Abstract

This communication deals with isolation of *Pasteurella multocida* subsp. *multocida* from a Muscovy duck (*Cairina moschata*). Ecchymotic haemorrhages in the epicardium, pulmonary congestion and edema, necrotic foci in the liver, haemorrhagic enteritis and typhilitis were noticed during necropsy of a Muscovy duck. The heart blood smear and liver impression smear revealed bipolar stained bacteria. On culture of heart blood and liver samples on blood agar, Gram negative coccobacilli were isolated which on biochemical characterization gave results which suggested that the isolate was *Pasteurella multocida* subsp. *multocida*.

Key words: *Pasteurella multocida*, Muscovy duck, Wayanad, India

Introduction

Pasteurella multocida has a broad host range causing specific infections that manifest differently. The major diseases of economic significance include porcine progressive atrophic rhinitis, haemorrhagic septicaemia of cattle and water buffaloes, fowl cholera of poultry and snuffles in rabbits. These infections can vary from slow or latent infections observed with porcine progressive atrophic rhinitis to rapidly developing fatal septicaemias seen with fowl cholera and haemorrhagic septicaemia. This article deals with isolation of *P. multocida* from a fatal case of pasteurellosis in a Muscovy duck (*Cairina moschata*).

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Materials and methods

Mortality was reported in a flock of Muscovy ducks reared in Lakkidi in Wayanad district in November 2008. The important lesions noticed during necropsy were ecchymotic haemorrhages in the epicardium, pulmonary congestion and edema, necrotic foci in the liver, haemorrhagic enteritis and typhilitis. For laboratory diagnosis of the cause of death, smears from the heart blood and liver impressions were taken and stained with Leishman's stain. The heart blood and liver samples were cultured on blood agar and incubated overnight at 37°C under increased carbon dioxide tension. A MacConkey agar plate was inoculated with the same samples and incubated at 37°C overnight. After incubation, the predominant colony type was subcultured on tryptone soya agar. The pure culture thus obtained was used for biochemical characterization of as per Quinn *et al.*, 1994.

Results

The heart blood smear and liver impression smear on staining revealed bipolar stained bacteria. Culture of the samples on blood agar yielded, a pure culture of Gram negative coccobacilli. No growth was obtained on MacConkey agar. The isolate was positive to oxidase, catalase, indole and nitrate tests and negative for methyl red, Voges - Proskauer and urease tests. The isolate fermented dextrose, sucrose, mannitol (weak), arabinose (weak) and sorbitol (weak). Dulcitol, maltose, lactose, trehalose and xylose were not fermented. Based on the results of these tests, the isolates were identified as *Pasteurella multocida* subsp. *multocida*. The isolate was sensitive to enrofloxacin, ciprofloxacin, amoxicillin and streptomycin.

Discussion

Dziva *et al.*, 2008, showed that blood agar was the most efficient in isolating various species of *Pasteurella* from clinical materials than selective media or mouse inoculation. In this study also, blood agar was used for primary isolation and found to be efficient for the purpose. Nakamine *et al.*, 1992, reported multiple necrotic foci in liver of Muscovy ducks which had died of fowl cholera. Similar lesions was noticed in this case also. Takahashi *et al.*, 1996, reported that isolates of *P. multocida*, from Muscovy ducks, though susceptible to many antibiotics, were considerably resistant to chloramphenicol. In our study also the isolate was susceptible to all the antibiotics tested; chloramphenicol was not included in our study.

Conclusion

Pasteurella multocida can cause fatal infection in Muscovy ducks. The bacterium can be easily cultured in the laboratory in enriched media like blood agar and can be identified by conventional methods. Though resistant to certain drugs have been reported, the organism was found to be susceptible to the commonly used antibiotics.

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THREAT ASSESSMENT OF AVIAN INFLUENZA THROUGH OBSERVATIONS ON MIGRATORY WATER FOWL IN KADALUNDI VALLIKUNNU COMMUNITY RESERVE OF KERALA

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Wild and domesticated waterfowl and shorebirds are the major natural reservoir of Avian Influenza virus and they excrete virus in the feces for long periods. Contact of migratory waterfowl with commercial flock is an important factor in many outbreaks.

Daily observation of migratory birds was done at 'Kadalundi - Vallikunnu community reserve', Kerala, India for a period from 16th September 2004 to 9th march 2006, to study various species of birds visiting the community reserve. Species of birds were identified and documented. Observations on these migratory waterfowls were correlated with the migratory trajectory of these birds with reference to countries affected with Avian Influenza. The specific species of birds which are potential carriers of the disease were identified and the months in which these birds visit the community reserve were noted.

Out of the 61 species of birds observed, 39 were migratory birds and 22 were native birds. Among these 39 migratory birds 8 species of migratory waterfowls were found to be potential species which can act as carriers of Avian Influenza, visiting the community reserve. The migratory pathway of these birds included countries like China, Japan, Germany, Malaysia, Canada, Pakistan, Indonesia, Viet Nam, Russia and Denmark where outbreak of Avian Influenza had been reported. This indicate that there is a possibility of these birds acting as a carrier of Avian Influenza, there by increases the risk of disease in India.

Based on these observations a local threat assessment pattern of Avian Influenza has been designed. The period of highest, moderate and lowest threat potential is suggested. The least threat is in the months of May, June, July and August, while in September, October, January, February, March and April there is moderate threat and the maximum threat is in the months November and December.

Continuous and scrupulous observation in all the geographical spots where migratory water fowl are visiting is required to develop an Avian Influenza warning system.

Key words: Migratory Waterfowl, Avian Influenza, Kadalundi – Vallikunnu

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Introduction

Avian influenza or "bird flu" is a contagious viral disease affecting chicken, duck, turkey and other birds, ranging from a mild to severe form of illness. These viruses are highly species specific, but on rare occasions they cross the species barrier to infect others even infect man . Wild birds, in particular certain species of waterfowl and shore birds are considered to be natural reservoirs of the disease and they act as potential carriers. Scientists are increasingly convinced that at least some migratory waterfowl are now carrying the H5N1 virus in its highly pathogenic form, sometimes over long distances, and introducing the virus to poultry flocks in areas that lie along their migratory routes. So the study was conducted with the objective of monitoring the migratory water fowls in 'Kadalundi-Vallikunnu community reserve' of Kerala and to design a threat assessment pattern of avian influenza.

Materials and methods

Migratory birds were observed daily, at 'Kadalundi Vallikunnu community reserve', of Kerala, India. The study was conducted for a period of one and a half year, starting from 16th September 2004 to 9th March 2006. The number and species of birds visiting the
Community reserve in a particular period (month) of year was identified. The birds visiting the community reserve which can act as carriers of Avian Influenza were specifically studied. Their migratory trajectory and the incidence of particular disease in those countries were studied. Depending upon the number of such carriers visiting the reserve, the whole year was divided into highest, moderate and least risk prone months, thus designing the threat assessment pattern of Avian Influenza.

Result

Within the period of study 61 species of birds, including migratory and native visited the community reserve. Among these 39 were migratory birds. List of migratory birds, which can act as carriers of Avian Influenza, visited the community reserve in different months were presented in table1.

There were reports of outbreak of Avian Influenza in Japan, China, Germany, Russia, Canada, Denmark, Malaysia, Pakistan, Indonesia and Vietnam in the years 2003, 2004, 2005, 2006 and 2007 which were some of the migratory tract areas of these birds. So there is a possibility that, an outbreak of Avian Influenza can occur in India due to the visit of these birds.

Based on these observations, a local threat assessment pattern of Avian Influenza had been designed. The period of highest, moderate and least threat is given in the pie diagram1.The highest threat is in the months November and December. In September, October, January, February, March and April there is moderate threat and least threat in May, June, July and August.

List of migratory birds, which can act as carriers of Avian Influenza, visited the community reserve in different months.

s/n	BIRDS	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
1	Ruddy Turnstone (*Arenaria interpres*)	7	5	3							6	24	53
2	Sanderling (*Calidris alba*)			30									
3	Great Black Headed Gull (*Larus ichthyactus*)	22	32	25	15							55	60
4	Brown Headed Gull (*Larus brunnicephalus*)	21	36	26	34							54	53
5	Sandwich Tern (*Sterna sandvicensis*)									35	36	60	50
6	Little Cormorant (*Phalacrocorase niger*)									17	34	20	43
7	Little Egret (*Egretta garzetta*)										13	54	22
8	Grey Heron (*Ardea cinera*)									2	3	7	2
	TOTAL	50	73	84	49					54	92	274	283

Table 1

Ruddy turnstone

Sanderling

Great black headed gull

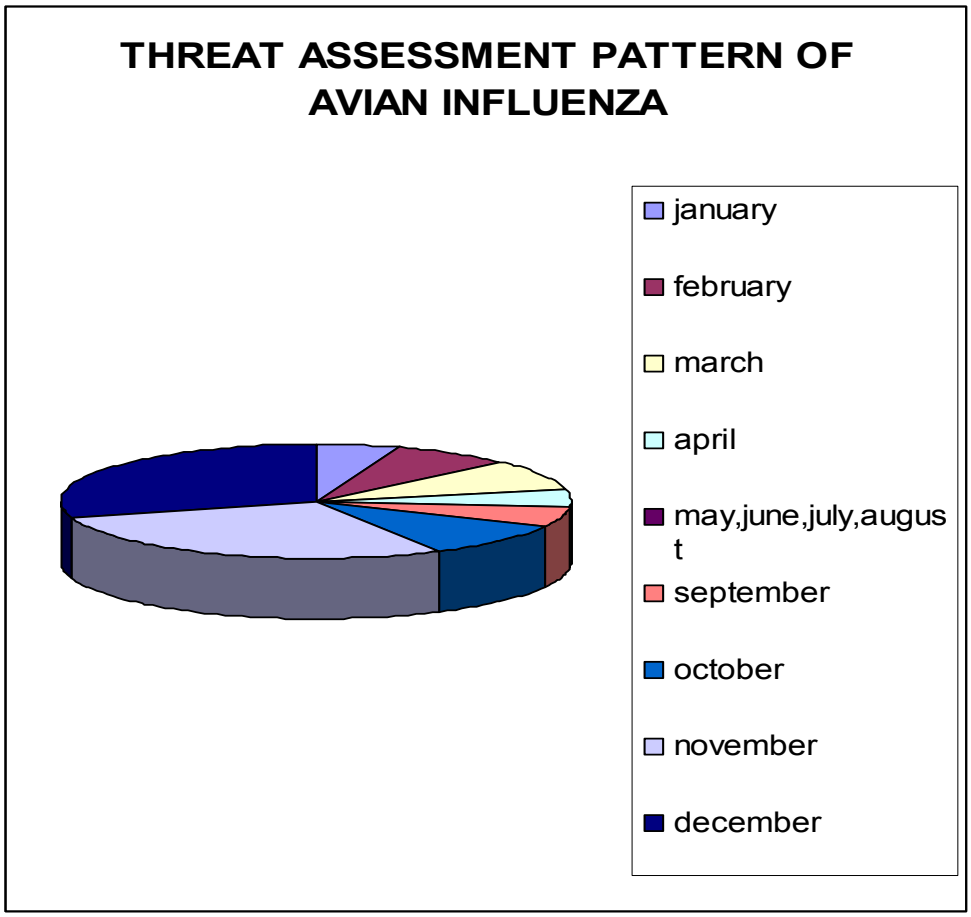
Black headed gull

Sandwich tern

Little cormorant

Little egret

Grey heron



Pie diagram 1

DISCUSSION

Waterbirds, are natural reservoirs for low-pathogenic avian influenza and have been implicated as the primary source of infection in outbreaks of highly pathogenic avian influenza. An understanding of the movements of birds and the ecology of avian influenza viruses within the wild bird population is essential in assessing the risks to human health and production industries Avian Influenza viruses have been shown to naturally infect a wide variety of wild and domestic birds, especially free living birds of aquatic habitats (Stallknecht, 1997). Wild waterfowls are considered the natural reservoir of all influenza viruses (pawar, 2006). They are known to carry viruses of the H5 and H7 subtypes, but usually in the low pathogenic form. Circumstantial evidence suggests that migratory birds can induce low pathogenic H5 and H7 viruses to poultry flocks, which then mutate to the highly pathogenic form (pawar, 2006). The first isolation of Avian Influenza from a free living bird was made from a common tern (Sterna *hirundo)* in South Africa during 1961(Becker, 1996).

By August 2006, 51 countries have reported Avian Influenza infection either in poultry or wild or migratory birds. (OIE report 2006). Recent outbreak of the disease occurred in China, Indonesia, Vietnam, Pakistan, India and Egypt (Chandrashekar et al., 2009). The disease is enzootic in China, Korea and Pakistan and endemic in many Asian counties(Kim et al.,2006).

WHO, FAO and OIE suggest that control of the disease in migratory birds is not feasible and should not be attempted. Killing of these does not prevent the disease but leads to the dispersion of virus to large areas. So the only method to prevent this disease is to avoid contact with diseased birds and migratory birds. Effective preventive measures are to be taken in the high risk periods.

Kadalundi – Vallikunnu community reserve is a place where about 39 migratory birds visit every year. So chance of an Avian Influenza cannot be avoided. As the country is having lot of locations with similar geographical and climatic conditions, these species will be visiting other locations also. Continuous and scrupulous observations in all the geographical locations, where migratory waterfowl are visiting is required to prevent outbreak of the disease in the country.

CONCLUSION

Migratory waterfowl may possibly spread these viruses over a wide range of territories. If viruses with the ability to replicate systemically in primates establish in migratory waterfowl, there would be an even more critical need for increased surveillance of poultry and the development of control measures.

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RADIOPROTECTION BY CURCUMIN ON DNA DAMAGE OF BLOOD CELLS IN DUCKS

(*Anas platyrhyncos domesticus*).

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Curcumin (Diferuloyl methane), a principal curcuminoid of the Indian spice turmeric (family:Zingiberaceae) was examined for its radioprotective effect in Kuttanad ducks. An intravenous injection of curcumin (40mg/kg b.w.) was given 20 min prior to blood withdrawal. Whole blood from curcumin treated and untreated ducks was exposed to 0.5 and 1 Gy gamma irradiation. Single cell gel electrophoresis under alkaline condition was performed to asses the comet parameters yielded by cellular DNA damage. Curcumin treated ducks showed a significant ($P< 0.005$) decreased damage, induced by both 0.5 and 1 Gy exposure as evident by 19.4±3.4% and 22.6±2.4% tail DNA compared to 24.9±4.0% and 30.8±4.0% tail DNA in control blood samples respectively. A similar result was obtained with respect to tail length 33.2±3.9 µm and 40.0±5.5 µm, tail moment 6.2±0.9 and 9.2±2.1 and olive tail moment 9.7±1.9 and 11.7±1.5 in curcumin treated blood exposed to 0.5 and 1 Gy respectively compared to tail length 79.4±4.4 µm and 112.0±15.8 µm, tail moment20.4±3.4 and 40.1±8.6 and olive tail moment 18.8±3.1 and 27.9±4.7 in control blood samples. Unexposed control blood sample yielded 11.0±1.2% tail DNA, 19.4±2.5 µm tail length, 2.2±0.4 tail moment and 5.4±0.9 olive tail moment values in comet assay. Results were suggestive of radioprotective property of curcumin in ducks.

Introduction

Water fowl such as ducks and geese are included in the diets of human. Water fowl that eat fish are higher on the food chain than those that eat plants or insects like geese. Contaminants like persistent organic and inorganic pollutants (insecticides, herbicides and radioactive heavy metals) ultimately reach water resources and build up in the fat tissue of aquatic fauna, are a concern to the health of water fowl. Contaminants become more concentrated when animals (predators) eat other animals (prey) leading to biomagnifications and bioaccumulation within the body system.

At high levels, radiations can cause cell damage or cause cancer. Ionizing radiation inflicts deleterious effects by damaging DNA and membrane (Weiss and Landauer, 2003). Little information is available about effects of low levels of radiations in health aspects of water fowl. Several plant compounds are reported to have radioprotection properties (Arora *et al.*, 2005)

Curcumin (Diferuloyl methane) is the principle curcuminoid of popular Indian spice turmeric; member of ginger family (Zingiberaceae). Curcuminoids are polyphenols, which impart yellow colour to rhizomes of *Curcuma longa*. Curcumin has been extensively studied for its anti-oxidant, anti-inflammatory (Menon and Sudheer, 2007) and anti-cancer (Jagetia and Aggarwal, 2007) properties. However radio protective potential of it, has not yet been exploited in the veterinary field. The present study is focused on the DNA protecting ability of curcumin in Kuttanad ducks by comet assay, which is considered to be a rapid and sensitive method for detection of primary DNA damage at the single cell level.

Materials and Methods

The study was performed on healthy adult female Kuttanad ducks; six months age; procured from University Poultry Farm, KAU, Mannuthy. These ducks were grouped (6 / group) into G I: Normal, G II: Untreated and G III: Treated with curcumin @40mg/kg b.w.

Required quantity of curcumin was dissolved in 500µL of Dimethyl sulfoxide (DMSO) and given by slow intravenous route through saphenous vein to G III birds. Blood was collected (3ml) in anticoagulant, potassium EDTA from all birds of G I and G II, but after 20 min of intravenous administration of curcumin from G III. Whole blood samples from untreated (G II) and curcumin treated (G III) was exposed to 0.5Gy Gamma radiation, to designate them as G IIA and G IIIA respectively. Those whole blood samples from untreated and Curcumin treated exposed to one Gy Gamma radiation were considered as G IIB and G IIIB respectively.

The alkaline comet assay (Singh, 2000) was used to access the effect of irradiation on cellular DNA and for any protective effect of curcumin on DNA damage. In short, the comet assay was conducted in alkaline medium on frosted slides

coated with agarose. Precoating of slides was done with normal melting point agarose (1% in PBS: pH 7.4). Immediately coversliped and kept at 4^0C for 10 min to get the agarose solidified. After removal of coverslip, 200 µL of 0.8% low melting point agarose containing 5 µL of whole blood, was added to the slide. Cover slips were placed immediately and slides were kept at 4^oC for 10 min. After solidification cover slips were removed and slides were immersed in prechilled lysing solution containing 2.5M NaCl, 100mM Na_2EDTA, 10mM Tris-HCl; pH-10, 1% DMSO, 1% Triton X and kept for 1 hour at 4^oC. After lysis , slides were drained properly and placed in a horizontal electrophoresis apparatus filled with freshly prepared electrophoresis buffer containing 300mM NaOH, 1mM EDTA and 0.2% DMSO; pH $\geq$ 13. The slides were equilibrated in buffer for 20 min and electrophoresis was carried out for 30 min at 25 V. The slides were washed gently with 0.4mM Tris-HCl buffer, pH-7.4 to remove alkali. The slides were again washed with distilled water. One percent propidium iodide was used for staining the gel and comets were visualized under fluorescent microscope with 40X magnification. The images were captured and analyzed using software 'CASP' which gives % DNA in tail, tail DNA length, tail DNA moment and olive tail DNA moment directly. The tail moment (TM) is the product of tail length and % DNA in tail and olive tail moment (OTM) is the product of the distance between the centre of gravity of the head and the centre of gravity of the tail and % DNA in tail.

Statistical analysis was carried out to find out any significant difference between untreated and treated groups when compared to normal group, using student 't'test.

Results

Exposure of duck blood cells to Gamma radiation *ex-vivo* induced damage to cellular DNA as evident from the comet formation in Fig.1. Exposure of blood cells to one Gy resulted in a significant ($P<0.05$) increase in comet parameters such as % DNA in tail (from 11.0$\pm$1.2% to 30.8$\pm$4%) (Fig 2.), tail DNA length (from 19.4$\pm$2.5µm to 112.0$\pm$15.8µm)(Fig 3.), tail DNA moment (from 2.2$\pm$0.4 to 40.1$\pm$8.6) (Fig 4.) and olive tail DNA moment (from 5.4$\pm$0.9 to 27.9$\pm$4.7) (Fig 5.) in untreated (G IIB) when compared to normal (G I) blood samples. However, blood samples exposed to 0.5Gy radiation (G IIA) exhibited significantly ($P<0.05$) lesser comet parameters such as % DNA in tail (24.9$\pm$4%), tail DNA length (79.4$\pm$4.4µm), tail DNA moment (20.4$\pm$3.4) and olive tail DNA moment (18.8$\pm$3.1) when compared to one Gy exposed samples. There was significantly ($P<0.05$) lesser damage of DNA, induced by 0.5 Gy (G IIIA) and one Gy (G IIIB) irradiated blood collected from curcumin treated ducks as evident by the comet parameters like % tail DNA 19.4$\pm$3.4% and 22.6$\pm$2.4%, tail DNA length 33.2$\pm$3.9 µm and 40.0$\pm$5.5 µm, tail DNA moment 62.0$\pm$0.9 and 9.2$\pm$2.1 and olive tail DNA moment 9.7$\pm$1.9 and 11.7$\pm$1.5 respectively.

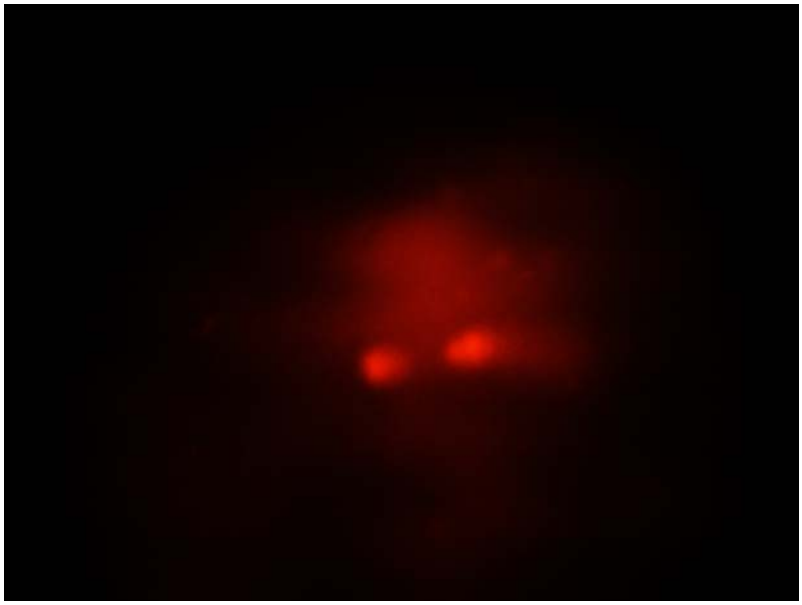


Fig 1. Comet characters of cellular DNA.

Fig 2. Gamma radiation induced changes in tail DNA content (%) of duck blood cells

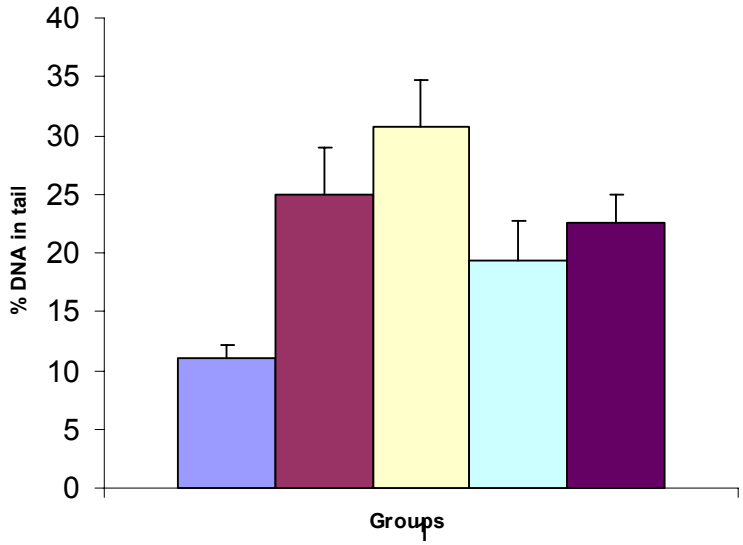


Fig 3. Gamma radiation induced changes in tail DNA length (micrometer) of duck blood cells

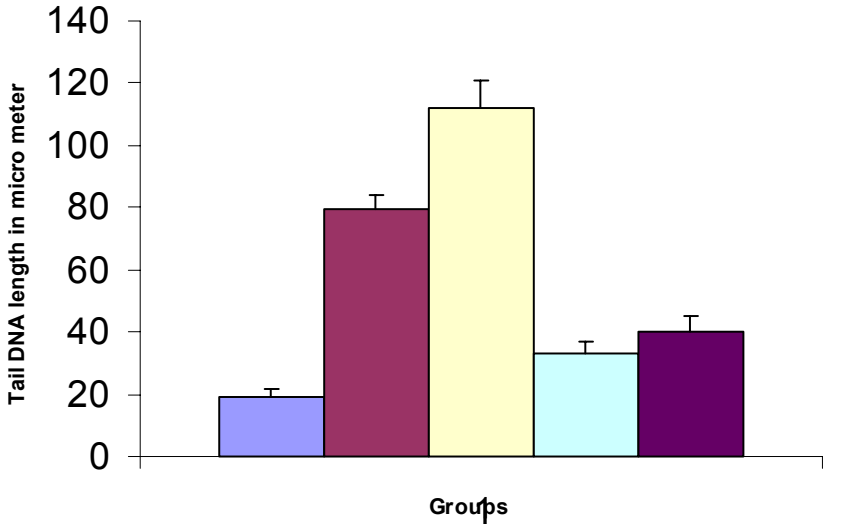
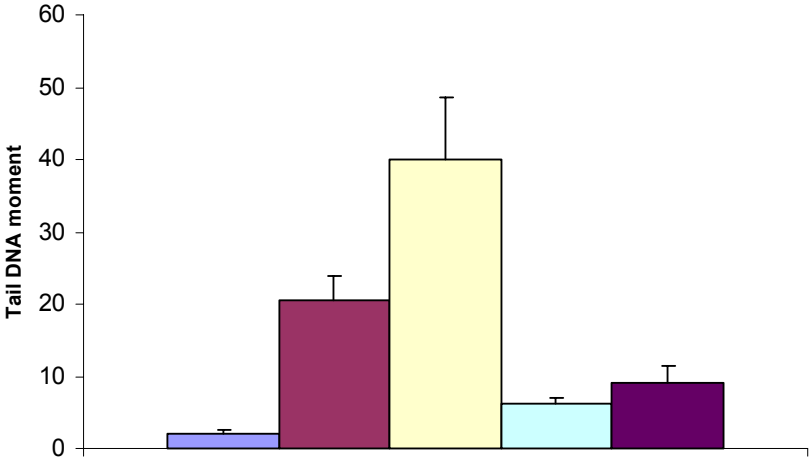
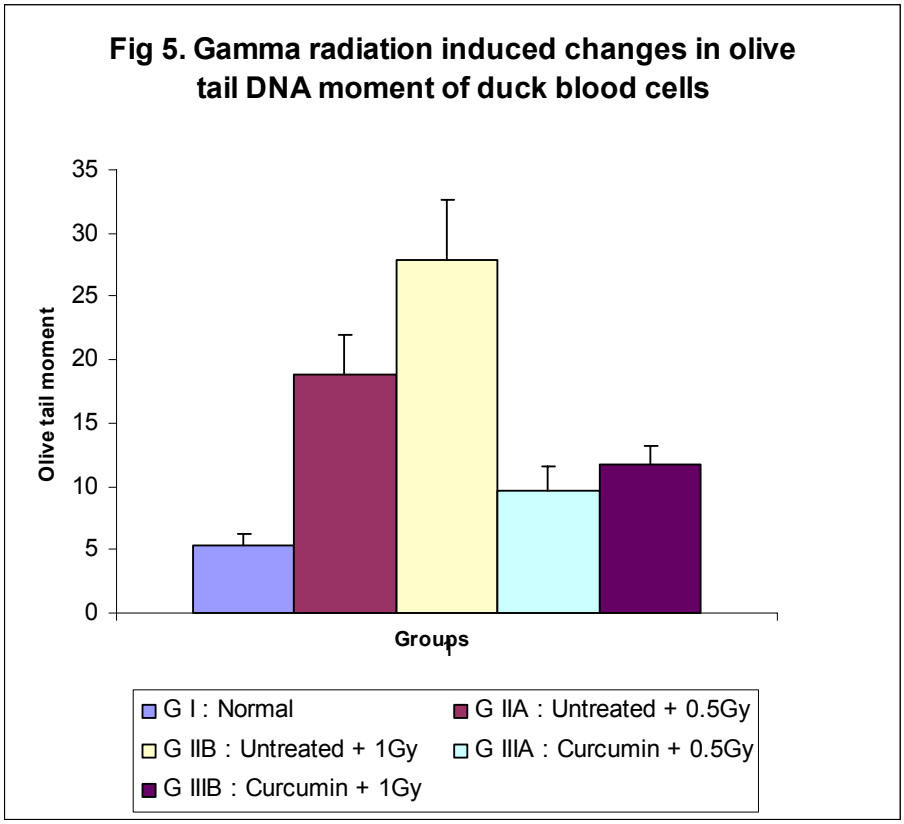


Fig 4. Gamma radiation induced changes in tail DNA monent of duck blood cells





Discussion

Ionizing radiations like X-rays and Gamma rays, beta particles, alpha particles and neutrons are known to induce oxidative stress due to Reactive Oxygen Species (ROS) production within cells, resulting in imbalance of the pro-oxidant and antioxidant in the cells which ultimately leads to cell death. The major damage due to ionizing radiation are single strand breaks, double strand breaks, DNA-DNA and DNA-protein cross links and damages to nucleotide bases. Overproduction of ROS, thus leads to mutation and chromosomal aberrations. Radiation induced loss of viability of cells has been attributed to unrepaired lesion in DNA. Thiol compounds such as amifostine, phosphonol, *N*-acetyl-L-cysteine, captopril and mesna have been shown to exhibit antioxidant properties and reduce radiation damage in DNA (Kataoka *et al.*,2007).

Alkaline comet assay is a sensitive technique to monitor strand breaks and alkali labile DNA lesions i.e. rightly used to study genotoxicity, cellular DNA lesions, apoptosis and DNA repair (Olive,1999).

Turmeric has been used to treat various ailments in the Ayurvedic system of medicine in India. In the present work, due to pretreatment of ducks with curcumin at the dose rate of 40mg/kg b.wt.: iv., resulted in decreased damage of cellular DNA, induced by Gamma radiation as evidenced by all the comet assay parameters. This may be due to antioxidant sparing action of Curcumin. Curcumin being lipid soluble reacts with lipid peroxyl radicals and acts as a chain terminating antioxidant (Srinivasan *et al.*, 2006). Curcumin being hydrophobic not only get localized in the lipid bilayer membrane, but also easily get into the cytoplasm. The presence of curcumin in the cytosol directly scavenges the free radicals like superoxide anion, hydroxyl radical and lipid peroxyl radicals, etc. and results in the formation of phenoxyl radicals. The phenoxyl radicals of curcumin thus produced are stabilized over the extended conjugation (Khopde *et al*., 2000). Curcumin stimulates gamma glutamyl cysteinyl synthase, the rate limiting step in the glutathione synthesis, thereby yielding protection to DNA against oxidative damage.

Studies have shown that curcumin significantly enhance the synthesis of antioxidant enzymes such as SOD, CAT and GPx in rat liver (Reddy and Lokesh, 1994).

In the present study the damage inflicted on blood cells by one Gy radiation yielded significantly higher levels of DNA damage, in a dose dependent manner. The dose selected for curcumin would have been insufficient to quench all free radicals generated. Thus, from the results obtained it was observed

that pretreatment with curcumin protects the cell from Gamma radiation to a significantly greater extent. These results are particularly interesting since turmeric is consumed in many parts of India. This may offer protection to individuals staying in areas where background radiation from natural radioactivity is higher. Supplementation of minimum dose of curcumin of turmeric in the diet of semi-intensively reared water fowl like geese and ducks would ensure protection against low levels of ionizing radiations.

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AVIAN VACUOLAR MYELINOPATHY– A EMERGING DISEASE IN WATERBIRDS

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Introduction

Avian vacuolar myelinopathy (AVM) is a recently discovered neurological disease affecting waterbirds, primarily bald eagles and American coots, in the southern U.S. An unusual neurological disease has caused the deaths of at least 85 bald eagles, thousands of coots and a small number of waterfowl and other species wintering in 5 southern states. During the winter of 1994-95,a neurologic disease ,described avian vacuolar myelinopathy (AVM) (Thomas et al.1998),killed 29 bald eagles (Haliaeetus leucocephalus) at DeGray Lake in southwestern Arkansas (USA). In 1996, the disease was also recognized in American coots (Fulica americana) at DeGray lakeand coots and/or bald eagles at two other lakes (Lake Ouachita and Lake Hamilton)in Arkansas

. AVM has also been confirmed as the cause of death in mallards, buffleheads, ring-necked ducks, Canada geese, killdeer, and a great horned owl.

It is believed that a man-made or naturally occurring toxin is the most probable cause of this disease. Sick birds were alert and aware of their surroundings, but all of the moribund bald eagles ultimately died. At least 58 bald eagles died from AVM in the three Arkansas lakes from 1994–98, and an undetermined number of coots were affected(Wiley et al.,2007)

Etiology

Thorough necropsy and diagnostic laboratory studies at the USGS National Wildlife Health Center (NWHC) produced no evidence of parasitic, viral, bacterial, or prion infections The etiology of this condition remains unknown. Many compounds are known to cause intramyelinic vacuoles ,including hexachlorophene, triethyltin ,bromethalin, anthelmintics, cuprizone, and isonicotinicacid hydrazide2-9; however, extensive tissue analyses for these compounds have not produced insight into the etiology of this disease. A sentinel study demonstrated that exposure to the agent that causes AVM is site-specific, seasonal, and relatively short in duration. Feeding trials performed at the NWHC with plant material collected from one of the lakes during an outbreak demonstrated that the causative agent of AVM is associated with submersed aquatic vegetation and that the onset of AVM is dose-dependent. two types of cyanobacteria discovered associated with the plant material collected during an outbreak(Rocke et al.,2005)

1. Pseudanabaena catenata
2. an unknown species of Stigonematales

Three types of invasive aquatic plants dominated AVM positive ponds

Hydrilla (Hydrilla verticillata)
Brazilian elodea (Egeria densa)
Eurasian watermilfoil (Myriophyllum spicatum

The results of the experimental trials suggest that the cause of AVM is either seasonally accumulated by aquatic vegetation, or is produced during the fall months by one or more organisms associated with aquatic vegetation at the affected lakes. It is important to note that hydrilla is ***not*** the cause of AVM and hydrilla need not be present for an AVM outbreak. Major AVM outbreaks have occurred at lakes without hydrilla**,** but with other submerged vegetation(Rocke et al., 2002)

Clinical Signs

Affected birds have difficulty flying, swimming, or walking and often appear disoriented. Eagles have been observed flying into rock walls and water birds have been seen crash-landing into the water, as well as trailing a leg or lying on their backs or sides while swimming. Typically, clinical disease is noticed in the autumn or early winter—as early as October at some lakes—with people observing sick birds for several months afterwards. Disease onset can be very rapid (5–7 days) and that exposure to the causative agent of AVM is site-specific, seasonal (late fall to early winter), and occurs over a relatively short duration(several months) supports the hypothesis that the disease is caused by a chemical substance, most likely of natural origin(Scott et al.,2002)

Diagnosis

Gross lesions are not apparent in affected birds. The consistent diagnostic finding across species, locations, and time is a microscopic lesion in the brains of affected birds. Consequently, AVM currently can only be diagnosed by microscopic examination of brain tissue collected and preserved in formalin shortly after the death of the bird . Histologically, the disease is characterized by diffuse, spongy degeneration throughout the white matter of the CNS, with the optic tectum most severely

affected. No cellular inflammatory response has been observed in association with the vacuolar lesions, and there have been no consistent histologic lesions reported in non-neural tissue.

It appears as open spaces in the white matter (myelinated areas) of the central nervous system in affected birds. Using electron microscopy, USGS pathologists have determined that the spaces are caused by separation of the myelin layers that surround and protect the nerves.

It appears as open spaces in the white matter (myelinated areas) of the central nervous system in affected birds. Using electron microscopy, USGS pathologists have determined that the spaces are caused by separation of the myelin layers that surround and protect the nerves.

Conclusion

Epizootic avian vacuolar myelinopathy (AVM) was first recognized as a neurologic disease in bald eagles (Haliaeetus leucocephalus) and American coots (Fulica americana) in Arkansas, USA in 1994 and 1996, respectively, but attempts to identify the etiology of the disease have been unsuccessful to date. The exposure is site-specific, disease onset is rapid, and the agent may persist in the environment for only a few months at a level sufficient to induce disease in birds further supports the hypothesis that the cause of AVM is chemical substance, most likely of natural
origin (viz., a toxin), and this knowledge will help focus the search for its identity .Future research should focus to monitor AVM at lakes where the disease occur and at nearby lakes without disease. Characterization of environmental factors at sites where AVM has occurred will be instrumental for developing risk assessment models and may generate hypotheses regarding environmental conditions conducive for AVM outbreaks.

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DUCK MORTALITY DUE TO FLUKE INFECTIONS

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A large number of flukes were recovered from the trachea upon postmortem of ducks that had died at Mankompu, a coastal village in Kerala. The flukes were identified as *Tracheophilus cymbius.* Water snails like *Planorbis* spp. that form food for these ducks aid in the transmission of this fluke. The cause of death was attributed to the abundance of flukes in the trachea and consequent obstruction resulting in asphyxia. Suggested control measures comprise of keeping the ducks away from suspected water and treatment with albendazole.

ROLE OF WILD AND DOMESTIC WATERFOWL IN AVIAN INFLUENZA OUTBREAKS IN DOMESTIC POULTRY

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It is generally accepted that waterfowl play an important role in the generation, spread, and enzootic transmission of avian influenza (AI). Wild waterfowl are considered the natural reservoir of all avian influenza A viruses. All 15 Hemagglutinin (HA) and 9 Neuraminidase (NA) subtypes have been isolated from wild waterfowl and aquatic shorebirds. Waterfowl act as a reservoir of avian influenza virus by carrying the virus in their intestinal tract and shedding it in their feces. The prevalence of AI subtypes in waterfowl varies by age, season, and species. Age appears to be the primary risk factor for AI infection. Avian influenza viruses are spread to susceptible birds through inhalation of influenza particles in nasal and respiratory secretions and from contact with the feces of infected birds. Most infected birds exhibit no symptoms, even when they are excreting large quantities of infectious virus. These asymptomatic birds act as "silent" reservoirs of the virus, perpetuating its transmission to other birds. Prevalence rates in juveniles have been reported to be significantly higher than prevalence rates in adults. Mallards and blue-winged teal have the highest species prevalence rates reported in surveys of wild waterfowl. Domestic waterfowl (e.g., ducks) may also act as a two-way intermediary in the transmission pathway of avian influenza between wild waterfowl and domestic terrestrial poultry (e.g., chickens). Although usually transmitted from wild birds as a virus of low pathogenicity, it may mutate during replication in domestic poultry and Highly Pathogenic Avian Influenza (HPAI) strains may arise.

Key Words: Waterfowl, Avian Influenza, Domestic Poultry

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ULTRASTRUCTURAL PATHOLOGY OF THE LYMPHOID ORGANS IN EXPERIMENTAL SUB LETHAL TOXICITY OFCARBOFURAN IN DUCKLINGS

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Carbofuran is an agrochemical used extensively in agricultural practice as a pesticide. Single L.D.50 for carbofuran as a 98% technical product was 25-39mg/Kg. in chicken.

Duck rearing in Kerala depend mainly on the harvested paddy fields which are contaminated with pesticide residues like carbofuran. The exposure to sub lethal doses of agrochemicals may lead to sub cellular changes which are not grossly and microscopically appreciable. Hence the significance of an experiment to study the ultrastructural changes in the lymphoid cells on exposure to sub lethal dose of carbofuran for six and ten weeks.

Carbofuran (98% technical grade) was administered orally at a dose rate of 0.06mg/Kg. body weight to two groups of one month old ducklings for a period of six and ten weeks. The ducklings were sacrificed at the end of the sixth and tenth week and the lymphoid organs like the bursa, thymus and spleen were collected in 3% glutaraldehyde. Ultra thin sections were stained with uranyl acetate and lead citrate and examined in an electron microscope at 75 K.V.

The number of lymphoid cells in the bursa, thymus and spleen were relatively less in the carbofuran treated group. The nuclear membrane changes like fusion, thickening, reduction in the nuclear pores, evagination and bizarre nucleus indicated sub cellular damages. The abundance of heterochromatin suggested the inactive state of the lymphoid cells. The accumulation of perichromatin granules in the group exposed to prolonged treatment indicated the suppression of the protein synthesis.

The prominent changes in the cytoplasmic organelles were pleomorphic swollen mitochondria with varying degree of crystolysis. The endoplasmic reticulum showed degranulation, fragmentation and dilatation. Dilated fragments of the endoplasmic reticulum was more pronounced in the prolonged treatment groups. The plasma cells in the spleen showed swollen mitochondria with crystolysis, disaggregation of polyribosomes and fragmented E.R.

The ultrastructural changes in all the lymphoid organs examined were more pronounced in the group exposed to prolonged treatment and the changes observed were co-related with the moderate histological changes and functionally with the immunopathological modulations observed. By this investigation the immunotoxicity of carbofuran was brought to light and the basic mechanism involved was clarified and one of the reasons for disease outbreaks among ducks was delineated.

ZOONOTIC DISEASES OF WATERBIRDS- A GLIMPSE

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ABSTRACT

Wild birds are important to public health because they carry emerging zoonotic pathogens, either as a reservoir host or by dispersing infected arthropod vectors. The instinct for survival causes migratory birds to seek favourable seasonal locations for food and breeding possibilities. Bird migration provides a mechanism for the establishment of new endemic foci of disease at great distances from where an infection was acquired, the result of which is a global spread of emerging infectious diseases. In addition, birds migrating across national and intercontinental borders can become long-range vectors for any bacterium, virus, parasite, or drug-resistant organism they harbor. This creates the potential for the establishment of new endemic foci of disease along migration routes, few important diseases being chlamydiosis, avian influenza, histoplasmosis, avian tuberculosis, eastern equine encephalitis, Arizona infection, colibacillosis etc. Aquatic waterfowl are asymptomatic carriers of essentially all hemagglutinin and neuraminidase combinations of influenza A virus. Avian influenza strains do not usually replicate well in humans, but they can undergo genetic reassortment with human strains that co-infect pigs, which can result in new strains with a marked increase in virulence for humans. Wild birds also can acquire enteropathogens, such as **Salmonella** and **Campylobacter** spp., by feeding on raw sewage and garbage, and can spread these agents to humans directly or by contaminating commercial poultry operations. Conversely, wild birds can acquire drug-resistant enteropathogens from farms and spread these strains along migration routes. The Indian subcontinent, hosting over a hundred species of migratory birds, provides a congenial climate for the spread of various zoonotic agents. Surveillance, diagnostics, an early warning system and other monitoring techniques based on the migratory pattern of these birds, is crucial to check the spread of zoonoses on a global perspective. A better understanding of avian migration patterns and infectious diseases of birds would be useful in helping to predict future outbreaks of infections due to emerging zoonotic pathogens, and devise appropriate methods conducive to the particular area for the control and prevention of the various emerging and reemerging zoonotic diseases. A detailed account of the some of the more important diseases is discussed.

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PRODUCT PROCESSING

EFFECT OF SEX ON CERTAIN CARCASS TRAITS OF CHARA-CHEMBALLI DUCKS OF KERALA UNDER RANGE CONDITION IN ASSAM

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The effect of sex on certain carcass traits of Chara-Chemballi ducks was studied in free range condition of Assam. The mean live weight, per cent yield of blood as well as shank and feet (amongst inedible parts) of male carcasses on live weight basis was significantly ($P<0.05$) higher than in females. Out of the edible parts, the male carcasses had significantly ($P<0.05$) higher mean per cent yield (on live weight basis) of back, dressed weight, eviscerated weight and ready-to-cook weight, whereas the mean yield of breast and wing was significantly more in female carcasses. There was no significant difference in yield of feather, inedible viscera, head, giblet, liver, heart, gizzard, neck, thigh and drumstick between the two sexes. The per cent water absorption of female carcasses was significantly ($P<0.05$) higher than those of males

Key words: Sex; carcass traits; Chara-Chemballi duck

Introduction

Chara-Chemballi is one of the popular varieties of duck which are native of Kerala. These ducks were introduced in selected clusters of villages of the state of Assam to give a new face to the traditional activity of duck rearing by the State Institute of Rural Development under the Panchayat and Rural development department, Govt. of Assam in the year 2003. Though Chara-Chemballi ducks are primarily reared for egg production, its meat is very popular amongst the rural consumers of Assam. However, no investigation, especially on the effect of sex on carcass qualities of this duck appears to have been undertaken. Therefore, the present study was undertaken to investigate the influence of sex on different edible and inedible component traits of Chara-Chemballi duck carcasses in range condition of Assam.

Materials and methods

Adult Chara-Chemballi ducks of aged 6 months, 20 from each sex, were obtained randomly from different self-help groups located at different districts of Assam. These were slaughtered by conventional method. Scalding, defeathering, evisceration, removal of head, shank and feet and final washing of the carcasses were done as per standard procedures (Sahoo and Panda, 1983). Live weight, dressed weight, eviscerated weight , ready-to-cook weight, weights of blood, feather, inedible viscera, head, shank and feet, giblet, neck, breast, wing, back, thighs and drumsticks were recorded. Per cent yields of different edible and inedible component part of the duck carcasses were expressed on live weight basis (LWB). Statistical analysis of data was done according to Snedecor and Cochran (1990).

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Results and discussion

The mean live weight and per cent yield of different edible and inedible component parts of Chara- Chemballi duck carcasses are presented in Table 1. At six months of age drakes had significantly ($P<0.05$) higher body weight as compared to ducks. The mean yields of blood as well as shank and feet of male carcasses were significantly ($P<0.05$) higher than that of female carcasses. In contrast to the present finding, Senani *et al.* (2005) did not find any significant difference in the blood loss between sexes. This might be due to differences in the rearing system and growth rate of the bird. The differences in respect of feather, inedible viscera and head were non-significant. These observations corroborate the findings of Gupta *et al*. (1978) for white Pekin ducks, Sahoo (1990) for Kashmiri *desi* ducks and Mahanta *et al*. (2000) in *Pati* ducks of Assam. Amongst the edible components, the male carcasses had significantly ($P<0.05$) higher mean per cent yields of back, dressed weight, eviscerated weight and ready-to-cook weight, whereas females had significantly heavier breast and wing. Similar finding was reported by Mahanta *et al*. (2000) in *Pati* ducks of Assam. In Pekin ducks Vanli *et al*. (1994) recorded significantly higher weights of back and thigh in males than in female counterparts. Senani *et al.* (2005) recorded much lower dressing percentage in male and female carcasses of Chara-Chemballi ducks respectively as compared to the present findings. Non-significant difference in the yields of giblet, liver, heart, gizzard, neck, thigh and drumstick were found in the present investigation between the two sexes. In contrary to this, male carcasses of *Pati* (Mahanta *et al*., 2000) *and* Kashmiri *desi* (Sahoo, 1990) showed significantly ($P<0.05$) higher yields of giblet, heart, liver and gizzard. The per cent water absorption was significantly ($P<0.05$) more in female ducks than in males. Similar observation was reported by Mahanta et al. (2000) in indigenous ducks of Assam.

Table 1. Live weight (g) and per cent yield (live weight basis) of different inedible and edible parts of Chara-Chemballi duck at 6 months of age

Trait	Mean (± SE)	
	Male	Female
Live weight	1515.25 ± 20.52[a]	1385.16 ± 31.61[b]
Per cent yield		
Blood	4.02 ± 0.6[a]	3.21± 0.52[b]
Feather	4.23 ± 1.02	4.35 ± 1.13
Inedible viscera	9.37 ± 1.24	9.26 ± 0.98
Head	6.18 ± 0.15	5.71 ± 0.71
Shank and feet	3.06 ± 0.41[a]	2.57 ± 0.37[b]
Giblet	8.43 ± 0.45	8.12 ± 0.33
Liver	2.71 ± 0.64	2.98 ± 0.21
Heart	0.93 ± 0.09	0.84 ± 0.10
Gizzard	4.96 ± 0.17	4.82 ± 0.21
Neck	5.34 ± 0.72	5.11 ± 0.54
Breast	18.61 ± 3.11[b]	20.22 ± 3.03[a]
Wing	10.48 ± 0.74[b]	11.41 ± 0.24[a]
Back	17.31 ±0.36[a]	15.24 ± 0.36[b]
Thigh	4.54 ± 0.16	4.15 ± 0.20
Drumstick	6.97 ± 0.61	6.85 ± 0.54
Dressed weight	84.72 ± 2.35[a]	82.58 ± 2.64[b]
Eviscerated weight	64.54 ± 1.93 [a]	60.89 ± 2.10[b]
Ready-to-cook weight	69.57 ± 1.83[a]	65.76 ± 1.98[b]
Water absorption during washing	3.45 ± 0.75[a]	4.55 ± 0.81[b]

Figures with different superscripts, row-wise differ significantly ($P<0.05$)

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THE CHANGE OF EICOSAPENTANOIC AND DOCOSAHEXAENOIC ACIDS DURING PROCESSING AND STORAGE OF SALTED DUCK EGGS

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Abstract

The objective of this experiment was to study of the behavior of eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA) of duck egg yolk during processing and storage time of salted eggs. They are polyunsaturated fatty acids which are believed having several health benefits.

During salting of eggs, EPA and DHA showed decrease in their concentration though the moisture content of salted eggs was also decreased. Salting of eggs at low temperature (ca 10^{o}C) affected on similar decreasing profile of both fatty acids but the rate of decreasing was lower than salting at room temperature. Store of salted eggs affected on decreasing of both fatty acids either at room temperature or at low temperature.

From three dimension of regression calculated by RSM with two factors, salting time and storage time, indicated the response surface of EPA and DHA were sadle forms. However, the slope taken by one of the factors was not depended on the value taken by another factor mean there was no interaction between the length of salting and length of storage. Salt concentration was the main factor on the length of storage.

The research concluded decrease in EPA and DHA during processing and storing of salted eggs were not affected by the length of salting and/or length of storage but tended to be affected by the concentration of salt in egg yolk. This indicated that there was a phenomenon that salt could provide with degradation of EPA and DHA caused by oxidation and/or hydrolysis during salting and storing of salted eggs. However, it should be noted that EPA and DHA were more stable during low temperature storage of salted eggs. From the result of the research it could be recommended that based on the degradation of EPA and DHA, salted eggs resulted from long time of salting should be stored for short time or consumed soon, in other side salted eggs resulted form short time of salting could be relatively longer stored.

Keywords: egg salting, salted eggs, fat, EPA, DHA

Introduction

EPA and DHA are the acronyms of eicosapentanoic acid (C20:5ω3) and docosahexaenoic acid (C22:6ω3) respectively, both are a group of omega-3 (ω3) fatty acids mainly found in fats or oils from animal origin including poultry egg yolk in particularly when the animals are fed with diet incorporated with polyunsaturated fatty acids. These fatty acids are believed having several actions that inhibit the development of atherosclerosis, triglyceride-lowering effect and also raise levels of high density cholesterol, prevent coronary artery disease and sudden death (Dickinson, 2002). Exploration of health benefit of EPA and DHA is base on the fact that Alaskans and Greenlandic Eskimos who only eat fatty foods mainly fish containing high fat and cholesterol, however, they rarely suffered from ischemic hearth disease. Health benefits of ω3 fatty acids especially from fish oils have recently been reviewed (Kinsella, 1986; Kinsella, 1988; Beare-Rogers, 1988; Holub, 1988). Due to the health benefits of EPA and DHA fatty acids, works have been conducted to produce foods and food products which contain high concentration of EPA and DHA or prevent or stabilize the EPA and DHA contents from any destruction such as oxidation and now still be an interesting area to study. Duck eggs are rich in EPA and DHA as stated by Thomas (2009) especially if the ducks were raised in laguna which there are many feed sources

containing ω3 fatty acids found such as snails, clams, small shrimps, small fishes, water insects and crabs, etc. as reported by Harimurti (2009). However, the concentrations of EPA and DHA in egg yolk are depended on the composition of feeds. Hargis *et al*. (1990) reported yolk content of ω6 and ω3 fatty acids were influences by diets, while the increasing of EPA and DHA contents in the egg yolk by feeding lying hens diets containing menhaden oil which is rich of ω3 polyunsaturated fatty acids was obtained by Huang *et al*. (1990) in their experiment. Significant change in the ω3 fatty acids composition of hen's egg in particularly EPA and DHA when oil seeds such as full-fat canola or flax seeds were added to layer diets was reported by Ajuyah *et al*. (1992). Review on the manipulation of the n-3 polyunsaturated fatty acid composition of avian eggs and meat has been written by Leskanich and Noble (1997).
It has been known that unsaturated fatty acids are more susceptible to oxidize due to the double bonds found in their molecule structure than saturated fatty acids. This oxidation can be promoted by enzymic and nonenzymic reactions (Asghar *et al*., 1990) and can reduce fat and/or fatty acid concentrations in egg yolk. Fat and fatty acid oxidations are not preferred because rancid flavor will be developed and reduce functional characteristics of egg for food processing. Some processings lead to increase or decrease fat content including EPA and DHA. Hadiwiyoto (2003) demonstrated that salting of short-bodied mackerel could reduce fat content. When NaCl was incorporated to meat turkey patties processing, fat content was reduced significantly obtained by King *et al*. (1988) work, while Huffman *et al*. (1981) reported that salting in and salting out can be occurred in fat when salt was added to restructured pork chops. However, Murugesu and Basha (1989) reported that oil in peanut seed remained unaffected by boiling it in the 0-5% salt solution for period of 0-2 hours.

The salting of duck eggs has been discovered for long time as a traditional processing in East, South and Southeast Asia with various methods and duration of salting. However, only little information can be found explaining the mechanism of the change of fat and/or polyunsaturated fatty acid contents regarding to egg salting. The role of salt on the reducing fat and/or fatty acid contents in foods and food products is still unclear to understand, except for Cu, Fe, and Mg that take a role as catalysts of the reaction of lipid oxidation.

The great objective of this research was to study the change of EPA and DHA during egg salting and storing of salted duck eggs and elaborated the role of salt on the mechanism of their change. Aims were also to study the relationship between salting time and shelf life of salted eggs.

Materials and Methods

Ingredients and preparation of salted duck eggs

Duck eggs, 24-48 hours old were directly obtained from the farm of duck raised in laguna at Bantul coast south of Yogyakarta city. Only eggs that had normal shape and no any damage found and high quality detected by candling were used throughout the study. Eggs were washed with clean water until the shell was free from impurity materials and stand at room condition to dry residual water. The medium for salting egg base upon the type of common used in traditional salted egg processing, contained wood ash, coast clay and commercial salt in the same portion. These ingredients for salting were macerated until a paste was formed and used for medium of egg salting. Washed eggs were covered with a salting medium maintained at approximately 0.5 *cm* of the thickness, packed in a soil basket and add another medium until all eggs were covered. Salting was carried out in a period of time. Harvesting of salted eggs was conducted at various time, washed and stored at either room temperature or in cool condition (ca 10^{o}C) without cooked prior to store.

Commercial salt (NaCl) was purchased locally (99.86% NaCl; product of Gudang Garam Ltd. Semarang, Indonesia). All chemicals were reagent grade from by BDH England, Sigma Chemical Co., Ltd. USA, Aldrich England U.K., and the Merck West Germany or otherwise stated.

Preparation sample for GC analysis

An aliquot part of duck eggs either fresh eggs or salted eggs were boiled at approximately 100^{o}C for 30 minutes to obtain cooked eggs. The delta weight between fresh and cooked egg was assumed to as much as water adsorbed during boiling of egg. The yellow portion of eggs were then separated manually,

ground and placed in a dark bottle with tight cup and storing at cool until used.

Lipid was extracted by the method of Bligh and Dryer (1959). It was performed by placing 25 *g* of ground duck egg yolk in the extractor and mix with 25 *ml* chloroform and 50 *ml* ethanol. The extractor was capped and shaken continuously for 60 minutes in an electric shaker. The organic solvent phase was separated by filtration using Whatman filter paper No. 41. The extraction procedure was repeated to the solid waste and the organic solvent extracts were pooled and filtered through Whatman filter paper No. 41. The filtrate was collected in a separation funnel then 25 *ml* 0.88% potassium chloride solution was added. After stand at room temperature for a minute the water phase was discarded and the organic solvent phase was centrifuged at 300 *rpm*. The supernatant was collected and evaporated by blowing with nitrogen gas. The oil was dried over anhydrous silica gel in an evacuated desiccator to remove residual solvent.

The fatty acids in the oil were then transesterified to their methyl esters by the potassium hydroxide-methanol according the procedure reported by Hadiwiyoto (1999). One gram of egg yolk oil was dissolved in 5 *ml* of hexane in a screwcapped glass centrifuge tube. To the tube was added 500 μl of 2 *N* potassium hydroxide-methanol. The tube was then capped tightly and vortexed for five minutes and centrifuge at 300 *rpm* for 10 minutes. The supernatant was pippeted into another tube, capped, and used for fatty acid determination.

Gas chromatography for fatty acids analysis

A sinchrome E71 5% simalite packed on stainless steel column with 3,1 *m* length x ID of 1,2 *mm* was used on a Hitachi 163 gas chromatograph equipped with flame ionization detector. The operating conditions for gas chromatography were as follows: column temperature was 215^{o}C operated isothermally for 50 minutes. The carrier nitrogen gas flow rate was maintained at 30 *ml*/min, hydrogen gas flow rate was 1 Kg/cm^2min^{-1}, and air flow rate was 1.2 Kg/cm^2min^{-1}. The injection and detector temperatures were 260^{o}C, respectively. Simadzu-C-RGA integrator was used to integrate retention times and peak areas. The 1 μl oil methyl ester fatty acids were injected into the column while standard methyl ester fatty acid mixtures (Sigma Chemical Co., Ltd. USA) including EPA and DHA were separated under the identical conditions to identify the compound and to calculate the response fractions of the acids.

Analytical analysis

All procedures for analytical analisis were base on AOAC (2000). Lipid content was determined as crude fat by the Soxhlet extraction method using Soxtech equipment. Hexane was used throughout the extraction of egg lipid. The content of salt (NaCl) was analyzed by the methods of Kohlman. Moisture was analyzed by thermogravimetric method.

Statistical analysis

A two-ways ANOVA was used to analysis the effects of salting time of duck eggs and storage of salted duck eggs. Duncan's multiple range tests was used to differentiate treatment means (Steel and Torrie, 1976). Three-dimensional surface analysis on the effects of salting time and storage of salted duck eggs on the fat change including EPA and DHA were determined by Response Surface Methods (Gacula and Singh, 1984) and plots were drawn using the Matlab version 5.0 release program.

Results

The change of moisture and salt contents

When duck eggs were salted the moisture content was tended to decreased as the increasing time of salting (Table 1, column 1). It was similar phenomena when salted eggs were then stored either at room temperature (ca 29°C) or low temperature (ca 10°C), however, a little increase of moisture contents after 12 days of storage but they were not significantly different (P 0.05) when analyzed using statistic. There were no different effects of storage condition on the change of moisture content except for the rate

of decreasing moisture content was lower at low temperature storage. Consequently, the salt content of duck eggs was increased as moisture content decreased with the increasing time of salting (Table 2, column 1). It is interesting to note, however, when salted eggs were stored either at room temperature or at low temperature the salt content changed to increase at initially until the day 8 of storage then decreased after that.

Table 2 The change of salt concentration in duck eggs during salting and storage

Salting time at room temp. (days)	Salt (NaCl) content, % wet basis									
	Storage: Day 0		Day 4		Day 8		Day 12		Day 16	
	RT	LT	RT	LT	RT	LT	RT	LT	RT	LT
0	0.29 ± 0.03	0.29 ± 0.03	0.40 ± 0.03	0.31 ± 0.03	0.40 ± 0.06	0.37 ± 0.03	0.50 ± 0.05	0.45 ± 0.03	0.42 ± 0.03	0.53 ± 0.06
4	0.86 ± 0.03	0.86 ± 0.03	1.30 ± 0.08	1.20 ± 0.03	1.16 ± 0.01	1.22 ± 0.09	1.19 ± 0.04	1.14 ± 0.07	1.22 ± 0.06	1.29 ± 0.05
8	1.28 ± 0.03	1.28 ± 0.03	1.45 ± 0.14	1.51 ± 0.06	1.50 ± 0.04	1.23 ± 0.04	1.66 ± 0.06	1.54 ± 0.09	1.61 ± 0.03	1.43 ± 0.05
12	1.58 ± 0.06	1.58 ± 0.06	1.68 ± 0.09	1.94 ± 0.04	1.72 ± 0.11	2.13 ± 0.08	1.80 ± 0.09	2.17 ± 0.08	1.40 ± 0.02	1.86 ± 0.10
16	1.61 ± 0.13	1.61 ± 0.13	1.87 ± 0.06	2.00 ± 0.03	1.79 ± 0.08	2.31 ± 0.11	2.25 ± 0.06	2.61 ± 0.09	1.94 ± 0.02	2.65 ± 0.14

RT: room temperature ; LT: low temperature
Data were taken from 3 batches with 3 replications for analysis respectivelly

The change of fat content Again, when duck eggs were salted the fat content tended to decrease as the increasing time of salting at the initial stage then little increase occurred at the day close to the end of salting (Table 3, column 1), but when the salted duck eggs were stored the salt content of salted duck eggs were increased at the initial stage then decrease after stored for about 8 days either at room temperature or low temperature.

Therefore, it can be said that the change of fat should be a combination of salting time and storage time effects as analyzed by response surface methodology (Figure 1). The mathematical formulas of fat change calculated by response surface method (Gacula and Singh, 1984) were $Y= 48.2676-3.4243X_1+0.6775X_2+0.1414X_1X_1-0.0251X_2X_2-0.0091X_1X_2$ with the interaction of 0.0091; and $Y = 45.9873-3.0758X_1+0.3353X_2+0.1332X_1X_1-0.0237X_2X_2+0.0186X_1X_2$ with interaction of 0.0186 for room and low temperature storage respectively. The symbols X_1 and X_2 were salting time and storage time respectively. Both responses showed saddle forms (Figure 1). The stationary points of the responses were $(X_1; X_2) = (12.47; 11.24)$ for room temperature storage and $(X_1; X_2) = (10.76; 11.30)$ for low temperature storage respectively.

Table 3 The change of fat concentration in duck eggs during salting and storage

Salting time at room temp. (days)	Fat content, % wet basis									
	Storage: Day 0		Day 4		Day 8		Day 12		Day 16	
	RT	LT	RT	LT	RT	LT	RT	LT	RT	LT
0	48.54±3.61	48.54±3.61	51.99±1.77	53.12±0.64	52.20±5.56	40.33±7.89	55.49±0.85	47.82±0.21	52.36±6.95	51.53±1.72
4	30.94±4.72	30.94±4.72	39.57±0.23	31.86±6.53	39.16±3.13	36.30±5.97	40.75±1.30	35.29±0.30	37.32±1.81	29.23±3.76
8	33.42±2.57	33.42±2.56	30.91±0.66	27.83±2.21	33.73±0.46	37.90±2.76	34.36±3.02	32.41±0.84	34.20±1.66	31.04±0.34
12	30.06±0.72	30.06±0.72	31.12±2.21	31.85±0.21	29.83±0.71	37.78±0.18	31.23±1.03	30.79±0.07	29.65±0.79	35.43±2.29
16	29.16±2.90	29.16±2.91	30.08±1.73	31.04±2.24	30.22±0.22	31.35±1.64	31.62±1.61	38.02±0.24	33.98±1.73	31.04±0.14

RT: room temperature ; LT: low temperature
Data were taken from 3 batches with 3 replications for analysis respectivelly

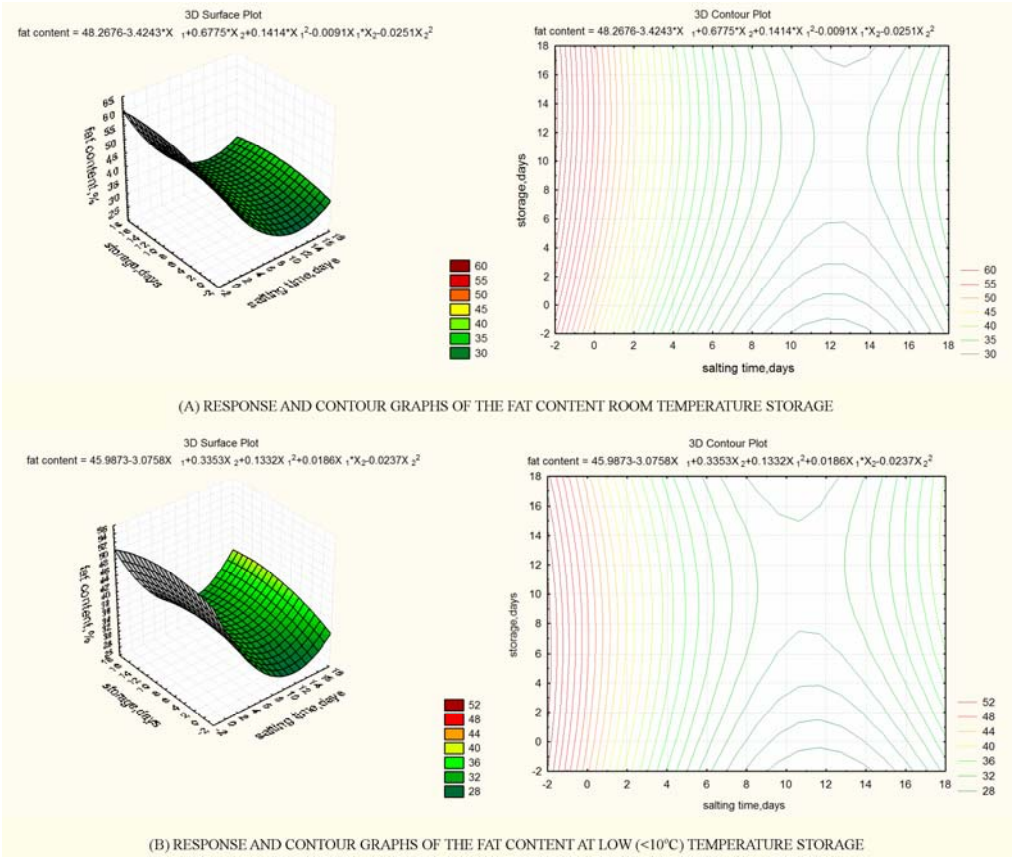


Figure 1 :Three dimension responses and contour graphs of the fat content of salted duck egg as function of salting time and storage.

The change of EPA and DHA

Table 4 and Table 5 shows the change of EPA and DHA during duck egg salting and storage of salted duck eggs at room temperature and low temperature storage respectively. The EPA and DHA contents tended to be affected by salting time as can be seen in those table under the column of zero time of storage. Increasing fat content after four days storage of salted eggs as the consequent of reducing

moisture content caused the non-soluble solid increased. Prolonging storage time reduced concentration of EPA and DHA but in the contrary little increase in EPA was occured in fresh egg.

Table 4 The change of EPA content of duck eggs during salting and storage

Salting time at room temp. (days)	EPA content, % wet basis									
	Storage: Day 0		Day 4		Day 8		Day 12		Day 16	
	RT	LT	RT	LT	RT	LT	RT	LT	RT	LT
0	0.82±0.45	0.82±0.45	1.53±0.82	1.56±0.84	1.29±0.81	1.20±0.31	1.41±0.01	1.21±0.01	2.24±0.02	2.20±0.02
4	1.46±0.59	1.46±0.59	1.01±0.32	0.82±0.26	0.83±0.38	0.77±0.35	1.64±0.51	1.42±0.45	1.06±0.07	0.83±0.05
8	0.91±0.25	0.91±0.25	0.75±0.09	0.67±0.08	0.59±0.12	0.66±0.13	0.85±0.07	0.81±0.07	0.83±0.18	0.75±0.16
12	0.85±0.10	0.85±0.10	0.64±0.12	0.65±0.12	0.70±0.31	0.88±0.39	0.91±0.24	0.90±0.23	0.64±0.13	0.76±0.16
16	0.32±0.28	0.32±0.28	0.46±0.10	0.48±0.10	0.61±0.04	0.64±0.04	0.62±0.15	0.75±0.18	0.45±0.04	0.41±0.03

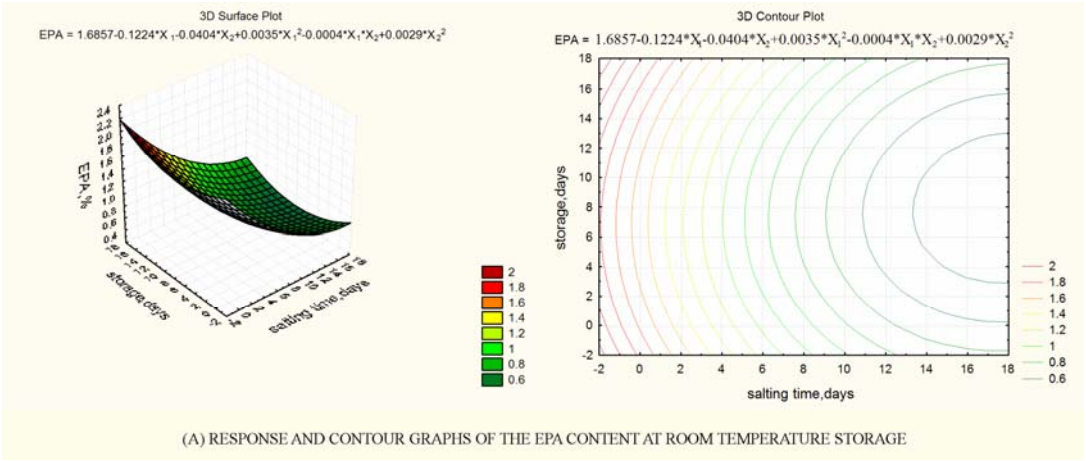
RT: room temperature ; LT: low temperature
Data were taken from 3 batches with 3 replications for analysis respectivelly

Table 5 The change of DHA content of duck eggs during salting and storage

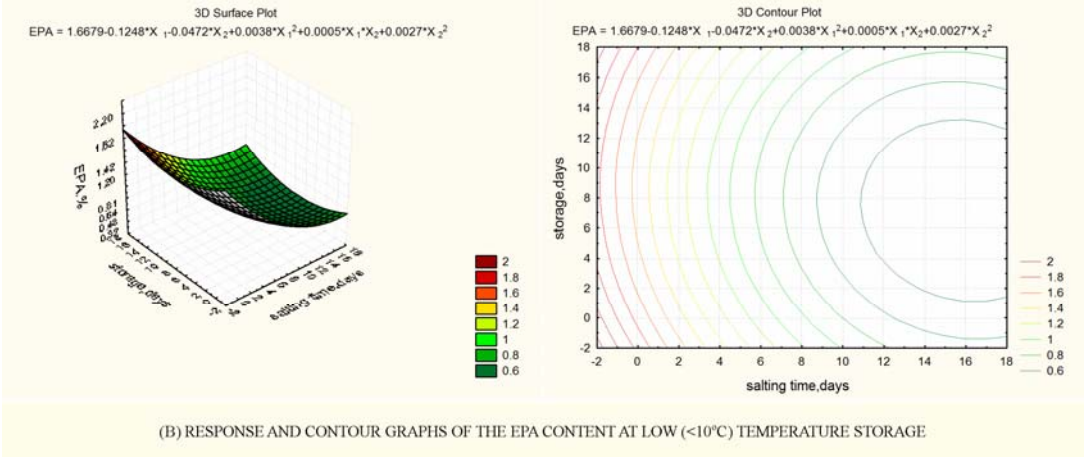
Salting time at room temp. (days)	DHA content, % wet basis									
	Storage: Day 0		Day 4		Day 8		Day 12		Day 16	
	RT	LT	RT	LT	RT	LT	RT	LT	RT	LT
0	9.50±0.73	9.50±0.73	8.86±5.60	9.05±5.71	7.15±3.74	4.31±1.62	3.15±2.00	2.72±1.73	6.52±3.66	6.42±3.61
4	9.17±0.45	9.17±0.45	7.76±4.39	6.25±3.53	3.98±1.56	3.69±1.45	4.12±0.67	3.57±0.58	1.75±1.17	1.37±0.92
8	8.61±0.45	8.61±0.45	7.31±5.27	6.58±4.74	1.77±0.56	1.99±0.63	1.77±0.56	1.67±0.53	3.08±1.87	2.80±1.69
12	7.03±0.34	7.03±0.34	4.30±3.43	4.41±3.51	2.69±0.08	3.41±0.10	1.61±0.25	1.53±0.24	2.29±0.20	2.74±0.24
16	5.29±0.84	5.29±0.84	4.96±4.73	5.12±4.87	1.44±0.73	1.50±0.76	1.19±0.01	1.43±0.01	1.98±0.67	1.81±0.62

RT: room temperature ; LT: low temperature
Data were taken from 3 batches with 3 replications for analysis respectivelly

The mathematical formulas of EPA change calculated by response surface method (Gacula and Singh, 1984) were $Y = 1.6857-0.1224X_1-0.0404X_2+ 0.0035X_1X_1+0.0029X_2X_2-0.0004X_1X_2$ for room temperature storage with the interaction of 0.0004 and the stationary point of the response was $(X_1; X_2) = (17.95; 8.20)$, and $Y= 1.6679-0.1248X_1-0.0472X_2+0.0038X_1X_1+0.0027X_2X_2+0.0005X_1X_2$ for low temperature storage (ca10^oC) with the interaction of 0.0005 and the stationary point of the response was $(X_1; X_2)= (15.94; 7.26)$. Both responses showed little saddle forms or almost plane (Figure 2).



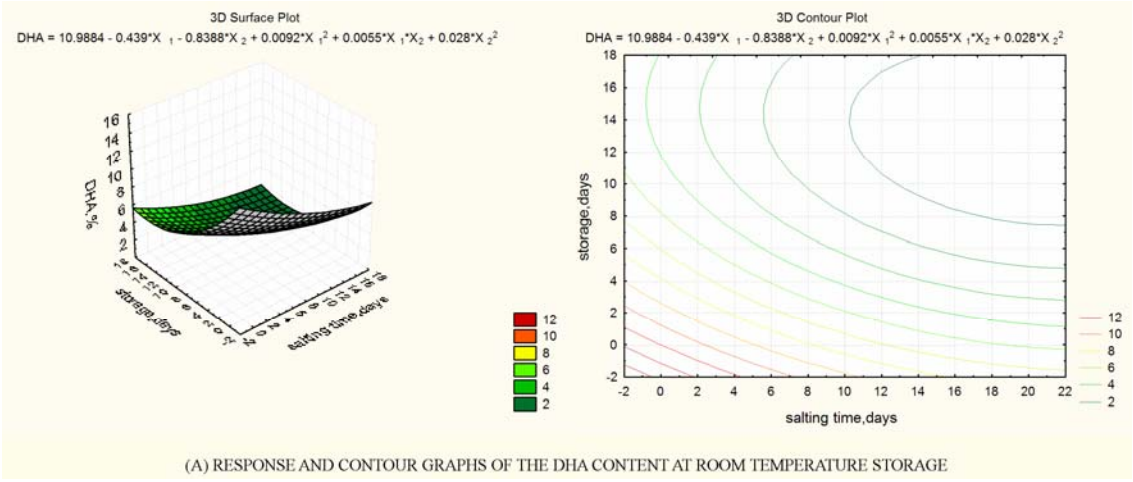
(A) RESPONSE AND CONTOUR GRAPHS OF THE EPA CONTENT AT ROOM TEMPERATURE STORAGE



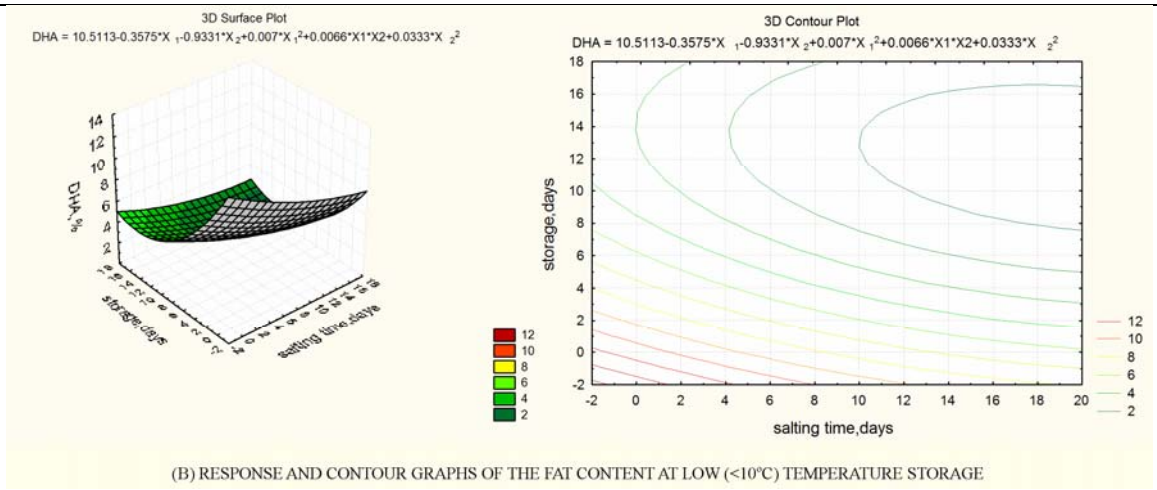
(B) RESPONSE AND CONTOUR GRAPHS OF THE EPA CONTENT AT LOW (<10°C) TEMPERATURE STORAGE

Figure 2 Three dimension responses and contour graphs of the EPA content of salted duck eggs as function of salting time and storage.

While the mathematical formulas of DHA change calculated by response surface method (Gacula and Singh, 1984) were $Y= 10.9884-0.439X_1-0.8388X_2+0.0092X_1X_1+0.028X_2X_2+ 0.0055X_1X_2$ for room temperature storage with the interaction or 0.0055 and the stationary point of the response was $(X_1; X_2)$ = (19.97; 13.02), and $Y= 10.5113-0.3575X_1-0.9331X_2+0.007X_1X_1+ 0.0333X_2X_2+ 0.0066X_1X_2$ for low temperature storage (<10°C) with the interaction of 0.0066 and the stationary point of the response was $(X_1; X_2)$ = (19.85; 12.04). The symbols X_1 and X_2 were salting time and storage time respectively. Both responses showed saddle forms (Figure 3).



(A) RESPONSE AND CONTOUR GRAPHS OF THE DHA CONTENT AT ROOM TEMPERATURE STORAGE



(B) RESPONSE AND CONTOUR GRAPHS OF THE FAT CONTENT AT LOW (<10°C) TEMPERATURE STORAGE

Figure 3
Three dimension responses and contour graphs of the DHA content of salted duck eggs as function of salting time and storage.

Discussion

Moisture and salt content changes during salting and storage of duck eggs

The chemical change of organic matters including moisture content of egg during salting and storage time is very complex to explain because physical and chemical mechanisms and microbial activity play an important role. Covering egg with high concentration semisolid media containing sodium chloride meant there was an osmosis process where moisture moved from low concentration part inside the egg to high concentration part outside the egg and salt move to inside the egg on the other hand. This

mechanism caused moisture content of the egg reduced during salting as shown in Table 1 and prolonging time of salting caused increasing of salt concentration in egg as shown in Table 2. It can be noted during salting the diffusion of salt solution into the egg was not finished yet since the increasing of salt content was continued with almost linear rate and still far away from the level off condition. When calculated the average rate of salt diffusion using linear regression analysis it was found 0.113 %/day of salting.

In the case of salting eggs, however, it was possible that egg protein breakdown also play a role. With the salting time, at the initial stage egg protein could be dehydrated because salt will absorb moisture followed by denaturation and coagulation of protein at the later stage caused weaken on the water binding protein. Sodium chloride at low concentration may interact with protein to bind moisture by very high levels salting out maybe occur followed by loss in moisture retention (Keeton, 1990). During salting, protein bind salt ions such as sodium ions then it will affect on the interaction of hydrogen and water molecules and hydrophobic interaction to weaken followed by excusing moisture. Breakdown of egg protein maybe also due to the activity of some salt tolerant bacteria which release proteases. With increasing storage time the moisture tended to loss (see Table 1) which maybe due to evaporation of part of free water found in salted eggs through the egg shell pores while increasing of salt concentration during storage maybe resulted by the effect of lowering moisture content.

It was surprised that sample of non-salted eggs (sample of egg salting at zero time) shown increasing of moisture content during storage which could be assumed to indicate that during storage even at low temperature storage there was a liberation of bound water due to degradation of some components found in egg such as egg protein. Protein maybe hydrolyzed by proteolytic enzymes cause to liquefy of white and yellow parts of egg. The non-salted egg also showed increase in its salt content during storage. The possibility of the increasing salt content of non-salted eggs during storage maybe due

to there was some minerals found in egg and decrease in moisture content will affect to increase in mineral concentration. Sugino *et al*. (1997) stated total mineral concentration in fresh chicken egg is about 0.550 *mg*/egg or about 0.9 to 1.1 *mg*/g egg includes sodium, magnesium, calcium, phosphor, etc. There was only little difference of moisture change during salting at low and room temperature, since increase or decrease in temperature will increase or decrease the rate of reaction. However, it can be noted the rate of reducing moisture content at low temperature of storage was lower than that at room temperature storage.

The change of lipid components

Reducing fat content during salting was difficult to explain due to limited information from the scientific researches about the process of salting eggs. Making an analogy with the organic matter changes during salting process of other food materials such as fish salting and storage of salted fish or other salting of foods and food products may be a great way to make a brief discussion of the change of lipid components during salting of duck eggs and used for practical approach.

Base on that assumption, at least there were three or four reasons can be used to explain the decreasing fat content of egg during salting and storing of salted eggs. Firstly, the breakdown of egg protein plays a role in the reducing fat during salting. It has been well known that egg yolk contains protein about a half of its fat content (Stewart and Abbot, 1972) while fat status is in an emulsion system where protein stabilizes it (Okuba *et al*., 1997). The breakdown of protein stabilizing emulsion can be in several ways. In the case of fish salting, Zaitzev *et al*. (1969) stated that salting cause protein stabilizing emulsion is syneresed and followed by fractionated into small molecules lead to the loss of fat during salting and storage. Hadiwiyoto (1999) reported decrease in lipid content in salted fish due to protein of cell walls and membrane protein at the surface of fat globules were denaturated. The breakdown of egg protein was also reported by Causerte *et al*. (1991). He found the ultrastructure of egg yolk by scanning electron microscopy as granule units in various shape range from 0.2-2.0 μm. The granules were progressively dissociated when the ionic strength was increase by addition of sodium chloride and can be attributed to the disruption of the protein structure. It was meant the breakdown of egg yolk protein.

Arntfield *et al*. (1990) indicated disruption of the structure of protein network during storage of heated salted eggs was attributed to the reducing of hydrophobic interaction in the protein molecules. Dixon and Cotterill (1981) found when sodium chloride was added to egg yolk and heated to pasteurization temperature showed two peaks of DEAE cellulose chromatogram separated while using electrophoretic evaluation showed some egg yolk protein bands such as phosvitin was disappeared and the other such as livetin became fainter. In the other work, Causeret *et al*. (1991) found 11 bands separated by electrophoresis of salted egg yolk. These findings can be assumed that breakdown in the protein was occurred during salting either with or without heating because heating only increase the rate of reaction. King *et al*. (1988) worked on the experiment of salted formulation of dark-meat patties with sodium chloride up to 2% concentration and found fat retention was reduced when compared to unsalted patties. They assumed sodium chloride obstructed emulsion and causing a salting out of the fat. The findings by researchers mentioned above strengthened the mechanism of fat loss during duck egg salting in this experiment.

The second reason which can be explained was a number of salt tolerance bacteria maybe found in salted eggs which can liberate some exogenous enzymes that hydrolyze egg proteins and lipids. These bacteria were activated due to carbohydrate found in egg though in a small amount as an energy source for their growth. Sugino *et al*. (997) said that egg white contains free sugar and conjugated carbohydrate in 3.5 *g*/egg and 0.132 *g*/egg respectively, while egg yolk contains o.137 *g*/egg free sugar and 0.056 *g*/egg conjugated carbohydrate. These carbohydrates can be fermented by lactic acid bacteria groups which liberate exogenous proteolytic and lipolytic enzymes. Since lipolytic enzymes hydrolyze fat, the proteolytic enzymes disrupt protein stabilizing emulsion; both caused reducing fat content of salted duck egg.

Fat oxidation due to contact with oxygen from the atmosphere and by photo-oxidation could be another reason. Hsieh and Kinsella (1986) stated that oxidation take an important role in the destruction of fat in food system either by enzymaticaly or non-enzymaticaly. The fat status in yellow part of egg is in emulsion state which is stabilized by lipoprotein membranes. This biological membranes contain phospholipids which are rich in polyunsaturated fatty acids that very susceptible to peroxidation as the subcellular membranes are bathed in fluid containing prooxidants such as oxygen, transition metals, and peroxidase enzyme (Asgar *et al*., 1990). Although egg yolk contain natural antioxidant, lecithin (Sugino *et al*., 1997), protecting the fat but soon after salting this antioxidant disintegrate. Salt, in addition, acts as a catalyst and accelerate the oxidation process as Zaitzev *et al*. (1969) stated to discuss the loss of fat during storage of salted fish. Huffman and Cordray (1981) also stated salt affects the rate of lipid oxidation in cured meats to acquire a rancid taste in shorter time. The egg shell contain about 10.000 pore canals range from 10-30 μm (Okubo *et al*., 1997), these can be the ways for air movement from the atmosphere into inside of the egg vise versa. Although the egg yolk covered with white egg albumin but during salting this protein disintegrated into small dehydrated protein molecules and the sandy gel like structure formed physically. In the presence of light and suitable sensitizers such as riboflavin found in egg during storing of salted eggs caused photo-oxidation involves reaction of an alkene with oxygen to produce the same products as autoxidation of fat (Gunstone and Norris, 1983). This photo-oxidation is much quicker than autoxidation. It was also a great possibility that decreasing of fat content was due to the formation of soap resulted from the reaction of fatty acids with sodium salt although at a slow rate.

The last, the loss of organic substances were also associated with diffusing water and other liquid materials from inside to outside of the egg throughout pore canals of egg shell. When salted egg was stored, those losses were enhanced and assumed to be subjected to autolytic process that degradation of all components let to matter pass out. With increasing fat content of non-salted eggs during storage maybe due to the decrease of water content, however lowering fat content after 12 days of storage of salted eggs indicated that the rate of water evaporation lower than that of fat disruption.

The effects of temperature condition on the loss of organic substances in various ways depending on whether the temperature increases the activity of enzymes or intensifies the salting out of protein and fat. High temperature normally increases enzyme activity and leads to larger losses of organic matters.

The low interactions, i.e. 0.0091 and 0.0186, calculated by three dimension response surface both for room temperature and low temperature indicated that there were no correlation between time of salting and the length of storage. It should be noted, in this case, that the interaction should be only meant that the length of salting will affect on the length of storage but not on the contrary. In the other words, salting time did not affect on the change of salt content of egg during storage at either room temperature or low temperature.

The explanation of EPA and DHA changes so far can be similar with the mechanism of the change of fat content. There are physical and chemical mechanisms which take a role and so microbial activity which liberate lipase extracellular. It should be noted that EPA and DHA are the member of polyunsaturated fatty acids which able to be disrupted by oxidation. Decreasing EPA and DHA could also be attributed to the formation of soap and dechlorination process of those fatty acids. Ghanbari (1982 in Wei, 1985) reported that chlorinated products were formed when free fatty acids, methyl ester fatty acids, or triglycerides react with chlorine III.

It is difficult, however, to explain why EPA in fresh eggs was increase during storage. Assuming sisthesis this component is unlogical while there is no information along literature study can be used to disccuss it. Probably increasing EPA was only due to decreasing moisture content during storage of duck egg.

Conclusions

The mechanism of either fat loss or fat increase and decreasing EPA and DHA during salting and storage of salted duck eggs were very complex. There were physical and chemical mechanisms which play an important role including microbial activity which release extracellular enzymes that can disrupt

all components of the duck egg. Salting of duck eggs cause disruption of protein stabilizing emulsion lead to fat pass out and reduce EPA and DHA concentrations. Fat oxidation, formation of soap and dechlorinated product as the result of the reaction of fatty acids as well as EPA and DHA with sodium chloride may take place. The finding indicated shelf life of salted duck egg was depended on the concentration of salt instead of length of salting. However, it still need a study in detail about the physical structure of white egg and egg yolk after salting by scanning electron microscopy and formation of flavor such as peroxide, aldehydes, and thiobarbituric acid (TBA) value for strengthened these findings.

So far, base on decreasing EPA and DHA during salting and storage it can be recommended to store in short time or consume soon salted eggs resulted from long time of salting, but salted eggs resulted from short time of salting can be stored in a relatively longer time.

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MICROBIAL QUALITY OF DUCK EGG FROM FARM AND RETAIL MARKET

Divya Rani Thomas[1*], B. Sunil[2], K. Vrinda Menon[3], C. Sethulekshmi[3], K. A. Mercy[4], C. Latha[5] and Leo Joseph[6]

Abstract

The study was conducted to assess the microbial quality of shell and contents of duck eggs from University Poultry Farm (UPF), Mannuthy and from retail market at Mannuthy, Thrissur. Twenty eggs each were collected from two sources during July 2009 for comparative evaluation. Egg shells and contents were subjected to microbiological examination. The mean atmospheric temperature and relative humidity inside duck sheds were measured. Enumeration of microbes in air inside the sheds was also carried out. Significant difference between sources was found in Total Viable Count (TVC) of egg shell and Coliform Count (CC) of egg contents. UPF eggs revealed higher TVC on shell (9.02±0.10 log $_{10}$cfu/egg shell), where as market eggs had higher counts of coliforms in egg contents (5.07±0.12 log $_{10}$cfu/g). No significant difference between sources was found in TVC of egg contents, CC of egg shells and Yeast and Mould Count (YMC) of shell as well as egg contents. *Escherichia coli* could be isolated from shell in 85% of UPF samples and 55% of market samples. No *Escherichia coli* could be isolated from egg contents. *Bacillus cereus* was present in shell of 50% of UPF samples and 85% of market samples. Fourty percent of UPF samples and 50% of market samples were positive for *Bacillus cereus* in egg contents. Only 5% of market samples was positive for *Pseudomonas aeruginosa* in egg shell. No *Pseudomonas aeruginosa* could be isolated from shell of UPF eggs and egg contents. *Salmonella spp*. was present in pooled egg shell wash from both sources. The mean atmospheric temperature during the sampling period was 23ºC and relative humidity was 90%. The microbial load of air inside duck shed was >300/ square feet/ minute. Litter collected from duck sheds showed a mean TVC of $9.12x10^{10}$ cfu/g, CC of $9.17x10^{7}$ cfu/g and YMC of $5.97x10^{4}$ cfu/g. *Escherichia coli* was isolated from all the litter samples. Drinking water provided for ducks showed a mean TVC of $1.53x10^{5}$ cfu/ml and CC of $3.37x10^{2}$ cfu/ml at 8:00 am. and $1.62x10^{9}$ cfu/ml and $1.49x10^{6}$ cfu/ml at 4:00 pm. respectively. *Escherichia coli* was absent at 8:00 am, while the evening count was $2.05x10^{5}$cfu/ml. *Bacillus cereus* and *Pseudomonas aeruginosa* could also be isolated from water. The egg contents of samples collected from UPF were found to show lower microbial load as compared to market eggs. However, good farm management practices during production can help in improving the quality of eggs.

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Key words: Microbial quality; Duck eggs; Egg shell; Egg contents

Introduction

Eggs are highly nutritious as well as cheap source of protein (Papadopoulou *et al*., 1997). On the basis of ease of spoilage, they come under perishable foods (Frazier *et al*., 1988). The shell gets infected when passing through the vent, but main contamination occurs within a short period after lay. The shells of freshly laid eggs soon become contaminated by litter, droppings and microflora in air inside the poultry shed. Bacterial contamination of the egg contents could be due to the penetration of the shell by bacteria on the surface (De Reu *et al.*, 2005). Duck eggs are a delicious and healthful alternative to chicken eggs. They are said to have higher omega-3 fatty acid content, which are essential for human health. People who are allergic to chicken eggs are able to eat duck eggs without allergic reactions. The

entry and growth of microbes may cause spoilage of eggs making them unfit for consumption. Such eggs can cause infection to the consumers. The association of such pathogenic microorganisms with our food supply is critical from a public health point of view. Hence a study was planned to assess the microbial quality of duck egg from farm and retail market.

Materials and methods

Twenty eggs each were collected from UPF Mannuthy and from retail market at Mannuthy during July 2009 for microbiological examination. Of the twenty eggs from UPF, twelve belonged to White Pekin ducks and eight to Kuttanadu ducks. Fresh eggs were collected from UPF by 8:00 am in sterile plastic bags and brought to the laboratory within 30 minutes. The eggs were processed immediately for examination. Eggs available on the day of evaluation were collected from market.

Preparation of sample

For recuperation of bacteria from egg shell, the method adopted was washing the intact eggs in sterile plastic bag with 10 ml buffered peptone water. The bag was held at an angle with the egg and the diluents in the corner. The washing of the egg was done by rubbing the egg shell through the bag (De Reu *et al*., 2004). From rinse sample serial dilutions were prepared. The interior contents of the eggs were sampled as per the procedure described by Ricke *et al.*, (2001). From the sample serial dilutions were prepared for enumeration of organisms.

The Total Viable Count was estimated as described by Morton, (2001) and Coliform Count was estimated as per the procedure described by Kornacki and Johnson (2001). The Yeast and Mould Counts of the sample were analysed by the procedure described by Beuchat and Cousin (2001).

Isolation of *Salmonella spp.* was done on Brilliant Green Agar after enrichment of pooled sample in Selenite Cystine Broth at 43ºC for 18-24 hours. Characteristic colonies selected from Brilliant Green Agar after incubation at 37ºC for 24 hours were confirmed using morphological, cultural and biochemical characteristics. (Barrow and Feltham, 1993). *Escherichia coli, Bacillus cereus* and *Pseudomonas aeruginosa* were isolated according to the procedure described by Kornacki and Johnson (2001), Bennett and Belay (2001) and Cousin *et al*. (2001) respectively. The colonies were confirmed using morphological, cultural and biochemical characteristics. (Barrow and Feltham, 1993).

The microbes in air inside duck sheds were enumerated using direct exposure method described by Evancho *et al.* (2001). The microbial load of litter and water samples was also enumerated. Atmospheric temperature and relative humidity inside the sheds were measured using dry and wet bulb thermometer. The data obtained were subjected to statistical analysis using SPSS software and comparison between groups was done by student's't' test (Snedecor and Cochran, 1994)

Result

Results of the analysis of bacterial contamination are presented in table.

Bacterial Count	**Mean bacterial count (log $_{10}$cfu/egg shell, log $_{10}$cfu/g of egg contents)**	
	UPF egg	**Market egg**
TVC Shell **	9.02±0.10	8.29±0.19
TVC Contents	6.87±0.11	6.74±0.08
CC Shell	4.50±0.15	4.30±0.19
CC Contents **	3.37±0.23	5.07±0.12
YMC Shell	2.95±0.17	3.13±0.09
YMC Contents	0.38±0.13	0.32±0.15

TVC: Total Viable Count, CC: Coliform Count, YMC: Yeast and Mould Count, (** P<0.01)

Significant difference between sources was found in TVC of egg shell and CC of egg contents.

UPF eggs had higher TVC on shell (P<0.01), where as market egg had higher counts of coliforms in egg contents (P<0.01). *Escherichia coli* could be isolated from shell in 85% of UPF samples and 55% of market samples. No *Escherichia coli* could be isolated from egg contents. *Bacillus cereus* was present in shell of 50% of UPF samples and 85% of market samples. Fourty percent of UPF samples and 50% of market samples were positive for *Bacillus cereus* in egg contents. Only 5% of market samples was positive for *Pseudomonas aeruginosa* in egg shell. No *Pseudomonas aeruginosa* could be isolated from shell of UPF eggs and egg contents. *Salmonella spp*. was present in pooled egg shell wash from both sources.

The mean atmospheric temperature during the sampling period was 23ºC and relative humidity was 90%. The microbial load of air inside duck shed was >300/square feet/minute. Litter collected from duck sheds showed a mean TVC of $9.12x10^{10}$ cfu/g, CC of $9.17x10^{7}$ cfu/g and YMC of $5.97x10^{4}$ cfu/g. *Escherichia coli* was isolated from all the litter samples. Drinking water provided for ducks showed a mean TVC of $1.53x10^{5}$ cfu/ml and CC of $3.37x10^{2}$cfu/ml at 8:00 am. and $1.62x10^{9}$ cfu/ml and $1.49x10^{6}$ cfu/ml at 4:00 pm. respectively. *Escherichia coli* was absent at 8:00 am, while the evening count was $2.05x10^{5}$cfu/ml. *Bacillus cereus* and *Pseudomonas aeruginosa* could also be isolated from water.

Discussion

The result indicates a significant difference in bacterial contamination of eggs from UPF and retail market. The mean TVC for the egg contents from both sources was higher than the limits recommended by American Public Health Association (APHA) and International Commission on the Microbiological Specification for Food (ICMSF). The higher TVC of shell of eggs procured from UPF could be attributed to the practice of laying eggs on litter. Quarles *et al.* (1970) reported higher counts of aerobic bacteria on shell of eggs from deep litter system. According to De Reu *et al*. (2005) total count of aerobic bacteria in air of poultry houses has also a positive correlation with initial bacterial egg shell contamination. A high humidity (90%) observed in the present study could lead to increased contamination of eggs. Graves and Mac Laury (1962) reported a significant positive correlation between the amount of water vapour present in atmosphere at the time of laying and incidence of contamination in egg. Enquiry with the retailers revealed that eggs reached the market about two to four weeks after lay, and during this period eggs are subjected to temperature abuse which is reflected in the high microbial load of its contents. Higher coliform counts of market egg could be due to storage at high temperature, which could lead to deterioration of cuticle quality there by enhancing microbial penetration (Bruce *et al.* 1994). It was observed that the retailers do not store eggs in refrigerators so that eggs are exposed to higher temperature. Moreover, Gram negative bacteria are better equipped to overcome the antimicrobial defenses of egg contents (De Reu *et al*., 2008). Presence of *Escherichia coli* in eggs indicate fecal contamination. In water fowl and duck egg Enterobacteriaceae mainly *E. coli* constitute the predominant flora (Bruce *et al.* 1994). Coliform, Enterobacteriaceae, and *E. coli* populations can be used as measures of food quality and sanitary processing conditions (Kornacki and Johnson, 2001*)*. All the microorganisms isolated are pathogenic to man and can cause varying diseases unless eggs are properly cooked. Potential hazards of presence of *Salmonella spp*. in egg shell and *Bacillus cereus* in both egg shell and egg contents is of concern if the eggs are used in other egg based products.

Conclusion

Despite the difference in TVC of egg shell and CC of egg contents, the microbial counts were comparable in two sources. With respect to coliforms, the egg contents of samples collected from UPF were found to show lower microbial load as compared to market eggs. The mean TVC for the egg contents from both sources was higher than the limits recommended by APHA and ICMSF. Since all the organisms isolated are human pathogens, consumers are at risk of diseases unless eggs are properly cooked. The study points to the need for improving the status of the environment in the farm at the point of lay so as to enhance the quality of eggs produced.

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PESTICIDE RESIDUES IN FORAGING DUCKS OF KERALA

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A study was carried out at Centre for Advanced studies in Poultry Science, Kerala Agricultural University to assess the presence of pesticide (Organochlorine) residues in foraging ducks in Kerala. Foraging ducks collected from paddy fields in three foraging regions of Kerala viz., Kuttanad, Palakkad and Thrissur and the organochlorine (OC) residues in their crop content and body fat were estimated using Gas Liquid chromatography. The results shown that the residues of various OC compounds were present in the crop content and fat samples collected from three regions. The samples from Kuttanad contained ά, β, γ and δ isomers of Hexachloro cyclohexane (HCH), metabolites of Dichloro diphenyl trichloroethane (DDT), Dicofol and ά-Endosulphan. The combined residue of these compounds accounted to 0.0018ppm in crop content and 0.0117 ppm in fat sample. The samples from foraging ducks in Palakkad contained ά, β, γ and δ isomers of HCH, isomers of DDT, Dicofol, ά-Endosulphan and Dieldrin. The combined residues were 0.0152 and 0.0419 ppm in the crop content and fat respectively. The samples estimated in crop contents and fat of foraging ducks from Thrissur showed the presence of isomers of HCH, primary derivatives of DDT and ά-Endosulphan. The combined residues in these samples were also negligible (0.0033 and 0.0077 ppm in crop and fat samples respectively). Even though the residues of many compounds present in the samples from all regions, the detected levels were well below the Maximum residue Limits (MRL) of these compounds in poultry. Presence of various OC compounds in the samples indicated the indiscriminate use of these compounds in paddy fields by the farmers even though the use of some of these compounds is banned.

Key words: Pesticide, foraging duck residue level, Kerala

Introduction

India's consumption of pesticides per hectare is low when compared with world averages-0.5 kg/ha against 6.60 kg/ha in Korea and 12.0 kg/ha in Japan. Yet, despite a comparatively low use of pesticides in India, the contamination of food products in the country is alarming. About 20% of Indian food products contain pesticide residues above tolerance level compared to only 2% globally. It is now increasingly believed that many of the environmental problems that have come to light in the past 40 years are not isolated from each other at all but rather have been caused by just one class of chemicals: organochlorines. This class includes the notorious DDT, dioxin, HCH (hexachlorocyclohexane), and aldrin. The production, use, and disposal of organochlorines create a scary range of problems. While not all organochlorines have the same impacts, the chemicals as a class include carcinogens, endocrine disruptors, and substances that harm nervous, reproductive, and immune systems.

Organochlorines are carbon-based substances that have one or more chlorine atoms. Many organochlorines are persistent, lasting in the world for years before degrading. Wind and air currents take these chemicals far from their homelands. Organochlorines have been found everywhere, even in areas where the chemicals have never been used. They are very persistent in the environment because of their resistance to chemical and microbial decomposition especially when protected by deep layers of soil. The OC compounds are more immunosuppressive than other classes of pesticides. The body fat, being the main storage area for pesticides, retains the compounds in the body for an extra ordinary length of time.

Kerala has a unique system of duck rearing. The vast stretch of paddy fields after harvest forms a potential and sustainable feed resource for ducks under the foraging system of rearing. Under foraging system of duck rearing, there is every chance of intake of the pesticides by the ducks due to the in discriminate use of the compounds in paddy cultivation. At present, the use of pesticides is alarmingly increasing for paddy cultivation in the State. The use of insecticides and herbicides in paddy fields reduce the snail population. The farmers often complain about marked drop in egg production and sudden mortality among flocks of foraging ducks in paddy fields. The nature of pesticides and their residue levels in animal tissues in these areas were not investigated. Therefore, in the present study an attempt was made to assess the residue levels of organochlorine pesticides in the crop content and body fat of foraging ducks from three distinct foraging regions in Kerala.

Materials and methods

Pesticide analysis of foraging ducks from three regions viz., Kuttanad, Palakkad and Thrissur was carried out using Gas liquid chromatography. The ducks were procured immediately after foraging in paddy fields and their crop and fat tissue were collected for further studies. The samples collected were stored in deep freezer for further analysis. The contents were weighed separately and processed for estimation of pesticide residue. The fat samples were also subjected to further processing for estimation of pesticide residue.

Pesticide residue analysis

Specific cleanup procedures were carried out for complete removal of interfacing impurities and extraction of pesticide residues from the collected samples before introduction in to the Gas liquid chromatograph.

RESIDUE EXTRACTION FROM THE CROP CONTENTS

Samples collected were dried and powdered and two grams of the sample was taken in an extraction thimble. The thimble was introduced in to a soxhlet extraction unit and extracted with 200 ml petroleum ether for six hours. This extract was concentrated in a vacuum flash evaporater to 10 ml and quantitatively transferred to a 100 ml separating funnel. Fifteen milliliter acetonitrile saturated with petroleum ether was added and shaken well and the layers were allowed to separate. The bottom layer containing pesticide was transferred to a one litre separating funnel having 600 ml water, 100 ml petroleum ether and 40 ml saturated sodium chloride solution. Extraction with acetonitrile was repeated for two more times and the bottom layer was collected in the same one litre separating funnel, shaken well and allowed to separate. The bottom aqueous layer was transferred to another one litre separating funnel containing 100 ml petroleum ether. It was also shaken well and allowed to separate. The aqueous layers were discarded and the petroleum ether layers from the two were pooled, washed with 100 ml of distilled water three times and dried with anhydrous sodium sulphate, then vacuum flash evaporated.

Five gram anhydrous sulphate was placed at the bottom of a glass column of size 30 mm x 450 mm and 25g of activated florisil was added to the top of sodium sulphate. Another 10 g of sodium sulphate was added above the florisil. After wetting the column with petroleum ether, transferred the acetonitrile clean up sample using small quantities of petroleum ether. Eluted the column first with 200 ml of 6 per cent diethyl ether in petroleum ether, followed by 200 ml of 15 per cent diethyl ether in petroleum ether. The elutes pooled together and evaporated to dryness in vacuum flash evaporator. The dry matter obtained was taken in two millilitre petroleum ether for injection in to GLC.

RESIDUE EXTRACTION FROM FAT TISSUE

Approximately two grams of fat tissue was weighed and homogenized with anhydrous sodium sulphate and this powder was transferred to a column pre wetted with petroleum ether and the fat was

carefully extracted with 200 ml petroleum ether. The extract was then subjected to further clean up procedures in the same method as done for crop content samples.

ANALYSIS ON GAS LIQUID CHROMATOGRAPHY

Quantification of pesticide residues in the collected samples were done using gas liquid chromatography as per the method specified by Sharma (1979) and FDA (1977). GLC analysis was performed on a Hewlett-Packard Agilent 6890 series GC with electron capture detector (ECD) having ^{63}Ni as the radioactive source and equipped with HP enhanced integrator algorithm.

DETECTION AND ESTIMATION

The chromatograph of samples and pesticides standard were obtained under identical conditions of GLC. Residues were detected by the combination of their retention time with the standard and the quantity by comparing the area with the standard using the HP enhanced integrator algorithm. Sum total of pesticides in the samples were quantified by the formula

$$\text{Pesticide residue in ppm} = \frac{X}{V_1} \times \frac{V}{M} \times \frac{1}{10^3}$$

X = Integrator reading in picogram
V_1= µl of the sample injected
V = Total volume of cleaned up sample in ml
M = Weight (g) of sample taken for extraction

Results and discussion

The results of the pesticide residue analysis in the samples collected from foraging ducks from Kuttanad (Table 1) revealed that the organochlorine residues present in the crop content and fat of foraging ducks ranged from 0.00014 to 0.00044 ppm and 0.00011 to 0.0089 ppm respectively. The samples in this region contained ά, β, γ and δ isomers of Hexachloro cyclohexane (HCH), metabolites of Dichloro diphenyl trichloroethane (DDT), Dicofol and ά-Endosulphan. The combined residue of these compounds accounted to 0.0018 and 0.0117 ppm in crop content and fat respectively.

The samples from foraging ducks in Palakkad (Table 2) contained ά, β, γ and δ isomers of HCH, isomers of DDT, Dicofol, ά-Endosulphan and Dieldrin. The residue in the crop content was ranging from 0.0002 to 0.0075 ppm and that in fat samples was ranging from 0.00014 to 0.0135 ppm. The combined residues were 0.0152 and 0.0419 ppm in the crop content and fat respectively.

The samples estimated in crop contents and fat of foraging ducks from Thrissur showed that only isomers of HCH, primary derivatives of DDT and ά-Endosulphan were present in the samples. The combined residues in these samples were also negligible (0.0033 and 0.0077 ppm in crop and fat samples respectively).

Report on the Australian National Residue survey results (Anon. 2001) indicated that the Maximum Residue Level (MRL) of various organochlorine pesticides in poultry fat are 0.2 ppm for endosulphan, aldrin and dieldrin compounds, 0.3 ppm for HCH and 5.0 ppm for DDT and its metabolites. MRL specified by Pesticide Manufacturers and Formulators Association of India (PMFAI) are 7.0 ppm for DDT, 2.0 ppm for HCH and 0.2 ppm for aldrin and dieldrin in poultry meat.

Table 1. Mean organochlorine residues present in the crop content and fat of foraging ducks from Kuttanad

Name of organochlorine	Crop content (ppm)	Fat (ppm)
A –HCH	0.00016	0.00058
B –HCH	0.00044	0.00066
γ –HCH	0.00014	0.0089
Δ –HCH	0.00026	0.00011
p, p'-DDE	0.00017	0.00038
o, p'-DDT	0.00028	0.00050
ά –Endosulphan	0.00031	0.0004
Dicofol	0.0000	0.0002
Total	**0.0018**	**0.0117**

Table 2. Mean organochlorine residue present in the crop content and fat of foraging ducks from Palakkad

Name of organochlorine	Crop content (ppm)	Fat (ppm)
α -HCH	0.00086	0.0021
β -HCH	0.0045	0.0092
γ -HCH	0.0075	0.0135
δ -HCH	0.0019	0.0066
p, p'-DDE	0.0000	0.00014
o, p'-DDT	0.0000	0.00018
ά -Endosulphan	0.00024	0.0004
Dicofol	0.0002	0.009
Dieldrin	0.0000	0.00077
Total	**0.0152**	**0.0419**

Table 3. Mean organochlorine residues present in the crop content and fat of foraging ducks from Thrissur

Name of organochlorine	Crop content (ppm)	Fat (ppm)
α -HCH	0.00015	0.00025
β -HCH	0.0006	0.00135
γ -HCH	0.0001	0.0008
δ -HCH	0.0002	0.0006
p, p'-DDE	0.0018	0.0042
o, p'-DDE	0.00014	0.00018
ά -Endosulphan	0.00026	0.00028
Total	**0.0033**	**0.0077**

The effects of feeding organochlorines on various poultry species have been reported by many authors. The effect of DDT and its derivatives on carbonic anhydrase enzyme activity and reduction in egg shell thickness was reported in chicken and Japanese quails by Miller et al. (1976) and Bitman *et al*. (1970) respectively. High dietary concentration of DDE caused extreme egg shell thinning and mortality in adult mallards with no significant effect in egg size, mass and shape (Blus *et al*. 997). While determining the residue in laying hens after feeding DDT at different levels, highest residue of DDT and its metabolites were found in adipose tissue than egg yolk, meat, blood and other organs (Singh *et al*., 1970 and George and Sundararaj, 1995). High levels of DDT were determined in ovary, oviduct and egg yolk than blood and liver, while DDE in liver, ovary and oviduct with the lowest in egg yolk by Furusawa (2002). The poly chlorinated biphenyls were reported as the most frequent contaminant among the organochlorine residues estimated in the breast muscle, skin and subcutaneous fat of mallards in Wisconsin and abdominal fat of avian species in Ontario (Botero *et al*., 1996).

Conclusion

Since the organochlorine residues detected in the samples collected from three regions in the study were below their MRL specified in poultry, the eggs and meat from foraging ducks could be considered as safe for human consumption. The results of the present study indicated that the residues from a series of organochlorine compounds are present in the paddy fields in Kerala. The farmers should be made aware about the fact that indiscriminate use of these compounds in the field may lead to the accumulation of the residues in meat in future creating risk and harm to human and animal population.

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COMPARISONS OF EGGSHELL QUALITY AND YIELD RATE OF *PIDAN* AMONG DIFFERENT TSAIYA POPULATIONS

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Abstract

The objectives of this study were to compare the eggshell quality and yield rate of *pidan* among Brown Tsaiya ducks with blue eggshell (BS), with high eggshell strength (HES), and from commercial hatchery (CM). The three populations of ducks were raised both at the Ilan Branch and in the field. Three hundred and 150 ducks from each population were raised in the field and at the Ilan Branch, respectively. Eggshell thickness, eggshell color, culling rate of fresh eggs, yield rate of *pidan* and shape index were recorded. The results showed that the HES ducks had the thickest eggshell, followed by BS and then CM ducks. Whereas, ducks raised in the field had a less consistent trend in the order of eggshell thickness at the same age and there was a fluctuation of eggshell thickness when the ages of ducks increased. In addition, the BS ducks had deepest eggshell color, followed by HES and then CM ducks. The BS and CM ducks had the lowest and highest culling rate of fresh eggs, respectively when eggs were detected to pick up the good-quality ones for production of *pidan*. Ducks at 33 weeks of age had the lowest culling rate irrespective of the duck population, and then the culling rate was increased with age. At 50 weeks of age, the BS ducks had a culling rate of less than 50% compared with those of over 60% in the other two populations. The BS ducks also had the highest yield rate of *pidan* followed by the HES ducks and then CM ducks. There were similar shape index among the three populations. Taken together, the differences of eggshell thickness, eggshell color, culling rate of eggs, and yield rate of *pidan* among duck populations did exist.

(Key words: Brown Tsaiya duck, Eggshell quality, *Pidan*)

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Introduction

The duck egg is an important nutrient source in Taiwan. *Pidan* (alkalized egg, thousand-year egg) and salted egg are the major duck products. Consumers like duck eggs with blue eggshells (Lin *et al*., 2006). It has been pointed out that the *pidan* yield rate is associated with the duck's age, the immersion liquid composition, environmental temperature and eggshell quality (Wang *et al.*, 1998). Eggshell color and strength can be improved via selection (Liu *et al*., 1998; Liu *et al*., 2001; Huang, 2004). The hybridized strain from the pure strain of Tsaiya selected for eggshell color or strength and other strains gave rise to different laying performance. Huang *et al*. (2007) showed that the Tsaiya populations selected for blue eggshell (BS) and high eggshell strength (HES) had better eggshell strength than the Tsaiya from a commercial hatchery (CM), irrespective of being raised in the field or at the Ilan Branch. However, the BS and HES had a tendency for lower egg production than the CM ducks. The CM ducks had the heaviest egg weight, followed by the HES, with the BS duck having the lightest egg weight. It was also observed that the feed efficiency of CM was better than that for the other two populations (Huang *et al*., 2007). Although the laying performance of the three Tsaiya populations was compared, the differences in eggshell quality and yield rate among the three Tsaiya populations were unknown. Therefore, the objectives of this study were to compare the differences in eggshell thickness, eggshell

color, the culling rate for fresh eggs (i.e. the rate of eggs improper for *pidan* production), and the *pidan* yield rate among BS, HES and CM populations.

Materials and methods

ANIMALS

Ducks were raised in the field (in Chiayi County, middle part of Taiwan) and at the Ilan branch, Livestock Research Institute (shortened to the Ilan Branch in this context) (in Ilan County, northeastern part of Taiwan). The BS Tsaiya population was produced by crossing the line L106 male (selected blue-shell line) (Liu *et al.*, 2001) with line L105 female (selected for laying performance). The HES Tsaiya population was produced by crossing high- eggshell-strength line males (at its 3rd generation) with line L107 female (selected for high egg production). For high-eggshell-strength selection we used eggshell strength at 40 weeks of age as the selection criteria (Huang, 2004). The CM Tsaiya ducks were bought from a commercial hatchery. There were 150 ducks in each population at the Ilan Branch, with a total of 450 ducks. Three hundred ducks were employed in each population in the field, with a total of 900 birds. All animals in this study were cared for according to Institutional Animal Care and Utilization Committee (IACUC) regulations at the Ilan Branch.

FEED AND MANAGEMENT

The ducks raised at the Ilan Branch were given a starter diet containing metabolizable energy (ME) 2,900 kcal/kg and crude protein (CP) 19% at 0-8 weeks of age. At 8-14 weeks of age, they were fed a growth diet (ME 2,778 kcal/kg, CP 15.5%). After 14 weeks of age, a laying diet (ME 2,750 kcal/kg, CP 19%) was provided. Ducks at the Ilan Branch were raised in an individual cage and exposed to natural lighting. The ducks raised in the field were fed a starter diet (ME 2,895 kcal/kg, CP 18.7%) at 0-3 weeks of age. At 3-9 weeks of age, they were given a growth diet (ME 2,763 kcal/kg, CP 15.5%). At 9-18 weeks, they were supplied with mashed corn, with mineral and vitamin supplements (ME 3,400 kcal/kg, CP 9.6%). After 18 weeks old, they were fed a laying diet (ME 2,900 kcal/kg, CP 20%). In the field, ducks were raised on the floor with 10 candle light bulbs for illumination at night. All birds in this study were given feed *ad libitum* and had free access to water.

TRAITS DETERMINED

- Eggshell thickness and eggshell color: The thickness gauge (FHK, Japan) was used to measure eggshell thickness and the COLORIMETER (JC-801, Japan) was used to determine the a value of eggshell color every 10 weeks. Each measurement was conducted for three consecutive days.
- *Pidan* production (in the field): *Pidan* was produced every 7-9 weeks during the age of 24-47 weeks and every 3-6 weeks during age of 47-61 weeks. After the eggs were collected, the technician carefully knocked one egg against another egg to judge whether the egg was “intact” or not. The eggs with breakage or abnormal sound were considered improper for *pidan* production and culled. The “intact” eggs were then put in the immersion fluid mainly containing NaOH and salt. The immersion period depended on environment temperature and in general it was between 45-50 days. After eggs were taken out of immersion fluid, a technician slightly flicked the eggshell to judge the quality of *pidan*.
- The shape index (at the Ilan Branch): The shape index was calculated as egg width/egg length * 100.

STATISTICAL ANALYSIS

The data of eggshell thickness, eggshell color, and shape index were analyzed by the GLM (General Linear Models) procedure using SAS software (SAS Institute, 1988). Significant effects were further explored by using Tukey’s honest significant difference. And Freq procedure was used to compare the differences between parameters of culling rate of fresh eggs and yield rate of *pidan*.

Results and Discussion

EGGSHELL THICKNESS

At the Ilan Branch, the HES ducks had the thickest eggshell, followed by BS and then CM ducks (*Table 1*). The differences among the three duck populations were significant in the period from 40 to 50 weeks of age ($P < 0.05$). From 20 to 60 weeks of age the average eggshell thickness for HES, BS and CM ducks were 0.383, 0.390 and 0.373 mm, respectively. The eggshell thickness trend was consistent with eggshell strength (Huang *et al.*, 2007). Tai *et al.* (1985) indicated that the eggshell thickness of white Tsaiya ducks was 0.364 mm, and the heritability estimating by sire variance component was 0.316. Wang *et al.* (1997a) pointed out that the eggshells of blue-shell eggs were slightly thicker than those of white-shell eggs, whereas the eggshell strength of both was not different. In the field, the order of eggshell thickness for these three Tsaiya populations was similar to that at the Ilan Branch (*Table 1*), but the eggshell thickness values in the field were higher than those at the Ilan Branch, except at 20 weeks of age. The average eggshell thickness of HES, BS and CM Tsaiya ducks in the field from 20 to 60 weeks of age were 0.390, 0.398 and 0.382 mm, respectively. The differences in these three populations at different weeks of age in the field were irregular. There was a fluctuation at different weeks of age in the same population (*Table 1*). Ducks were raised on the ground in the field, which rendered the ducks more vulnerable to environmental effects such as invading cats or rats (Lee *et al.*, 1991). At the Ilan Branch, ducks were raised in cages, with egg production conducted in a steadier manner than in the field (*Table 1*). The reason why average eggshell thickness of each population in the field was thicker than the same population at the Ilan Branch (*Table 1*) was probably related to the higher egg weight in the field. The average egg weight of ducks in the field was higher than that at the Ilan Branch by approximately 5 g (Huang *et al.*, 2007). Huang (2004) also found that egg weight and eggshell weight were positively correlated. Although the ducks in the field and at the Ilan Branch had the highest eggshell strength at 30 weeks of age (Huang *et al.*, 2007), there were different alteration patterns in eggshell thickness in the field and at the Ilan Branch when the age of Tsaiya ducks increased (*Table 1*). The eggshell thickness of ducks at the Ilan Branch decreased gradually with age. However, in the field it increased from 20 weeks of age and reached the peak value at 40 weeks of age, and then decreased gradually or fluctuated. Therefore, there are other factors that affect eggshell strength besides for eggshell thickness (Bain, 1991). According to the study by Sadjadi *et al.* (1983) the blue-shell egg layers had a significantly lower egg production rate than the white-shell egg layers. However, there were no significant differences in eggshell quality, eggshell thickness, albumen weight, yolk weight and yolk cholesterol. The genetic correlation of eggshell quality and eggshell color were only between -0.23 to 0.13 in brown-shelled layers, therefore, Zhang *et al*. (2005) believed that relationship between eggshell quality and eggshell color was weak.

Table 1 Comparisons of eggshell thickness (0.01 mm) among different Tsaiya populations.

Weeks of age	Tsaiya population*			
	BS	HES	CM	N**
	----------At the Ilan Branch----------			
20	41.6 ± 0.3^{a}	41.6 ± 0.3^{a}	41.1 ± 0.3^{a}	90
30	38.8 ± 0.2^{b}	39.7 ± 0.2^{a}	39.0 ± 0.2^{b}	367-433
40	38.5 ± 0.2^{b}	39.6 ± 0.2^{a}	37.2 ± 0.2^{c}	356-411
50	36.0 ± 0.2^{b}	37.6 ± 0.2^{a}	35.0 ± 0.2^{c}	277-335
60	36.8 ± 0.2^{a}	36.7 ± 0.2^{a}	34.4 ± 0.2^{b}	309-367
Average	38.3	39.0	37.3	
	----------In the field----------			
20	38.1 ± 0.3^{a}	37.5 ± 0.3^{a}	36.7 ± 0.3^{b}	90
30	38.9 ± 0.1^{b}	40.8 ± 0.1^{a}	39.0 ± 0.1^{b}	612-746
40	42.1 ± 0.1^{b}	42.9 ± 0.1^{a}	39.3 ± 0.1^{c}	591-759
50	36.6 ± 0.1^{b}	38.2 ± 0.1^{a}	38.3 ± 0.1^{a}	565-643
60	40.1 ± 0.2^{a}	39.5 ± 0.2^{b}	37.7 ± 0.1^{c}	471-662
Average	39.2	39.8	38.2	

*BS, HES, and CM represent the Brown Tsaiya ducks with blue eggshell, with high eggshell strength, and from commercial hatchery, respectively.
**N represents the sample size used to measure eggshell thickness.
[a, b, c] Values (means ± SE) in the same row with different superscripts differ significantly ($P < 0.05$).

EGGSHELL COLOR

At the Ilan Branch and in the field, the BS ducks had the deepest color, followed by HES and then CM ducks (*Table 2*). The a value for average eggshell color for these three populations from 20 to 60 weeks of age were -6.8, -6.2 and -5.4, respectively at the Ilan branch, and -5.4, -4.6 and -4.3, respectively in the field. It showed that eggshell color was deeper at the Ilan Branch. It was possible that egg weight was heavier in the field (Huang *et al.*, 2007), and the pigments secreted by shell gland would be "diluted". In the present study, the parent of the HES population was selected only for eggshell strength, and not for eggshell color. However, the eggshell color value for HES ducks was still lower than CM ducks ($P < 0.05$) (*Table 2*), it showed that there might be a linkage between eggshell strength and eggshell color. In general, the eggshell color of Tsaiya ducks becomes paler when the laying duck age increases. Liu *et al.* (2004) reported that the eggshell value produced by the blue-shell Tsaiya line showed a linear increase when the laying duck age increased, and this value was -6.60 at 29 weeks of age and then increased to -6.12 at 60 weeks of age. It was found that there was a trend that the eggshell color of ducks at 50 weeks of age was deeper than at 40 weeks of age (i.e. the a value decreased slightly from 40 to 50 weeks old) for both the Ilan Branch and field ducks (*Table 2*). This might be associated with the decline of egg production caused by the feed and the weather around 50 weeks of age (Huang *et al.*, 2007).

Table 2 Comparisons of eggshell color (a value) among different Tsaiya populations.

Weeks of age	Tsaiya population*			
	BS	HES	CM	N**
	----------At the Ilan Branch----------			
20	-6.8 ± 0.17^{c}	-5.9 ± 0.17^{b}	-5.3 ± 0.17^{a}	88-90
30	-6.9 ± 0.07^{c}	-6.3 ± 0.07^{b}	-5.5 ± 0.07^{a}	356-409
40	-6.6 ± 0.07^{c}	-5.8 ± 0.08^{b}	-5.4 ± 0.08^{a}	359-413
50	-7.1 ± 0.08^{b}	-6.9 ± 0.08^{b}	-5.9 ± 0.08^{a}	282-342
60	-6.4 ± 0.07^{c}	-6.0 ± 0.08^{b}	-4.7 ± 0.07^{a}	317-373
Average	-6.8	-6.2	-5.4	
	----------In the field----------			
20	-5.6 ± 0.14^{b}	-4.9 ± 0.14^{a}	-5.0 ± 0.14^{a}	90
30	-5.9 ± 0.05^{c}	-4.8 ± 0.05^{b}	-4.3 ± 0.05^{a}	637-750
40	-5.4 ± 0.05^{c}	-4.7 ± 0.04^{b}	-4.1 ± 0.04^{a}	590-732
50	-5.5 ± 0.07^{c}	-4.8 ± 0.06^{b}	-4.3 ± 0.06^{a}	573-652
60	-4.5 ± 0.05^{b}	-3.9 ± 0.05^{a}	-3.7 ± 0.04^{a}	461-670
Average	-5.4	-4.6	-4.3	

*BS, HES, and CM represent the Brown Tsaiya ducks with blue eggshell, with high eggshell strength, and from commercial hatchery, respectively.
**N represents the sample size used to measure eggshell color.
[a, b, c] Values (means ± SE) in the same row with different superscripts differ significantly ($P < 0.05$).

CULLING RATE OF THE FRESH EGG

The fresh egg culling rates from low to high were BS population, HES population and CM ducks, respectively (*Figure 1*). The HES ducks had the thickest eggshell thickness (*Table 1*), and also the highest eggshell strength (Huang *et al.*, 2007). However, the high eggshell thickness and eggshell strength did not give rise to a low fresh egg culling rate. The main reason might be that the *pidan* producer culled not only the broken eggs but also the eggs with abnormal shape, corrugated shells and abnormal hardness, etc when examining the eggs. Hen eggs are regarded as abnormal eggs when there were breakages, holes or wrinkles, etc (Solomon, 1991). The culling rate in every population in this experiment was lowest at 33 weeks of age, and increased with age. At 50 weeks of age, the culling rate for the BS population maintained below 50%, but those of the other two populations were over 60%.

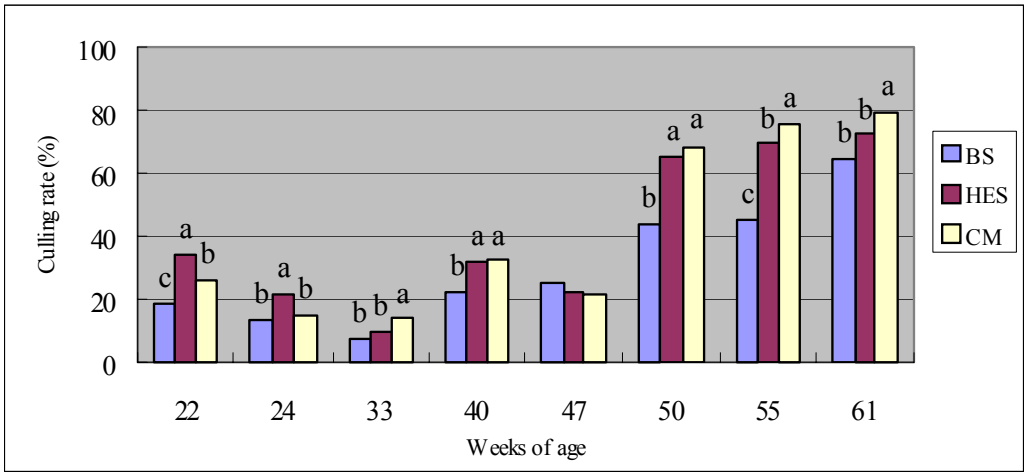

Figure 1 Comparisons of culling rate among different Tsaiya populations. BS, HES, and CM represent the Brown Tsaiya ducks with blue eggshell, with high eggshell strength, and from commercial hatchery, respectively.

[a, b, c] Values in the same age with different letters differ significantly ($P < 0.05$). Sample size ranged between 1079 and 1814 for any combination of age and Tsaiya population.

YIELD RATE OF *PIDAN*

In the *pidan* yield rate (*Figure 2*), the BS ducks were the highest followed by the HES ducks and then CM ducks. *Pidan* is produced when alkali liquid penetrates the eggshell via gas pores, therefore, eggshell quality, environmental temperature and components of immersion liquid, and so on, may influence the *pidan* quality (Su *et al.*, 1985; Su and Lin, 1991; Wang *et al.*, 1998). To increase the *pidan* yield rate some commercial *pidan* producers add heavy metals like lead or cooper into the immersion liquid. Because heavy metals present a risk to human health, researchers <http://cdict.net/?w=research> have expended many efforts to develop recipes void of heavy metals (Wang *et al.*, 1997b). The result in the present study showed that 40 weeks of age seemed to be a key period influencing duck egg utilization. The eggs laid before this age were more suitable to *pidan* processing. Because duck eggshell quality diminishes with increased age, duck egg processors usually use the eggs laid before the period from 36 to 40 weeks of age to manufacture *pidan*. Those eggs laid after this period are used to manufacture salted eggs.

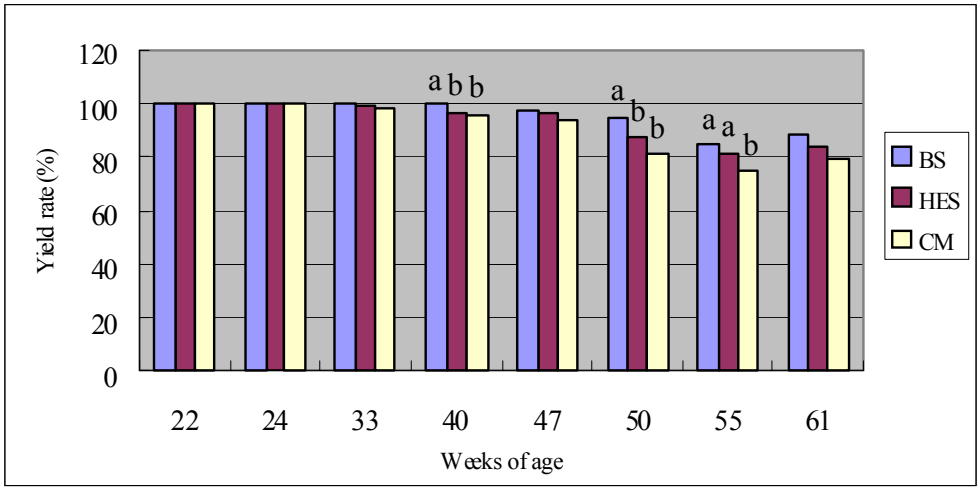

Figure 2 Comparisons of yield rate of *pidan* among different Tsaiya populations. BS, HES, and CM represent the Brown Tsaiya ducks with blue eggshell, with high eggshell strength, and from commercial hatchery, respectively.

[a, b] Values in the same age with different letters differ significantly ($P < 0.05$). Sample size ranged between 818 and 1592 for any Tsaiya population aged 22-47 weeks, whereas it ranged 291-815 when ducks were 50-61 weeks of age.

SHAPE INDEX

Although there were significant differences among HES, BS and CM populations in *pidan* culling rate and yield rate after 47 weeks of age, a similar shape index from 47 to 61 weeks of age was observed among the three populations (*Figure 3*). Because of the Ca and P proportions in the diet were imbalanced around 50 weeks of age at the Ilan Branch, the duck egg production rate declined (Huang *et al.*, 2007). The egg shape index also declined from 72 to about 68.5 in this period. After about 5 weeks, the shape index started to restore to a normal condition (*Figure 3*). Differences in shape index among the three Tsaiya populations at all weeks of age were not significant ($P > 0.05$), and there was a trend that the average shape index of the HES population was lower than that for the BS and CM ducks in the 47 to 61 weeks period of age. The average shape index for the three populations were 70.69, 71.09 and 71.31, respectively. This order is consistent with the eggshell thickness order (i.e. HES population thickest and CM one thinnest) (*Table 1*). Bain (1991) reported that rounder eggs were more resistant to deformation than longer eggs. Furthermore, Kul and Seker (2004) indicated that the shape index for quail eggs was negatively related to the egg weight and eggshell weight. Therefore, it is worthwhile to study if the shape index of Tsaiya ducks is negatively related to the eggshell thickness. It was also found in this study that variation patterns in the shape index for the HES and BS populations were slightly different from the CM population (*Figure 3*). This was probably because both the HES and BS ducks were derived from line L105. Therefore their genetic backgrounds were similar, which rendered similar responses when faced with environmental factors. Chen *et al.* (2003) reported that the shape index for duck eggs was 72.78, slightly higher than the average value (70.69-71.31) in the present study. Tai *et al.* (1985) indicated that shape index for white Tsaiya ducks was 70.3, and it was relatively close to our result. The heritability of shape index in white Tsaiya ducks was 0.011 (Tai *et al.*, 1985).

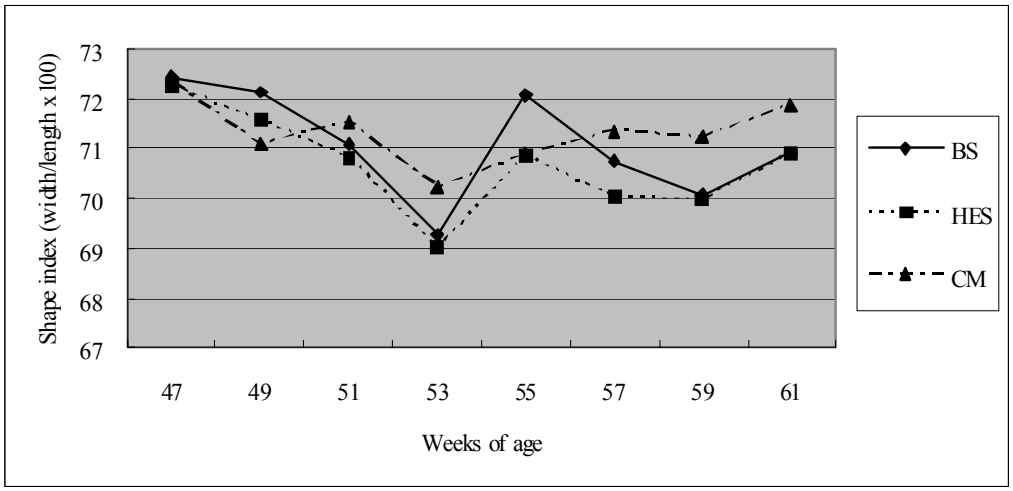

Figure 3 Comparisons of shape index among different Tsaiya populations. BS, HES, and CM represent the Brown Tsaiya ducks with blue eggshell, with high eggshell strength, and from commercial hatchery, respectively. Sample size=30 for any combination of age and Tsaiya population.

Conclusions

Eggshell thickness, eggshell color, culling rate and yield rate for *pidan* among three Tsaiya ducks populations were significantly different. The results suggested that duck egg processors need to take into account the price of fresh eggs, *pidan* and salted eggs, and the culling rate for fresh eggs and yield rate in *pidan* to determine the optimum ages for ducks to lay eggs for manufacturing *pidan*.

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PHYSICAL QUALITY AND FATTY ACID PROFILES OF EGGS PRODUCED BY THE INDONESIAN DUCKS RAISING ON THE LAGUNA

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ABSTRACT

The most common method of duck production in the traditional herding system along of the south coast region of Yogyakarta, Indonesia is raising duck on the Laguna. Herded flock under the care of a single herdsman usually ranges in size from 100-150. However, in a Laguna Samas there were about 600–1000 ducks swimming and scavenging. Twice a day ducks were provided whole grains of paddy or dried rice remnants, approximately 110 *g*/duck/day as their main energy source. For the animal protein source these ducks consumed such as snails, clams, small shrimps, small fishes, water insects and crabs freely during almost a day swimming. Algae (*Spirulina platensis*), seaweed, leaf materials and organic matters that found in Laguna were regarded as their fibers, minerals and vitamins sources.

Herded flocks were confined at night. Eggs laid during the night or early morning were collected for measuring the daily egg production (% HDA) in this study. Egg quality analyzed three times of the 28 day egg production cycles. The physical quality of egg consists of weight (*g*), egg index (%), egg shell thickness (*mm*), albumen weight (*g*), egg yolk weight (*g*), egg yolk diameter (*cm*), egg yolk color index and haugh unit (HU). The fatty acid profiles were analyzed by gas chromatography.

The results of physical quality of eggs were 70.66 *g*, 81.51%, 0.47 *mm*, 37.43 *g*, 24.98 *g*; 4.31 *cm*; 14.10 and 83.18 respectively. Identification of the fatty acid profiles from chromatograms showed that C14:0 ; C16:0 ; C16:1 ; C18:0 ; C18:1 ; C18:2 ; C20:4 ; C20:5 and C22:6 were 1.65 ; 1.64 ; 0.23 ; 1.28 ; 1.80 ; 0.73 ; 0.28 ; 2.46 ; 1.63 and 1.16 respectively. The average of egg production of ducks (%HDA) was 71.40 ± 20.20.

The conclusion of the study showed that duck eggs from the Laguna have the "A Grade " quality, enrichment with omega 3 and a suitable eggs for eating (un-fishy taste) and a low cholesterol eggs.

Key words: physical quality, fatty acid profile, duck egg, Indonesian duck, raising on the laguna

INTRODUCTION

Different duck production systems are used in the world. In developed countries, ducks are mainly reared intensively in total-confinement housing or with access to pasture (free- range : mule ducks reared for fatty liver production) and sometimes to water for swimming. In Asia (including Indonesia) extensive systems are largely used, ducks being housed above fishpond (Pingel, 2004). Raising ducks and the fish together was commenced rather recently in Taiwan. Now duck fish farming is widespread and it is practiced in China, Indonesia, Malaysia, Singapore, Thailand and other countries. In the Philippines, many ducks are produced on land in the areas around Laguna De Bay in Los Banos (Scott and Dean, 1991). Similar to that the duck raising in Indonesia in many areas are typical small farm for producing duck eggs. To decrease feed costs, local ducks are also reared in rice field and sometime the farmers look after the duck in the back yard of their home and let them scavenging around. Ducks in Indonesia are used mainly for egg production and meat is a by-product. The raising system of the ducks is always associated to the egg flavor and of course to the consumer preference. The duck eggs produced from the rice field rearing usually have a good score egg yolk color and high quality of shell thickness.

In the rice field, the herded ducks found small amounts of insects, leaf material, crabs and frogs as their feed however whole grains of rice and snails usually account for more than 90% of the crop contents (Evan and Setioko, 1986). In the development of intensive rice paddy plantation is widely used the artificial fertilizer, insecticides, pesticide and other chemicals wild grass protection. Under these conditions the whole small of insects, snails, leaf-material, crabs and frogs in the rice fields are difficult to find. The herded ducks in the rice field system may result in the presence of insecticide and pesticide residues in animal products and decreasing hatchability of the fertile duck eggs.

The shore of laguna zone in South Bantul region, Yogyakarta Indonesia can not use as plantation area. These areas are being a resources of organic matter such as snails, clams, small shrimps,"jingking"(*Uca vocans*), "grayah" (*Uca* sp), "yode" (*Mytillus viridis*), "gangsing" shrimps, and small fishes that duck dredged it from the bottom of the swamp. The report of proximate analysis showed that these organic matters are satistactory for the laying water fowl particularly ducks feed as their protein, fat, fibers, minerals and vitamins sources (Iskandar, 2004).

The fatty acid composition of yolk fat is altered by dietary and highly unsaturated fatty acids present in the yolk, but high levels of saturated fat in the diet have less influence on yolk fat composition (Naber and Biggert, 1989; Hargis *et al*., 1990). When hens were fed fish oil, the fatty acid composition of egg yolk reflected that of the diet. So the effective level of fish oil in the diet was found to be 2 - 6% (Huang *et al*., 1990). For lowering the cholesterol content previous reseachers reported that diets containing high fiber (Sutton, *et al*., 1980; Sri-Harimurti, 1983) and omega-3 resulted in a decrease in yolk cholesterol amounts (Adams *et al*., 1989).

The objective of this study was to obtain information on physical quality, fatty acid profiles and cholesterol of duck eggs as influenced by the duck raising system in the laguna. The raising system is related to the feeding behaviour and kind of feed stuff of the duck. In addition, the results from this study will be useful for the manipulation of duck diet in the confinement housing system.

MATERIALS AND METHODS

The herded flock of laying local ducks (120 ducks, 50 week of age) reared on land in the areas around Samas shore Laguna in Bantul, Yogyakarta, Indonesia. Ducks were swimming and scavenging at day and confined at night. Twice a day : morning and afternoon (returning from the lagoon), ducks were provided whole grains of paddy (40 *g*) and dried rice remnants (70 *g*), approximately 110 *g*/duck /day as their main energy source. For the animal protein and fat sources, these ducks regarded consuming such as snails, clams, small fishes, water insects, small shrimps, "jingking", "grayah", "gangsing" and crabs freely during almost a day swimming. Algea (*Spirulina platensis*), seaweed, leaf materials and organic matters that found in lagoon were regarded as their fibers, minerals and vitamins sources.

Sampling duck crops were measured the content and followed by the proximate analyzed consisted of CP (crude protein), Ca, P, ME (metabolizable energy), crude fat and crude fiber. The crops were obtained from random sampling ducks in the afternoon, when the duck crop was full (before ducks were provided the second added feed).

Eggs laid during night or early morning (in the bamboo pen confinement) were collected for measuring the daily egg production (% HDA). Physical egg quality measured at the last three days respectively (day 26^{th}, 27^{th} and 28^{th}) of the 28 days egg production cycle. The variable of physical egg quality consisted of egg weight (*g*), egg index (%), egg shell thickness (*mm*), albumen weight (*g*), egg yolk weight (*g*), egg yolk diameter (*cm*), egg yolk colour index and haugh unit (HU). For determination of yolk fatty acid profiles and cholesterol content were randomly selected yolks from all of the yolks at the physical egg quality test. Fatty acids were quantified by a Hitachi 163 gas chromatograph equipped with flame ionization detector using a sinchrome E71 5% simalite on stainless steel column with 3.1 *m* length x ID of 1.2 *mm*. The samples were chromatographed at 215^0C operated isothermally for 50 minutes. The injection and detector temperatures were 260^0C. Simadzu-C-RGA integrator was used to integrate retention times and peak areas. Fatty acids peaks were identified by comparison with retention

times of fatty acid methyl ester standard including EPA and DHA. For determination of egg yolk cholesterol content used the procedure of Liebermann-Bunchard (Christina, 1987)

RESULTS

Nutrient intake of the duck affected by the duck raising system.

Table 1 presents the results of chemical analysis of the duck crop content consisted of percentage of crude protein, crude fat, crude fiber, Ca and P. In the table shows the amount of nutrients chemical compostion of duck crop as such as 11.46 % crude protein, 8.86 % crude fat, 17.44 % crude fibers, 1.96% Ca, 0.86% P (available), others 59.42%, and the energy (ME) 3379.72 kcal/kg. The duck crop contained soil, clay, sand, grit and unidentified materials that namely "others" did not analyzed. To chemical analyze the duck crop content, the samples were obtained from surgerical ducks in the afternoon, when ducks were returning from the lagoon (before ducks were provided the second added feed).

Table 1. Chemical composition of duck crop content and calculated nutrient intake of the duck raised on the Samas Laguna, Bantul Yogyakarta, Indonesia

Chemical composition of crop [1)]	Amounts (%)[3)]	Calculated nutrients intake (*g*/duck/day)	Added feed [4)] (*g*/duck/day)	Total nutrients intake (*g*/duck/day)
Crude protein	11.46	19.32	4.79 (2.38) [5)]	21.70
Crude fat	8.86	14.93	1.42 (0.71)	16.35
Crude fiber	17.44	29.40	5.66 (2.83)	32.23
Ca	1.96	3.30	0.03 (0.015)	3.33
P (available)	0.86	1.38	0.2 (0.1)	1.48
Others[2)]	59.42			

[1)] Sample of duck crop content weight = 168.60 *g* (ME 569.82 kcal);
[2)] Soil, clay, sand, grit etc. (unidentified) ;
[3)] Theoretical ME 3379.72 kcal/kg
[4)] 110g/duck/day (whole grains of paddy 40 *g* and dried rice remnants 70 *g*; ME 237.80 kcal)
[5)] Data under bracket are 50% of added feed nutrients (ME 118.9 kcal).

The average weight of duck crop content was 168.60 *g*. Calculated nutrients intake of ducks (*g*/duck/day) based on crop chemical analysis and crop weight were 19.32 *g* crude protein, 14.93 *g* crude fat, 29.40 *g* crude fibers, 3.30 *g* Ca, 1.38 *g* available P, and 569.82 kcal of ME. The calculated nutrients intake of added feed (provided to ducks twice a day) consisted of whole grains of paddy (40 *g*) and dried rice remnants (70 *g*), approximately were 4.79 *g* crude protein, 1.42 *g* crude fat, 5.66 *g* crude fibers, 0.03 g Ca, 0.2 *g* available P, and energy (ME) 237.80 kcal per duck. The amounts of duck nutrients intake daily (*g*/duck/day) were the sum of the calculated nutrients intake of ducks (*g*/duck/day) based on crop chemical analysis and crop weight plus 50% of the calculated nutrients intake of added feed. The daily nutrients intake of duck raised in the Samas laguna in Bantul, Yogyakarta (g/duck/day) approximately were 21.70 *g* crude protein, 16.35 *g* crude fat, 32.23 g crude fibers, 3.33 *g* Ca, 1.48 *g* available P, and ME 688.72 kcal.

Physical egg quality

Table 2 presents the results of physical egg quality of ducks raised on the laguna in Bantul when compared to the confined ducks raised in Mojosari and Brebes region. The results of this study did not compare statistically between unconfined and confined ducks. The data in the table shows that egg weight, egg shell weight, egg shell thickness, albumen index, egg yolk high of duck eggs produced from the laguna raising system have higher value than those of the others, particularly to the Roche egg yolk color scores.

Fatty acid profiles

Table 3 shows the advantage of the shore laguna raising ducks system which have produced the smart egg with omega 3 enrichment. High concentration of omega-3, especially EPA and DHA.

Table 2. Physical egg quality of ducks raised on the laguna in Bantul compared to the confined ducks raised in Mojosari and Brebes regions

No	Variabel of duck egg [1)]	Unconfined ducks	Confined ducks	
		Laguna (Bantul)	Mojosari	Brebes
1	Egg weight (gram)	70.66	63.29	68.70
2	Egg index (%)	81.51	81.36	78.64
3	Egg shell weight (gram)	8.18	5.82	7.31
4	Egg shell thickness (mm)	0.47	0.40	0.40
5	Albumen weight (g)	37.43	34.34	37.14
6	Albumen Index (%)	95.73	71.16	60.74
7	Egg yolk weight/ yolk (g)	24.98	22.96	24.80
8	Egg yolk diameter (cm)	4.31	4.74	4.63
9	Egg yolk high (mm)	17.82	14.41	15.12
10	Roche egg yolk color scores	14.1	7.2	6.0
11	Egg Haugh Unit (HU)	83.18	62.15	55.73

[1)] Average of eggs measured at day 26th, 27th and 28th of the 28 days egg production cycle.

Tabel 3. Fatty acid profiles of duck eggs produced by herded ducks raised on the Samas laguna in Bantul, Yogyakarta, Indonesia.

Molecular structure	**Chemical name**	**% of fatty acid content**
C14:0	tetradecanoic acid (myristic)	1.65
C16:0	hexadecanoic acid (palmitic)	1.64
C16:1	9-hexadecanoic acid (palmitoleic; **omega-7**)	0.23
C18:0	octadecanoic acid (stearic)	1.28
C18:1	9-octadecanoic acid (oleic; **omega-9**)	1.80
C18:2	9,12-octadecadinoic acid (linoleic; **omega-6**)	0.73
C18:3	C18:3 : 6,9,12-octadecatrinoic acid (linolenic; **omega-6**)	0.28
C20:4	C20:4 : 5,8,11,14-(eicosatetranoic acid; **omega-6**)	2.46
C22:4	C22:4 : 5,8,11,14,17-eicosapentanoic acid (**omega-3; EPA**)	1.63
C22:6	C22:6 : 4,7,10,13,16,19-docosahexanoic acid (**omega-3 DHA**)	1,16

Egg production and egg cholesterol content.

Table 4 presents the effect of duck raised on the shore laguna system to the egg production and egg cholesterol content. This study did not compared statistically between unconfined ducks (herded duck flock in the lagoon) and two confined duck flocks in Mojosari and Brebes ragions. In fact ducks reared in extensive system as ducks raising in shore laguna in Bantul produced more egg production and lower egg cholesterol content than those ducks are reared intensively in total- confinement housing.

Table 4. Egg production (HDA,%) and Egg Cholesterol content of herded duck raised on the laguna in Bantul compared to the confined ducks raised in Mojosari and Brebes regions

No	Variabel	Unconfined ducks	Confined ducks	
		Laguna (Bantul)	Mojosari	Brebes
1	Egg production (HDA, %)	71.40 ± 20.20	70.80 ± 15.66	58.10 ± 17.27
2	Egg cholesterol content (mg/egg)	261.1 ± 15.66	270.83 ± 13.24	273.81 ±18.0

DISCUSSION

The requirement of energy will be sufficient, when added to the total of energy (ME) from the duck crop content (569.82 kcal). Total energy intake will be increased to the amounts 688.72 kcal /duck/day. Lee *et al*. (1984) reported that energy (ME) requirement of laying duck approximately 570 kcal/ day/ bird. However, the energy requirement of extensive system laying ducks higher than those the confined rearing ducks, they need approximately 17 kcal/duck/ day for walking and about 44 kcal to 83 kcal/ duck/ day for swimming, playing, standing, preening, and do their behaviour for looking for feed (Khalsum, 2004).

The total calculated nutrient intake of the duck diet / day in this study such as 21.70 % CP, ME 688.72 kcal, 16.35 % crude fat, 32.23 % crude fiber, 3.33 % Ca, and 1.48 % P (available). The high precentage of crude fibers in take as high as 32.23% (Table 1.) was assumed to be correlated by the consumption of algae (*Spirulina platensis*), seaweed, and leaf materials that were found in the lagoon (Samas laguna, Bantul). *Spirulina platensis* (as these ducks consumed daily in the Samas laguna) reportedly has a total xanthophyll concentration as high as 5.787 *mg*/kg (83.6%) and total carotenoids 6.928 *mg*/kg (Anderson *et al*., 1991). Previous reseachers reported that diets containing xanthophyll produced significantly darker egg yolks and also reported that the addition of 4 % animal fat in the diet improved egg yolk pigmentation (Mackay *et al*., 1963; Avila and Cuca (1974) cit. Anderson *et al*., 1991). In this study the role of xanthophyll content from the algae and leaf materials reflected to the best result of Roche egg yolk color scores, i.e.14.10 compared to 7.2 and 6.0 as shown in Table 2.

Fiber plays a role in cholesterol metabolism by a possible combination of its ability to decrease absorption of cholesterol, bind with bile salts in intestinal tract, shorten the intestinal transit time, and increase fecal sterol excretion (Sutton *et al*., 1981). It stands to reason that high fiber intake caused the lowering duck egg cholesterol content 261.1 ± 15.66 *mg*/egg compared to 270.83 ± 13.24 and 273.81 ±18.0 *mg*/egg (Table 4).

In fish is found high concentration of omega 3 PUFA, especially EPA and DHA. Certain marine algae and phytoplankton that like plants can photosynthesise (use sunlight to produce carbohydrate), also contain the omega - 3 PUFA (Farrel, 1996). The fatty acid composition on egg yolk is readily altered by dietary manipulation (Hargis *et al.,* 1991). Based on the previous researchers proved that the feeding behaviour of ducks raising in the laguna affected an increase in yolk composition of the omega -3 fatty acids, EPA (1.63 %) and DHA (1.16 %) as shown in Table 3. One egg on the market contains only 300 *mg* total omega-3 per 100 *g* or 0.3% (Farrell, 1996).

CONCLUSION

Extensive rearing system as ducks raising in shore laguna in Bantul produced more eggs production, good physical egg quality, enriched omega-3, EPA and DHA, and lower cholesterol egg content. The duck eggs in this herded flock have the best result of Roche egg yolk color scores. The kinds of feed stuff from this study will be useful for the manipulation of duck diet in the confinement housing system.

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CHARACTERISTICS OF DUCK MEAT IN COMPARISON WITH OTHER POULTRY MEATS

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Duck meat has combined characteristics of red meat and the dietetic characteristics of poultry meat. Its taste is as red meat while that of chicken meat is great and turkey meat is bland. Meat colour of chicken and turkey is white and dark while that of duck is all dark. Texture of duck meat is vertical cell structure and that of chicken and turkey meat is horizontal cell structure.

Duck breast contains 73.3 % type IIB and 26.7 % type II A muscle fibers while chicken breast contains 100 % type IIB muscle fibers. Duck breast is high in fat while chicken breast high in protein content. Redness, cooking loss & TBARS value are higher in duck breast than chicken breast. P^H of chicken breast declines rapidly during post mortem while TBARS value increases rapidly during cold storage of duck breast. Duck breast has higher levels of fatty acids C 14:0, C 16:0, C 16:1, C 18:2 and C 18:3 while chicken breast has higher levels of C 18:0 and C 20:4 fatty acids. Higher redness, fat content, cooking loss (34.5 %) & rapid lipid oxidation of duck breast may be due to its higher content of type IIA muscle fiber and unsaturated fatty acids than chicken breast.

In case of cooking time, when 5 to 7 lb of whole chicken, 8 to 12 lb of whole turkey and 4.5 lb of whole duck heated indirectly have grilling time of 18 to 25 min / lb, 120 to 180 min and 60 min respectively at 180 ^{O}F internal temperature.

Protein content per 100 g of whole chicken roast, whole turkey roast and whole duck are 23, 25 and 17 g respectively while total calories, total fat, saturated fat and cholesterol content of those are 200, 130 and 292 C; 12, 13 and 25 g; 3, 1 and 8 g; 75, 65 mg and 73 mg respectively. Lipid levels of duck beast meat are higher (2.26 to 7.57 %) than chicken and turkey breast meat (1 – 2 %).

	Moisture%	Ash%
Chicken	75.5	1.1
Duck	76.4	0.9

Comparison of Duck Meat with other poultry meat

Duck meat has combined characteristics of red meat and the dietetic characteristics of poultry meat. It has higher lipid content than chicken and turkey meat. The susceptibility of duck meat to oxidation is high than chicken and turkey meat. Lipids are therefore an important component of duck meat. Increase in muscle lipid content increases lightness, yellowness, juice loss after cooking, tenderness and flavour of meat. The increase in lipid content of breast muscle with age may be involved in the increase in meat flavour. Ducks consume twice as much feed as broilers during growth; therefore, duck meat is more likely to be influenced by diet than chicken meat. Duck meat has relatively high levels of unsaturated fatty acids and low levels of antioxidants. Protein percentage and ether extract of muscle increased with age.

Muscle levels of haeminic pigments increase with age, and the meat is therefore darker and redder

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In Muscovy duck ideal slaughter age is 10 and 12 weeks in female and male ducks respectively. Age has a major effect on muscle development. Between 8 to 15 weeks of age, the weight of breast muscle is 3.3 fold in males and 2.3 in females (Baeza et al., 1997). Fiber area and length strongly increases with age (Baeza et al., 1999). As the collagen content in breast muscle decreases during the same period while collagen solubility remains unchanged, the decrease in meat mellowness and tenderness, and increase in stringiness, may be related to fiber size (Baeza et al., 1997; 2002). (Baeza et al., 2002).

Brest muscle compared with thigh muscle has higher Extract Release Volume (ERV) and lower P^H. Storage at 4^OC for 120 h increased P^H value and reduced ERV. Thiobarbituric acid values increased with duration of storage..(A study on duck meat physico-chemical and chemical properties, Reddy, K. P., Reddy, P. V. V. S., Indian Veterinary Journal, (http://www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=19921442604)

Moisture content of duck meat is 72.69 to 76.72 per cent which is not affected by breed or sex . Water holding capacity is 62.46 – 71.06 % which is also not affected by breed or sex. (A. B. Omojola, 2007).

Comparison of poultry meats Nutritional Value

Meat	Calories	Fat (%)	Cholesterol (Mg)	Protein (%)
Chicken Breast	140	1.1	72	22
Turkey Breast	120	120	55	26
Duck Breast	292	1.8	73	20.1

Meat	Calories	Total Fat (G)	Sat Fat (g)	Cholesterol (Mg)	Protein (g)
Whole Chicken Roast	200	12	3	75	23
Chicken BLSL Breast	140	3	1	72	26
Chicken Thigh	210	13	3.5	81	21
Whole Turkey Roast	130	130	1	65	25
Turkey BLSL Breast	120	120	0	55	26
Whole Duck	292	25	8	73	17
Goose		7.1 %	50.4 %		25

Characteristics	Chicken	Turkey	Duck	Goose
Taste	Great	Bland	Gamey Read Meat	
Colour	White & Dark	White & Dark	All Dark	
Texture	Horizontal Cell structure	Horizontal Cell structure	Verticle Cell structure	
Moisture	White Meat is Dry	White Meat is Dry	All Meat is Moist	
Size	01.75 to 02.75	03.60 to 20.00	03.00 to 03.98	04.00 to 06.00

Comparison of poultry meats Cooking Time

Meat	Amount	Grilling Time	Broiling Time	Internal Temp.^{O}F
Chicken BLSL Breast	4 Halves	12 – 16	14 – 18	170
Chicken Legs	8 no.	12 – 16	30	180
Chicken Wings	2 lb	20 – 25	15	180
Turkey BLSL Breast	2 halves	20 – 25	NA	170
Turkey Thigh	2 no	45	NBA	NA
Turkey Patties	4 Patties	5 – 7	6 – 8	165
Whole Duck	4 Qtr	45	NA	Clear Juice
Duck BLSL Breast	1 no	8 – 10	NA	170
Goose	8 – 12 lbs	18 – 20 min / lb	NA	180 - 185

Comparison of Duck species

Characteristics		Pekin	Muscovy	Mule
Taste		Fatty	Gamey	Gamey
Colour		All Dark	All Dark	All Dark
Fat		Fatty	Meaty	Meaty
Size:	Female	2.10	3.20	3.20
	Male	3.96	3.96	3.40

Goose **meat** is rich in protein (typically around 25g per 100g). The fat content of the **meat** varies depending on: the breed of bird used; the way it has been managed; and the feed it has eaten. The fat content of the **meat** once cooked depends greatly on the cooking method. **Goose** **meat** without its skin is not particularly high in fat. Furthermore, it tends to have a relatively high proportion of monounsaturated fatty acids. In recent years, the demand for **goose** fat in its own right has grown exponentially following promotion by TV chefs as the ideal fat to use when cooking roast potatoes.

Lipid levels of duck beast meat are higher (2.26 to 7.57 %) than chicken and turkey breast meat (1- 2 %).

Effect of lipid levels of sensorial characteristics of duck breast meat
E Baeza,

Duck meat: 73.3 % IIB muscle fibers, 26.7 % II A fibers
Chicken meat: 100 % IIB fibers
Duck breast high in fat while chicken breast high in protein
Redness, cooking loss & TBARS value higher in duck breast.
PH of Chicken breast declines rapidly during post mortem while TBARS value increases rapidly during cold storage of duck breast.
Duck breast has higher C 14:0, C 16:0, C 16:1, C 18:2 and C 18:3
Chicken breast has higher C 18:0 and C 20:4
Higher redness, fat content, cooking loss & rapid lipid oxidation of duck breast may be due to its higher contents of type IIA muscle fiber & unsaturated fatty acids than chicken breast.
Effect of muscle fibre type on meat chact. Of chicken and duck breast muscle,
C D Kim

Characteristics of Duck Meat

Duck meat has combined characteristics of red meat (containing for example high levels of phospholipids, precursors of aromas) and the dietetic characteristics of poultry meat (containing for example high levels of unsaturated fatty acids, representing about 60 % of fatty acids). It has higher lipid content than chicken and turkey meat. As the meat of other poultry species, it contains high levels of unsaturated fatty acids (around 60 % of total fatty acids) and also high levels of haeminic pigments rich in iron which is a good catalyst of oxidation reactions. The susceptibility of duck meat to oxidation is thus high than chicken and turkey meat.

(Major trends in research into domestic ducks recent results concerning meat quality by E. Baeza, http://74.125.153.132/search?q=cache%3ATmtWSpsOXtUJ%3Awww.animalscience.co...)

Duck meat is red and its oxidative energy metabolism is higher than in chicken and turkey meat. Lipids are therefore an important component of duck meat.
(Major trends in research into domestic ducks recent results concerning meat quality by E. Baeza, http://74.125.153.132/search?q=cache%3ATmtWSpsOXtUJ%3Awww.animalscience.co...)

Ducks consume twice as much feed as broilers during growth; therefore, duck meat is more likely to be influenced by diet than chicken meat. Duck meat has relatively high levels of unsaturated fatty acids and low levels of antioxidants (E. A. Russel et al, 2003).

Like chicken meat, duck Meat is lean (breast meat contains only 2 % fat), and rich in polyunsaturated fatty acids. However, unlike chicken meat, duck meat is red. Duck muscles contain mainly red muscle fibers (70 to 90 % in the breast). This structural characteristic determines in part the technological and sensory properties of the meat (P^H
, colour, tenderness, juiciness, flavour).(E. Baeza, Inra Production Animales, 8 (2), 117 – 125.).

In Muscovy duck ideal slaughter age is 10 and 12 weeks in female and male ducks respectively. (Major trends in research into domestic ducks recent results concerning meat quality by E. Baeza, http://74.125.153.132/search?q=cache%3ATmtWSpsOXtUJ%3Awww.animalscience.co...) Age has a major effect on muscle development. Between 8 to 15 weeks of age, the weight of breast muscle is 3.3 fold in males and 2.3 in females (Baeza et al., 1997). Fiber area and length strongly increases with age (Baeza et al., 1999). As the collagen content in breast muscle decreases during the same period while collagen solubility remains unchanged, the decrease in meat mellowness and tenderness, and increase in stringiness, may be related to fiber size (Baeza et al., 1997; 2002). Muscle levels of haeminic pigments increase with age, and the meat is therefore darker and redder (Baeza et al., 2002).

Increase in muscle lipid content increases lightness, yellowness, juice loss after cooking, tenderness and flavour of meat. The increase in lipid content of breast muscle with age may be involved in the increase in meat flavour (Baeza et al., 1997; 2000; 2002).

Brest muscle compared with thigh muscle has higher Extract Release Volume (ERV) and lower P^H. Storage at 4^OC for 120 h increased P^H value and reduced ERV. Thiobarbituric acid values increased with duration of storage. Protein percentage and ether extract of muscle increased with age.(A study on duck meat physico-chemical and chemical properties, Reddy, K. P., Reddy, P. V. V. S., Indian Veterinary Journal,
(http://www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=19921442604)

Moisture content of duck meat is 72.69 to 76.72 per cent which is not affected by breed or sex . Water holding capacity is 62.46 – 71.06 % which is also not affected by breed or sex. (A. B. Omojola, 2007). Duck breast meat had significantly higher redness (a*), but lower lightness (L*) value compared to chicken breast. During whole storage time, the a* value remained constant in duck breast. Cooking loss (%) was higher in duck breast compared to chicken breast during the whole storage time. Shear force decreased with increasing storage time in both chicken and duck breast meat, moreover, it decreased rapidly in duck breast compared to chicken breast. The TBARS values increased with increasing storage time in both duck breast and chicken breast meat and was significantly higher in duck breast. The fatty acids (%) C14:0, C16:0, C16:1, C18:2 and C18:3 were significantly higher while C18:0 was significantly lower in duck breast compared to chicken. SFA was increased, while USFA and MUSFA decreased only in duck breast during the 7 day storage time.

http://cat.inist.fr/?aModele=afficheN&cpsidt=18741157

(A comparison of meat characteristics between duck and chicken breast, SHAWKAT ALI Md. ; KANG Geun-Ho ; YANG Han-Sul ; JEONG Jin-Yeon ; HWANG Young-Hwa ; PARK Gu-Boo ; JOO Seon-Tea, Asian-australasian journal of animal sciences, 2007, vol. 20, n^o6, pp. 1002-1006)

STUDIES ON PROXIMATE COMPOSITION OF MEAT FROM *CINA HANH* (*CAIRINA MOSCHATA*) DUCKS OF ASSAM

M. ISLAM[29], J.D. MAHANTA[30*], D. SAPCOTA[31], N. BARUA[32] AND G. ZAMAN[33]

Proximate composition of meat from 12 numbers (6 males and 6 females) of adult clinically healthy *Cina hanh*, a local type of Muscovy duck of Assam was analyzed at 30 weeks of age. The results showed non-significant difference in the mean percentage of moisture, fibre, ash and phosphorus content breast meat of these ducks between sexes. However, the males had significantly ($P<0.05$) higher muscular protein (18.70 ± 1.01 *vs* $12.82 \pm 0.32\%$) and calcium (1.69 ± 0.06 *vs* $1.13 \pm 0.07\%$); whereas, the muscular fat content was just reverse (12.79 ± 0.65*vs*$15.34 \pm 0.64\%$).

Key words: Proximate composition; Meat; *Cina hanh* duck

Introduction

In India, although Muscovies (*Cairina moschata*) ducks are available in small groups in few states, this species has not gained popularity as meat producer. Muscovy varieties i.e. *Moti or Kadna* were found in hilly and tribal districts of Orissa (Sahoo *et al.,* 2005). In Assam, *Cina hanh* (*Cairina moschata*) are kept by the farmers for meat production under scavenging system of rearing. Meat of this fowl is very popular amongst the rural people of Assam. However, no study, especially on the proximate composition of meat of this duck appears to have been undertaken. Therefore, the present study was conducted to study the proximate composition of meat from *Cina hanh* ducks of Assam.

Materials and methods

A total of 12 numbers (6 males and 6 females) of adult clinically healthy Cina hanh (Muscovies) of 30 weeks of age were selected randomly from the different districts of Assam which were reared under range condition. After slaughtering the birds as per standard procedure, breast meat samples were collected to analyze for proximate composition. The moisture, protein, fat, fibre and ash content of raw meat from either sex were determined by the method of AOAC (1990). The calcium and phosphorus were determined according to the procedure of Talapatra et al. (1940). The data obtained were statistically analyzed following the methods of Snedecor and Cochran (1994).

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Results and discussion

The results of the study (Table 1) showed that the mean percentage of moisture, fibre, ash and phosphorus content of breast meat of *Cina hanh* did not differ significantly between sexes. However, significant (P<0.05) differences existed between male and female in respect of protein (18.70 ± 1.01 and 12.82 ± 0.32%), fat (12.79 ± 0.65 and 15.34 ± 0.64%) and calcium (1.69 ± 0.06 and 1.13 ± 0.07%) content, respectively. The sex had a significant influence on the chemical composition of breast meat. Similar observations were made by Guerzilov (1999) and Steklenov (1999) on Muscovy ducks and Isguzar *et al*. (2003) in Turkish Pekin ducks. In contrary to the present findings higher percentages of protein, fat and moisture were recorded in breast meat of Muscovies slaughtered at 12 weeks of age by Salichon *et al*. (1997).

The data on protein, fat and moisture recorded in the present study were found to be lower as compared to the observations made by some earlier workers (Salichon *et al*., 1997; Guerzilov, 1999 and Steklenov, 1999). This might be due to the effects of certain inherent factors like feeding, rearing system, slaughter age and genetic make up of the birds. Perhaps due to lower percentage of fat, the meat of *Cina hanh* has been enjoying the patronage of meat consumers in the area under study.

Table 1. Mean ± SE of proximate composition of meat of *Cina hanh* (Muscovy duck)

Parameters (%)	Male	Female
Moisture	73.780 ± 0339	71.920± 1.060
Protein	18.700 ± 1.010^{a}	12.820 ± 0.320^{b}
Fat	12.790 ± 0.650^{a}	15.340 ± 0.640^{b}
Fibre	1.650 ± 0.140	1.770 ± 0.180
Ash	4.230 ± 0.320	3.830 ± 0.390
Calcium	1.693 ± 0.066^{a}	1.134 ± 0.078^{b}
Phosphorus	0.708 ± 0.082	0.615 ± 0.042

Means bearing different superscripts within row differ significantly (P<0.05)

Acknowledgement

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PHYSICAL CHARACTERISTICS OF CHARA-CHEMBALLI DUCK EGGS UNDER RANGE CONDITION IN ASSAM

J.D.MAHANTA[34]*, RAJ J. DEKA[35], D. SAPCOTA[36] AND A. JALALUDEEN[37]

A total of 120 eggs of Chara-Chemballi ducks aged 40 to 52 weeks were evaluated to study different egg quality traits under range condition in Assam. The average means for egg weight, shape index, specific gravity, albumen index, albumen weight, yolk index, yolk weight, Haugh unit, shell weight, shell thickness, albumen pH and yolk pH were recorded to be 69.86 ± 1.06 g, 74.23 ± 2.21, 1.089 ± 0.001, 0.112 ± 0.002, 35.03 ± 1.27 g, 0.41 ± 0.04, 25.14 ± 1.20 g, 91.52 ± 2.32, 9.02 ± 0.28 g, 0.41 ± 0.02 mm, 9.2 ± 0.17 and 5.8 ± 0.1, respectively.

Key words: Chara-Chemballi ducks; Egg quality

Introduction

Chara-Chemballi is one of the popular varieties of duck which is native of Kerala. These ducks were introduced to the state of Assam by the State Institute of Rural Development, Govt. of Assam in the year 2003. At present these are flourishing in the hands of about 2352 women Self Help Groups (SHGs) located in different districts of Assam. It has been reported that the average annual income of nearby 1600 SHGs was Rs. 9.60 crores with a collection of more than 2 lacs of eggs per day through backyard farming (Anon, 2005-06). The physical quality characteristics of eggs from Chara-Chemballi reared under semi-intensive system of rearing were evaluated in Kerala (Mahanta et al., 1998). The investigation under report deals with the egg quality traits of Chara-Chemballi ducks reared under range condition in Assam.

Materials and Methods

A random sample of 120 eggs from Chara-Chemballi duck aged between 40 to 52 weeks reared by different SHGs of Assam constituted the material for the present study. The collection and evaluation was done on the same day of laying. Eggs were weighed individually up to 0.01 g. Shape index, specific gravity, albumen index and yolk index were determined as per the method of Shultz (1953), Bernier (1955), Heiman and Carver (1936) and Funk (1948), respectively. Haugh unit score was measured as per Haugh (1937). The shell thickness (without membrane) for an egg was the average of 3 different screw gauze readings. The individual weight of albumen, yolk and shell with membrane were recorded. The pH of albumen and yolk were measured with the help of pH indicator paper. Statistical analysis of data was done according to Snedecor and Cochran (1990).

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Results and discussion

The means for different egg quality traits are presented in Table 1. The mean egg weight of the Chara-Chemballi duck (69.86 ± 1.06 g) as observed in the present study was higher than the reported values (60.54, 60.55, 60.55 and 62.45 g) in *desi* ducks of Kerala (Andrews, 1978) and Assam (Mahanta *et al*., 1993; Mahanta *et al*., 2001and Sharma *et al*., 2002). However, the present egg weight agrees closely with the findings (68.86 g, 69.69 g, and 71.43 g) of George *et al*. (1980), Mahanta *et al*. (1998) and Senani *et al.* (2005) in desi, Chemballi and Chara-Chemballi ducks of Kerala, respectively.

The mean shape index of the present study was similar with the value (74.05) reported by Senani *et al*. (2005) in Chara-Chemballi in Andaman Islands. However, higher shape indices (75.32 and 75.45) were recorded by Eswaran et al. (1985) and Mahanta et al. (1998) in indigenous ducks of Kerala and lower shape indices (72.99, 72.82 and 71.95) were observed by George *et al*. (1980), Mahanta *et al*. (1993) and Sharma *et al*. (2002), respectively. The mean specific gravity value of the present investigation was similar with the reports of Mahanta *et al*. (1998) and Sharma *et. al*. (2002) in Chara and Chemballi of Kerala and Nageswari of Assam, respectively.

The present mean values for albumen index, yolk index and Haugh unit score of Chara-Chemballi duck were comparable to the observed values in such ducks in Kerala as reported by Mahanta *et al*. (1998). Comparatively higher and lower values for albumen (0.586) and yolk indices (0.367), respectively was reported in Chara-Chemballi ducks in Andaman Islands (Senani *et al*., 2005). Of the total egg weight, the egg shell was 9.02 g, albumen 35.03g and yolk 25.14g. The mean shell thickness (0.41 ± 0.02 mm) obtained in the present study was higher than the findings (0.38 mm and 0.39 mm) of Mahanta *et al*. (1998) and Shama *et al.* (2002), respectively. However, Senani *et al*. (2005) recorded much higher shell thickness (0.47 mm) in Chara- Chemballi ducks in Andaman Islands. The mean albumen and yolk pH of the present study were found to be comparable with the findings of Senani *et al*. (2005) in Andaman Islands.

The egg shell colour of Chara–Chemballi ducks under investigation was white, whereas Nageswari ducks of Assam (Sharma *et al*., 2002) lay greenish blue colour eggs. This might be due to the inherent characteristics of the breeds used.

Table 1. Mean (± S.E.) egg quality traits of Chara-Chemballi duck

Parameter	Value
Egg weight (g)	69.86 ± 1.06
Shape index	74.23 ± 2.21
Specific gravity	1.089 ± 0.001
Albumen index	0.112 ± 0.002
Albumen weight (g)	35.03 ± 1.27
Yolk index	0.41 ± 0.04
Yolk weight (g)	25.14 ± 1.20
Haugh unit score	91.52 ± 2.32
Shell weight (g)	9.02 ± 0.28
Shell thickness (mm)	0.41 ± 0.02
Albumen pH	9.2 ± 0.17
Yolk pH	5.8 ± 0.1

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EFFECT OF PRESERVATION METHODS ON DUCK EGG QUALITY

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Abstract

Ducks play an important role in the economy of rural people in our country. Duck rearing is practised by poor rural farmers and agricultural landless labourers in Tamilnadu. At present, there is an increase in the consumer awareness for the quality of a product to be purchased. Eventhough eggs are classified as perishable item, quality fetches it optimum price. Though duck eggs are produced in large quantity in various duck pockets of Tamilnadu, they are mainly transported to Kerala for marketing. The egg quality deteriorates during transit from the point of production to the consumption. In order to assess the quality of duck eggs, an experiment was conducted based on preservation methods for a period of four weeks. Three hundred freshly laid duck eggs were procured from the field duck units at Uthiramerur. They have been subjected to five treatments such as control (T_1), lime sealing (T_2), water glass method (T_3) and vegetable oil coating with washing (T_4) and without washing (T_5). Every week twelve eggs from each treatment were subjected to quality studies. The results revealed non-significant difference among treatments in egg quality parameters like egg weight, shape index, air cell depth, albumin index, yolk index and shell thickness. But, highly significant ($p<0.01$) differences were observed in parameters like air cell depth and shell thickness among weeks. Based on the results of this study, it can be concluded that duck eggs from the field duck units in Tamilnadu have to be marketed to Kerala or distant places within ten days from the date of egg laying at room temperature without subjecting to any preservation method.

Key words: Tamilnadu, duck eggs, preservation methods, lime sealing, waterglass, oiling and internal quality

Introduction

Ducks play an important role in the economy of rural people in our country. India has a total population of 22.08 million ducks concentrated mainly in the coastal regions of India, especially Assam, West Bengal, Orissa, Tamilnadu and Kerala. Duck rearing is practiced by poor rural farmers and agricultural landless labourers in Tamilnadu. At present, there is an increase in the consumer awareness for the quality of a product to be purchased. Eventhough eggs are classified as perishable item, quality fetches it optimum price. Though duck eggs are produced in large quantity in various duck pockets of Tamilnadu, they are mainly transported to Kerala for marketing. The egg quality deteriorates during transit from the production to the consumption. In order to assess the quality of duck eggs, an experiment was conducted based on preservation methods for a period of four weeks.

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Materials and methods

A total of three hundred freshly laid duck eggs were procured from the field duck units at Uthiramerur taluk of Kancheepuram district in Tamilnadu.. They have been subjected to five treatments

such as control (T_1), lime sealing (T_2), water glass method (T_3) and vegetable oil coating with washing (T_4) and without washing (T_5).In lime sealing method, one litre of boiling water was added to one kg of quick lime. The fluid was brought to room temperature and 4-5 litres of cold water and 225g of Table salt were added to it. After precipitation, the solution was drained.The duck eggs were immersed in this clear fluid for 16 hours and taken out. Eggs were dried out and transferred to filler flats. In water glass method, one part of sodium silicate was added to ten parts of water and eggs were immersed in the mixture and taken out. Oiling method involved spraying the eggs with groundnut oil, allowing them to drain before placing in egg flats and storing at room temperature. The eggs were washed in water and then they were sprayed with oil (T_4) and the eggs belonging to T_5 group were not washed with water but sprayed with oil only. Each treatment consisted of 60 eggs. Every week twelve eggs per each treatment were subjected to quality studies. The quality parameters such as egg weight, shape index air cell depth, albumen index, yolk index and shell thickness have been studied as recommended by Mountney (1976) and subjected to statistical analysis as per Snedecor and Cochran (1989)

Results

1. **Egg Weight**

The mean egg weight values for different treatments were furnished in the Table 1. It was observed that though there was no significant difference in egg weight among treatments and among weeks, numerical differences were observed among weeks.

Table 1. Egg weight (Mean ± S.E.) as influenced by different reservation methods n=12

Weeks/ Treatments	Control (T_1)	Lime sealing (T_2)	Water glass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day	61.73±1.30	62.85±1.33	62.47±1.71	63.22±1.32	63.93±1.41
I week	61.34±1.33	60.61±1.52	62.73±1.24	60.73±1.17	61.41±1.10
II week	60.72±1.45	60.47±1.26	62.31±1.85	58.59±1.21	60.48±0.89
III week	59.78±1.35	58.33±1.08	62.20±1.43	58.53±1.06	59.97±0.95
IV week	56.96±1.19	56.98±1.21	62.06±1.30	57.39±1.17	59.32±1.48

The values were not significant among weeks and treatments

2. **Shape Index**

The mean shape index values for different treatments were furnished in the Table 2. It was observed that there was no significant difference in shape index among treatments and among weeks.

Table 2. Shape index (Mean ± S.E.) as influenced by different preservation methods n=12

Weeks/ Treatments	Control (T_1)	Lime sealing (T_2)	Water glass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day	74.93±0.65	73.86±0.80	75.20±0.65	74.32±1.15	74.82±0.84
I week	74.80±0.69	73.88±0.43	74.94±0.89	74.27±0.75	74.32±1.79
II week	74.27±0.46	73.42±0.87	74.77±0.77	74.07±0.44	73.49±0.72
III week	73.45±0.47	73.03±0.48	73.38±0.60	73.62±0.81	73.42±0.60
IV week	73.36±0.92	72.89±0.67	72.47±0.73	72.55±0.60	72.42±0.45

The values were not significant among weeks and treatments

3. Air Cell Depth

The mean air cell depth values for different treatments were furnished in the Table 3. It was found that highly significant ($P < 0.01$) differences were observed among weeks and no significant differences were noticed among treatments.

Table 3. Air cell depth (Mean ± S.E.) as influenced by different preservation methods n=12

Weeks/ Treatments	Control (T_1)	Lime sealing (T_2)	Water glass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day **	1.75±0.13	1.50±0.15	1.50±0.15	1.25±0.13	1.67±0.14
I week **	3.67±0.22	4±0.21	4.33±0.19	3.83±0.21	3.25±0.13
II week **	5.33±0.28	4.75±0.30	4.50±0.19	4.17±0.11	4.50±0.19
III week **	5.42±0.31	5.50±0.15	5.25±0.13	5.08±0.31	5.25±0.28
IV week **	6.75±0.13	5.58±0.42	6.50±0.47	5.58±0.45	5.75±0.13

The values were not significant among treatments

** - highly significant

4. Albumen Index

The mean albumen indices for different treatments were furnished in the Table 4. It was observed that no significant differences were noticed among treatments and among weeks. The albumen index values were measured up to two weeks only, because after two weeks, the duck eggs were spoiled and not able to study the albumen quality

Table 4. Mean albumen index as influenced by different preservation Methods n=12

Weeks/ Treatments	Control (T_1)	Lime sealing (T_2)	Water glass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day	0.12	0.14	0.13	0.15	0.14
I week	0.13	0.15	0.15	0.15	0.14
II week	0.16	0.16	0.19	♦	♦
III week	♦				
IV week	♦				

♦ - The eggs were spoiled on storage

5. Yolk Index

The mean yolk index values for different treatments were furnished in the Table 5. It was noticed that no significant differences were observed among treatments and among weeks. The yolk index values were measured up to two weeks only, because after two weeks, the duck eggs were spoiled and not able to study the yolk quality

Table 5. Mean yolk index as influenced by different preservation methods n=12

Weeks/ Treatments	Control (T_1)	Limesealing (T_2)	Waterglass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day	0.30	0.39	0.41	0.42	0.42
I week	0.29	0.36	0.35	0.38	0.38
II week	0.26	0.22	0.27	♦	♦
III week	♦				
IV week	♦				

♦ - The eggs were spoiled on storage

6. Shell thickness

The mean shell thickness values for different treatments were furnished in the Table 6. It was noticed that highly significant differences were observed among weeks and no significant differences were noticed among treatments.

Table 6. Mean (± S.E.) shell thickness as influenced by different preservation methods n=12

Weeks/ Treatments	Control (T_1)	Limesealing (T_2)	Waterglass (T_3)	Oil coating with washing (T_4)	Oil coating without washing (T_5)
O day**	1.292±0.29	1.325±0.76	1.483±0.30	1.483±0.51	1.433±0.40
I week**	1.258±0.15	1.325±0.25	1.300±0.25	1.292±0.26	1.325±0.25
II week**	1.258±0.19	1.258±0.15	1.267±0.19	1.267±0.14	1.267±0.14
III week**	1.242±0.15	1.250±0.19	1.267±0.14	1.233±0.14	1.225±0.13
IV week**	1.233±0.50	1.183±0.63	1.242±0.23	1.217±0.24	1.225±0.22

The values were not significant among treatments

** - highly significant

Discussion

1. Egg weight

It was observed that though there was no significant difference in egg weight among treatments and among weeks, numerical differences were observed among weeks. This is in agreement with the reports of Quadratulla *et al.* (2005) who reported that loss of duck egg weight was significantly higher on eggs washed with plain water than other water treatments such as washing in water containing antimicrobial agents like Eco-Kill (0.2 g / lit) or hydrogen peroxide (6g / lit) or chloramphenicol (2 mg / lit) on duck egg shell on 0, 3, 6 and 9 days of storage periods. Sharma *et al.* (2002) recorded average egg weight of ducks as 62.45 ± 0.45 g which is found to be higher than control eggs but lower than other treatments on the day of laying. Mahanta *et al.* (1993) also recorded lower egg weight (60.55 ± 0.29 g) of indigenous ducks than all the treatments in this study including control eggs. But, Okruszek *et al.* (2006) recorded higher duck egg weight values (70.64 g) in Orphington ducks and 72.46 g in Orphington X Khaki Campbell crossbred ducks.

2. Shape Index

It was noticed that the shape index values ranged from 73.86 to 75.20 at 0 day and from 72.42 to 73.36 at 28th day of storage of duck eggs. Nageswara *et al.* (2003) recorded slightly higher shape index values of 76.5 in indigenous ducks under traditional management but Mahanta *et al.* (1993) and Sharma

et al. (2002) recorded lower shape index values of 72.82 in Pati ducks and 71.96 in Nageswari duck eggs, respectively than the values obtained in this study. Okruszek *et al.* (2006) also noticed slightly lower shape index values of 72.22 in Orphington ducks and 72.58 in Orphington X Khaki Campbell crossbred ducks.

3. Air cell depth

It was observed that the highly significant differences ($P < 0.01$) were noticed among weeks as the age of the duck eggs advanced towards 28th day and no significant differences among treatments. Air cell depth of duck eggs increased from the time of laying (0 day) to 28th day on all the preservation methods.

4. Albumen index

It was found that albumen index values ranged from 0.12 (soon after time of laying) to 0.16 (second week) in duck eggs of this study. Nageswara *et al.* (2003) recorded lower albumen index value of 0.096 in the indigenous ducks than the values obtained in all the treatments in this study. Sharma *et al.* (2002) also recorded similar lower albumen index value of 0.071 in Nageswari duck eggs in their study. But Mahanta *et al.* (1993) obtained albumen index value of 0.114 close to the values of this study. In a recent study, on the quality of Orphington and Orphington X Khaki Campbell crossbred duck eggs, Okruszek *et al.* (2006) also observed albumen index value of 0.08 and 0.07, respectively in Orphington and Orphington X Khaki Campbell crossbred duck eggs.

5. Yolk Index

It was noticed that as age of duck eggs advanced, yolk index values decreased from 0.30 to 0.26 in control and 0.42 to 0.38 in oil coating method. This is in accordance with the findings of Raji *et al.* (2004) who observed that yolk index decreased with increase in storage time of eggs of laying hens. Nageswara *et al.* (2003) also recorded a slightly close value of yolk index of 0.425 in indigenous ducks in their study when compared to duck eggs coated with vegeTable oil at the time of laying. Sharma *et al.* (2002) recorded a higher yolk index value of 0.43.

6. Shell thickness

It was observed that shell thickness values ranged from 1.23 to 1.48 mm in this study. Nageswara *et al.* (2003) recorded lower shell thickness values of 0.338 mm in indigenous duck eggs under traditional management system than the values obtained in this study. Sharma *et al.* (2002) also observed lower shell thickness values of 0.395 mm when compared to this study. Mahanta *et al.* (1993) recorded shell thickness value of 0.34mm in Pati duck eggs. Okruszek *et al.* (2006) also observed shell thickness value

of 0.65 and 0.67, respectively in Orphington and Orphington X Khaki Campbell crossbred duck eggs in their study.

Conclusion

It was observed from the study that egg weight, shape index and yolk indices decreased with increase in storage time. The results revealed non-significant difference among treatments in egg quality parameters like egg weight, shape index, air cell depth, albumin index, yolk index and shell thickness. But, highly significant ($p<0.01$) differences were observed in parameters like air cell depth and shell thickness among weeks. Since the eggs were spoiled after two weeks in all the treatment groups, it can be concluded that duck eggs from the field duck units in Tamilnadu have to be marketed to Kerala or distant places within ten days from the date of egg laying at room temperature without subjecting to any preservation method.

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EXTERNAL AND INTERNAL QUALITY CHARACTERISTICS OF MARKET DUCK EGGS IN CHENNAI METRO

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Abstract

A study was carried out to evaluate the external and internal quality characteristics of market duck eggs in Chennai metro. Twenty four fresh duck eggs available in the commercial market were procured during the period of April-2009 and subjected for external and internal quality evaluation. The results revealed that the mean egg weight, length, width and volume were 59.67 ±0.85 g, 58.02 ± 0.45 mm, 43.17 ±0.32 mm and 52.67 ± 0.54 ml respectively. The shape index, specific gravity and surface area were 74.46± 0.86, 1.13± 0.01 and 80.65±0.79 sq.cm respectively. The mean albumen and yolk heights were 6.37± 0.25 and 17.70 ±0.33 mm. The mean albumen length and width, yolk width were 84.70 ±2.13 and 59.16 ±1.77 mm, 48.44±0.99 mm respectively. The mean albumen and yolk index were 0.09±0.01 and 0.37 ±0.01.The mean albumen, yolk, and shell weights were 31.08 ±1.29, 23.22± 1.33 and 5.37±0.08 g respectively. The mean Haugh unit score was 78.99 ± 1.74. The mean percent albumen, yolk and shell weight to egg weight were 52.12-±2.11, 38.87 ± 2.10 and 9.01 ±0.14 respectively. The mean shell thickness was 0.38± 0.01 mm. The mean yolk colour score was 10.08 ±1.05

Key words: Duck egg, egg quality traits

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Introduction

India has 4000 kilometers long coastal and extensive water shed areas in several parts of the country offer excellent natural habitat for ducks. Ducks occupy the second position among the domesticated poultry. Ducks are valued for their versatility and adaptability and they exhibit rapid growth rates and produce heavier table birds more quickly than chicken. Apart from being good source of eggs and meat for humane consumption .Of the 500 million plus ducks reared world wide, almost 90% are Asia-Pacific region. In India indigenous ducks contribute about 90% of the total duck population. Although most breeds used are relatively poor layers, the flocks should be managed to save the eggs produced for food purpose. The popularity of duck farming has been gaining momentum day-by-day especially in the states like Assam, West Bengal,Kerala,Tripura and Tamil Nadu.In abroad , ducks are reared for meat purpose , whereas in India these are primarily raised for egg production. Duck population increased gradually from 9 million to 29.96 million during the last thirty years and which is 6.13 percent of total poultry population in the country (GOI, 2006). In India, duck rearing is practiced as a profitable traditional backyard enterprise and continues the livelihood preposition of several poor rural farmers. Duck eggs contain nutrients in a well balanced ratio; it also contains unsaturated fatty acids which help in the control of

cholesterol. In addition to its nutritional qualities, people prefer duck egg because of their opinion that it has certain inherent medicinal properties. The effect of duck age on egg quality was dealt with Yannakopoulos and Tserveni-Gonsi (1987). Davis *et al.* (1993) investigated the effect of temperature and season on the quality of duck eggs, while Minh *et al.* (2000) determined quality characters of Khaki

Campbell duck eggs, and also developed a method of duck egg storage for humane consumption during which the egg quality deteriorates only slightly. In this connection, a study was designed to assess the external and internal quality characteristics of market duck eggs in Chennai city

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Materials and methods

Twenty Four number of fresh duck eggs were purchased from two different places of egg market in Chennai city. In the same day of collection, these eggs were subjected to external and internal qualities assessment at Department of poultry science, Madras Veterinary College, Chennai-7. In the external quality parameters, egg weight, length, width of the egg were recorded and shape index, specific gravity and surface area were calculated. In internal quality characteristics, height of albumen and yolk , length and width of albumen and yolk, weight of albumen, yolk and shell, yolk color score, egg shell thickness were recorded and albumen index, yolk index, Haugh unit , proportion of different egg components to egg weight to were calculated.

Results and Discussion

The external quality parameters of the market duck eggs of Chennai city were presented in Table.1

Table. 1 External characteristics of Market Duck Egg

Sl.No.	Traits	Mean ± S.E
1	Egg weight (g)	59.67 ± 0.85
2	Egg length (mm)	58.02 ± 0.45
3	Egg width (mm)	43.17 ± 0.32
4	Volume ((ml)	52.67 ± 0.54
5	Shape Index	74.46 ± 0.86
6	Specific gravity	1.13 ± 0.01
7	Surface area (sq.cm)	80.65 ± 0.79

The mean egg weight recorded in the present in the study was slightly lesser than the values reported by Abraham and Ravindran (2009) of 66.1± 0.98 The average egg weight of Khaki Campbell(58.55) was closely in agreement the recorded value (Reddy *et al* :1979) This value is also closely to indigenous duck(Pati) of Assam (60.55±0.29) Mahanta *et al*(1993).The reported shape index desi duck eggs were 72.82 ± 0.46 of Mahanta *et al* (1993) , 72.9 of George *et al* (1980) and 74.16 ±1.08 of Padhi *et al* (2009) and the recorded value in the present study was also in this range. Specific gravity recorded in this study (1.13± 0.01) was also comparable with the value reported by Mahanta *et al* (1993) for indigenous ducks of Assam (1.11± 0.006).Egg shell surface area recorded in this study (80.65± 0.79) was closely related to finding of Kokoszynski *et al* (2007), 88.3. The internal quality parameters of the market duck eggs of Chennai city were presented in Table.2

Table. 2 Internal Quality characteristics of Market Duck Egg

Sl.No.	Traits	Mean ± S.E
1	Albumen height(mm)	6.37 ± 0.25
2	Albumen length(mm)	84.70 ± 2.13
3	Albumen width (mm)	59.16 ± 1.77
4	Albumen Index	0.09 ± 0.01
5	Yolk height (mm)	17.70 ± 0.32
6	Yolk width(mm)	48.44 ± 0.99
7	Yolk Index	0.37 ± 0.01
8	Albumen weight (g)	31.08 ±1.29
9	Albumen (%)	52.12 ± 2.11
10	Yolk weight (g)	23.22 ± 1.33
11	Yolk (%)	38.87 ± 2.10
12	Shell weight (g)	5.37 ± 0.08
13	Shell (%)	9.01 ± 0.14
14	Shell thickness (mm)	0.38 ± 0.01
15	Haugh unit	78.99 ± 1.74
16	Yolk colour	10.08 ±1.05

Albumen index of this study was higher than the values reported by Abraham and Ravindran (2009) of market duck egg and slightly lower than Mahanta *et al* (1993) and Padhi *et al* (2009). In this study yolk index value was lower than Mahanta *et al* (1993) and Padhi *et al* (2009); this value is slightly higher than Abraham and Ravindran (2009) of market duck egg.

Albumen percent of this study was closely in agreement with the values reported by Mahanta *et al* (1993) and Padhi *et al* (2009) for indigenous ducks. Percent yolk of this study was closely related to Panda *et al* (1984) and Padhi *et al* (2009) and it is higher than the value 28.67 ±0.15 of Mahanta *et al* (1993).

Egg shell percent of this study was similar to the values reported by Panda *et al* (1984), lower than the value of (12.11 ±0.10) Mahanta *et al* (1993) and Padhi *et al* (2009). Shell thickness of this study was slightly higher than Mahanta *et al* (1993), Panda *et al* (1984) and similar to Abraham and Ravindran (2009). Haugh unit of the present study was lower than value (94 .08± 0.52) reported by Mahanta *et al* (1993).Yolk colour of this study was lower than value(8.56± 0.00) reported by Niranjan *et al* (2008) in Vanaraja chicken at 32 weeks of age

Conclusion

In this study the market duck egg weight is lower than other research worker. The albumen index and Yolk index value is almost similar to other worker and Haugh Unit is slightly lower. Percent albumen is similar to other researchers reported value, percent yolk is higher than other research workers findings and percent shell is lower than others. So duck egg quality of Chennai city quality is good.

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NUTRIENT COMPOSITION OF DUCK EGG AND MEAT

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Egg is the most nutritious, natural, unadulterated and easily digestible food on earth with high biological value, net protein value and net protein utilization. Duck eggs are larger than those laid by chickens, and have a higher fat, calcium, iron, phosphorus, selenium, Pantothenic acid and Vitamin A content. Duck egg white tends to be more gelatinous and the yolks are a brighter yellow. Duck meat is usually consumed less frequently than meat such as chicken, beef or pork. Duck leg meat (thigh + drumstick), with or without skin or duck breast without skin contain relatively low levels of fat and calories and compare favorably, even to chicken and turkey. Nutrient content of duck egg and meat are compared with other species of poultry.

Key word: Nutrient, values, duck egg and duck meat

Milk is an animal product and cannot be by any means, be included in a strict vegetarian diet. It serves the purpose of meat to a large extent. In medical languages, it is classified as animal food. A Layman does not consider milk to be animal food. On the other hand, eggs are regarded by Layman as a flesh-food. In reality, they are not. Nowdays, sterile eggs are also produced. The hen is not allowed to see the cock and yet is lays eggs. A sterile-egg never develops into a chick. Therefore, he who can take milk should have no objection to taking sterile-eggs"

- Mahathma Gandhi

Introduction

Egg is the most nutritious, unadulterated, yet relatively cheaper, natural food, with highest digestibility coefficient. The egg protein is the best protein available in nature for human consumption, with well balanced amino acid profile, having the highest biological value, protein efficiency ratio, net protein utilization, net protein value and chemical score. It is the golden standard to measure the quality and nutritive value of any other human food. Besides high protein quality, it is rich in all essential vitamins and minerals, except vitamin C.

Taste, nutritional value, availability, and the minimum cost make eggs universally popular. Due to the taste, ease, and flexibility of cooking, egg preparations are a favourite among bachelors and working couples. This traditional breakfast food is also consumed in different forms throughout the day and there are appreciable numbers of "eggetariens" among the vegetarians. Even though the egg is nutritionally superior, its cost is relatively cheaper, due to low cost egg production technology. Hence, the egg is within the reach of the poor people, even in developing countries and available in plenty everywhere. An egg is cheaper than a cup of coffee, tea or soft drinks yet far superior to them nutritionally. The egg is available round the year at uniformly low cost unlike many seasonal vegetables and fruits.

Ducks Eggs consist of complete nutrients and easy to be absorbed by the body. Ducks eggs as an alternative choice for consume eggs than chicken eggs as sources of protein beside fish and milk.

Eggs are the ideal nutritive food for the ill and convalescent patients. Those who suffer from gastrointestinal tract disorders, particularly in diseases of the colon, for children, pregnant and feeding mother eggs are the best food because of their nutritional value and lack of residue. The British Heart Foundation recommends eating no more than four eggs a week. But the World Health Organisation however suggests an upper limit of ten eggs per week from all sources including biscuits, cakes and sauce.

The body requires different amounts of each vitamin and mineral because each has a different function. People have different requirements according to their age, sex, level of activity and state of health. Eggs contain some of most of the recognized vitamins and minerals that help to maintain essential bodily functions. There is also evidence that other substances found in eggs but are not classified as nutrients – the lutein zeaxanthin and anti-oxidants etc.

Nutrient composition of Duck egg

Gross composition of eggs from different species of Poultry is given in Table No.1. Albumen, yolk and shell percentage of various poultry species varies from 52-58, 32-35 and 9-14 respectively.

Table No. 1 Gross composition of eggs from different species of Poultry

Species	Weight (g)	Albumen %	Yolk %	Shell %	Length (cm)	Breadth (cm)
Chicken	58	56	32	12	507	4.2
Turkey	85	53	33	14	6.6	4.8
G. Fowl	40	52	35	13	4.9	3.7
Pheasant	32	53	35	12	4.4	3.5
J. Quail	9	58	33	9	3.2	2.4
Goose	155	56	32	12	8.7	6.1
Pekin	92	57	33	10	6.6	4.8
Muscovy	80	53	35	12	6.2	4.5
Source : Etches, 1996						

Nutrient composition of different species of poultry egg is presented in Table No.3. Water content of Duck, Goose, Turkey and quail eggs are 70.83, 70.43, 75.33, 72.5 and 74.35 respectively. Duck and goose eggs having higher energy value followed by Turkey, Quail and Chicken egg.

Table No. 2 Nutrient content of eggs: comparison (Per 100 g)

S.No	Nutrients	Chicken	Duck	Remarks
1	Water (g)	75.33	70.83	Less water is better
2	Energy (KCal)	149	185	More energy, dense food
3	Protein (g)	12.49	12.81	better protein
4	Fat (g)	10.02	13.77	Better Fats
5	Carbohydrate (g)	1.22	1.45	Packed with nutrients
6	Minerals (mg)	486.58	674.36	Lots of extras
7	Vitamin B_6 (mg)	0.139	0.25	2x as much
8	Amino acids (g)	12.49	12.99	more amino acids
9	Pantothenic acid (mg)	1.255	1.862	2 fold higher
10	Riboflavin (mg)	0.508	0.404	lower
11	Thiamin (mg)	0.062	0.156	2 fold higher
12	Vitamin A (IU)	635	1328	2 fold higher
13	Niacin (mg)	0.073	0.20	3 fold higher
14	Vitamin B_{12} (mcg)	1.00	5.40	5 fold higher

Table No. 3 Nutrient composition of different species of poultry egg

S. No.	Nutrient (100 g)	Duck	Goose	Chicken	Turkey	Japanese Quail
1	Water content %	70.83	70.43	75.33	72.5	74.35
2	Calories (kcals)	185	185	149	171	158
3	Protein content %	12.81	13.87	12.49	13.68	13.05
4	Fat content %	13.77	13.27	10.02	11.88	11.09
5	Ash content %	1.14	1.08	1.0	0.79	1.1
6	Cholesterol (mg)	621	1226	201	747	76

Eggs are an excellent source of protein. Egg protein is of high biological value as it contains all the essential amino acids needed by the human body. Eggs therefore complement other food proteins of lower biological value by providing the amino acids that are in short supply in those foods. 12.5% of the weight of the egg is protein and it is found in both the yolk and the albumen. Although protein is more concentrated around the yolk, there is in fact more protein in the albumen. On the evaluation scale most commonly used for assessing protein, egg is at the highest point, 100, and is used as the reference standard against which all other foods are assessed. Goose egg is having the higher protein content followed by Turkey, quail, duck and chicken egg. Duck is having higher value of fat content, where as Goose is having higher values of Cholesterol content.

Table No. 4 Vitamins composition of different species of poultry eggs

S. No	Nutrient (100 g)	Duck	Goose	Chicken	Turkey	Japanese Quail
1	Thiamin (mg)	0.156	0.147	0.062	0.11	0.13
2	Riboflavin (mg)	0.404	0.382	0.508	0.47	0.79
3	Niacin (mg)	0.2	0.189	0.073	0.024	0.15
4	Pantothenic Acid (mg)	1.862	1.759	1.255	1.889	1.761
5	Vitamin B_6 (mg)	0.250	0.236	0.139	0.131	0.15
6	Folate (µg)	80	76	44	71	66
7	Vitamin B_{12} (µg)	5.4	5.1	1.00	1.69	1.58
8	Vitamin A IU	194	187	169	166	156
9	Vitamin E (µg)	1.34	1.29	1.03	-	1.08

Eggs contain most of the recognized vitamins with the exception of vitamin C. The egg is a source of all the B vitamins. It is a particularly rich source of vitamins B_{12} and B_2 (riboflavin) and a useful source of folate. The egg is also a good source of the fat-soluble vitamins A and D and vitamin E. Vitamins composition of different species of poultry egg is given in Table No.4. Duck egg is having highest Vitamin A, Vitamin E, Thiamin, Niacin, Vitamin B_6, folate and Vitamin B_{12} content when compared to other species of Poultry.

Table No. 5 Mineral composition of different species of poultry eggs

S. No	Nutrient (100 g)	Duck	Goose	Chicken	Turkey	Japanese Quail
1	Calcium (mg)	64	60	50	99	64
2	Iron (mg)	3.85	3.64	1.19	4.1	3.65
3	Magnesium (mg)	17	16	10	13	13
4	Phosphorus (mg)	220	208	172	170	226
5	Potassium (mg)	222	210	126	142	132
6	Sodium (mg)	146	138	124	151	141
7	Zinc (mg)	1.41	1.33	1.05	1.58	1.47
8	Copper (mg)	0.062	0.062	0.013	0.062	0.062
9	Manganese (mg)	0.038	0.038	0.026	0.038	0.038
10	Selenium (µ g)	36.4	36.9	30.8	34.3	32

Eggs contain many of the minerals that the human body requires for health. In particular eggs are an excellent source of iodine, required to make the thyroid hormone, and phosphorus required for bone health. The egg is a significant source of selenium, an important antioxidant and provides some zinc, important for wound healing, growth and fighting infection. Eggs also contain iron, the vital ingredient of red blood cells, although the availability of this iron to the body is still being investigated. Mineral composition of different species of poultry egg is presented in Table No. 5. Duck eggs having higher value of Iron, Magnesium, Potassium when compare to chicken egg.

Eggs also contain cholesterol and lecithin, which are fat-like substances that are essential to the structure and function of all cells in the body. However these substances are not dietary essentials, as our bodies are able to synthesize them. Cholesterol helps to maintain the flexibility and permeability of cell membranes and is also a raw material for the fatty lubricants that help to keep the skin supple. Cholesterol is essential for the production of sex hormones, cortisol, vitamin D and bile salts. Eggs are also rich in choline, an essential component of all cells. Recent research suggests that choline may have a role in normal development of memory.

CHOLESTEROL PHOBIA

The cholesterol phobia has scared the people all over the work until 1990 resulting in a significant drop in egg consumption in several developed countries from 400 to 200 per year, between 1940 to 1990.

Several workers have established beyond any doubt that dietary cholesterol had no significant correlation with the serum cholesterol levels. They have also identified more than 200 factors for elevated serum cholesterol levels: out of which more than 75% are non-dietary causes.

Epidemiological evidences have reveled that Eskimos, who are consuming the highest cholesterol in the world (> 1000 mg / day) are having the lowest incident of CVD. People in France, Japan, Maxico, China and Spain who are consuming more than 300 eggs per person per annum are also having lesser incidence of elevated serum cholesterol and CVD compared to others.

Latest advice on cholesterol and eggs

In the past, it was thought that people should limit the number of eggs they eat because they contain dietary cholesterol, but recommendations on limiting egg consumption have now been relaxed by heart and health advisory groups in both the US and UK including the British Heart Foundation and the Food Standards Agency.

Over 30 years of prospective epidemiological surveys of CHD risk have consistently found no independent relationship between dietary cholesterol or egg consumption and CHD risk . In addition, there is strong evidence showing that the effects of cholesterol-rich foods on blood cholesterol are small and clinically insignificant in comparison with the effects of dietary saturated fatty acids (SFA). SFA influence the level of circulating low density lipoprotein (LDL)-cholesterol to a much greater extent than dietary cholesterol in foods such as eggs.

This evidence has led to major world and UK health organisations revising their guidance, including the British Heart Foundation which has dispensed with its recommendation limiting eggs to 3-4 a week, although people with familial hypercholesterolaemia would still be advised to restrict dietary cholesterol intake. The Food Standards Agency also advises that most people don't need to limit how many eggs they have, if they are eating a balanced diet. The American Heart Association has also removed specific reference to eggs in their dietary recommendations for heart health.

The misconceptions around eggs and cholesterol largely stem from incorrect conclusions drawn from early research.

- Research on animals in the early twentieth century, when they were fed foods that were high in cholesterol and saturated fat, led researchers to an oversimplified conclusion that dietary cholesterol was the key component in CHD risk in both animals and humans.
- Later studies proved a definite link between raised LDL-cholesterol and increased risk of coronary heart disease (CHD), but small changes in LDL- cholesterol do not translate into clinically significant changes in CHD risk.
- Early studies on the effects of dietary cholesterol on serum cholesterol levels produced misleading results because the diets contained high levels of saturated fat and / or extremely high amounts of cholesterol (>1000 mg per day).
  Later studies have been able to separate the cholesterol-raising effects of dietary cholesterol from saturated fat, which often exist together in the same foods.
- Studies in the 1990s began to look in more depth at the separate effects of dietary cholesterol and saturated fat, which tend to exist together in the same foods.
  A review of these studies in 2006 concluded that although dietary cholesterol can increase serum cholesterol, both the LDL- and HDL- components are increased. The review noted that the effect was apparent at cholesterol intakes of less than 400 mg per day, but was small relative to the effect of saturated fat. In addition, any impact of dietary cholesterol on LDL or CHD risk was potentially offset by a favourable increase in HDL.

Functional eggs

Functional eggs are specially produced eggs, which supplies additional nutrients as well as many health promoting components. They are also called as diet eggs, designer eggs, Omega-3 FA rich eggs and sold in the market under various brand names.

Ordinary egg is already rich in many nutrients; whereas the functional egg is, not only rich in many nutrients; but supplies various substances like Linolenic acid, Eicosapentaenoic acid, Docosahexaenoic acid, beta carotene, vitamin E, selenium, chromium, zinc, lycopene, sialic acid, lumiflavin, lumichrome etc., which can improve the cardiac health reduce the blood pressure and aging process, LDL cholesterol, peroxidation and free radicals as well as improve the anti carcinogenic properties, immunity and overall health of the consumer. One can forget the cholesterol level in the functional eggs, because it is packed with several serum cholesterol lowering factors.

Organic eggs

Organic eggs are cage free eggs produced by poultry reared under natural conditions and fed with feed free anti-microbial drugs, antibiotics, pesticide residues, mycotoxins and other harmful chemicals. These eggs are comparable with the back yard free range eggs.

NUTRITIONAL COMPOSITION OF DUCK MEAT

Meat is a very well recognized nutritious food due to abundant high quality protein, B complex, vitamins and important minerals especially iron. However, all the nutrients contained in fresh meat do not reach the consumer. Several of them could be partially lost in the processing steps undertaken during the manufacture of a particular product. Hence, there is a need to have a fresh look at the nutritive value of poultry meat.Most processing procedure involves cooking which brings about a number of changes in meat. Cooking coagulates and denatures the meat proteins altering their solubility. It inactivates or destroys the indigenous proteolytic enzymes. Cooking invariably decrease the water content of meat lowering the water activity level. It intensifies the flavour and modifies the texture. In addition considerable number of microorganisms are killed enhancing the storage life of meat.

Meat product could meet a major portion of recommended dietary allowance (RDA) of 56 g protein per day as prescribed by the National Research Council. Since, protein is needed to make up the day to day wear and tear of body tissue in adults and large amount of protein can be stored in the body. Meat products contain ample amount of fatty acids that are essential in the diet of human, the recommended dietary allowance of fat is relatively less it can be easily met. Nutritional composition of raw poultry meat is shown in Table No.6. Poultry meat proteins are of high biological value; the biological value of poultry meat varies inversely with its collagen (fiber) content. Therefore, meat from older birds is of low biological value than that from younger birds. In general, the biological value poultry meat ranges between 65 and 85.

Poultry thigh and leg muscles appear darker (reddish) whereas the breast meat is pale in color. This is mainly because of difference in among of exercise, the respective muscles are subjected to. The leg muscles have to work more; hence they contain more adipose tissue, blood (myoglobin and iron), mitochondria and energy-producing enzyme activities than breast meat. Light meat has more protein and saturated fat whereas; fat and cholesterol are normally high in the dark meat. Fat in light meat is more saturated and skin has more fat, cholesterol and monounsaturated fatty acids. Organ meat (liver) has very high levels of cholesterol whereas abdominal fat and breast meat are low in cholesterol. Breast meat has more protein whereas heart and back have more fat. Other difference include higher niacin and pyridoxine and lower iron, Zinc, sodium, thiamin, riboflavin and tocopherols and high meat than in dark meat.Meat products contain enough of vital minerals such a iron, sodium, potassium and phosphorus. Much of the requirement of iron which is an absolute necessity for health up keep, can be made available by the meat products. Anaemic patients are usually recommended by the meat products. A regular intake of iron is must for the proper synthesis of heamoglobin, myoglobin and certain enzymes due to very limited capacity to store iron in the body.

All the water soluble vitamins are present in meat products but thiamine, riboflavin and niacin are present in significant quantities. Liver containing meat products are extremely rich in vitamin A content.

Water content of duck meat is lower than chicken meat where as energy content of duck meat is higher than chicken meat. Similarly, protein content of duck meat is lower than chicken meat whereas lipid content of duck meat is higher than chicken meat.

Table No. 6 Nutritional composition of raw poultry meat (per 100 g edible portion, flesh and skin)

Nutrient	Chicken/ Broiler	Turkey	Duck	Goose
Water %	65.99	70.40	48.50	49.66
Calorie %	215	160	404	371
Protein %	18.6	20.4	11.49	15.86
Total Lipid %	15.06	8.02	39.34	33.62
Ash %	0.80	0.88	0.68	0.87
Source: Stadelman *et al.,* 1988				

Nutrient composition of cooked leg meat and breast meat from duckling, broiler and turkey (100 g edible portion) are presented in Table No. 7 and 8 respectively.
It supplies good amount of phosphorus and iron. Iron in meat is not only highly available, but also increases the availability of iron from other sources. Meat, being predominantly skeletal muscle, is very rich in potassium. Meat is probably the best natural of niacin and is a good source of riboflavin. The organ meat (liver) is an excellent source of iron, vitamins A, B_2 and niacin. Protein, Iron, sodium and cholesterol content of duck meat is higher than chicken leg meat. Similarly, Iron, sodium, selenium and cholesterol content of duck breast meat is higher than chicken breast meat.

Table No. 7 Nutrient composition of cooked leg meat (lean only) from duckling, broiler and turkey (100 g edible portion)

S.No	Nutrient	Duckling leg	Broiler leg	Turkey leg
1	Calories Kcal	178	191	159
2	Fat (g)	6	8	4
3	Protein (g)	29	27	29
4	Calcium (mg)	10	12	22
5	Iron (mg)	2.3	1.3	2.7
6	Sodium (mg)	108	91	81
7	Selenium (mcg)	22	41	50
8	Niacin (mg)	5.3	6.3	3.3
9	Cholesterol	105	94	119
				Source: USDA

Table No. 8 Nutrient composition of cooked breast (lean only) from duckling, broiler and turkey (100 g edible portion)

S.No	Nutrient	Duckling breast	Broiler breast	Turkey breast
1	Calories Kcal	140	165	135
2	Fat (g)	2.5	3.6	0.7
3	Protein (g)	28	31	30
4	Calcium (mg)	9.0	15.0	12.0
5	Iron (mg)	4.5	1.0	1.5
6	Sodium (mg)	105	74	52
7	Selenium (mcg)	29.0	27.6	32.1
8	Niacin (mg)	10.4	13.7	7.5
9	Cholesterol	143	85	83
				Source: USDA

Among the nutrients poultry meat, lipid content is the most variable. It depends on sex, age, species, diet etc., Most of the fat poultry meat is subcutaneous. Poultry met contains higher proportion of unsaturated fatty acids than fat from other meats.
The cholesterol content of poultry meat is quite low; chicken breast meat contains 70 mg whereas, drumstick meat has 91 mg and chicken fat has 65mg per 100g. Composition of meat -lipid (g /100 g edible portion) is given in Table No.9. Duck meat is having higher lipid content in terms of saturated fat, Monounsaturated fat and polyunsaturated fat when compared to broiler meat.

Table No. 9 Composition of meat -lipids (g /100 g edible portion)

Nutrient	Broilers	Turkey	Goose	Duck
Saturated fat	4.50 (29.90)	2.37 (29.50)	13.10 (33.30)	9.35 (27.80)
Monounsaturated fat	6.73 (44.70)	3.44 (42.90)	19.43 (49.40)	19.10 (56.80)
Polyunsaturated fat	3.16 (21.00)	1.86 (23.20)	5.11 (13.00)	3.70 (0.080)
Value in the parentheses indicates % of total fat Source : Stadelman *et al*., 1988				

Poultry meat is an excellent source of vitamins. Consumption of 100 g of organ meat, especially liver, supplies seven times the requirement of vitamin A, about 14% of the requirement of vitamins B_1, 1½ times the requirement of vitamin B_2 about ¾ the requirement of niacin and 1/3rd the requirement of vitamins C. Vitamin content of chicken, Turkey and duck meat (per 100 g Food) is presented in Table No. 10. Duck meat contains higher amount of Thiamin, Riboflavin, Vitamin B_{12}, Panthothenic Acid, biotin and folate.

Table No. 10 Vitamin content of chicken, duck and Turkey meat (per 100 g Food)

S. No	Nutrient	Chicken meat	Turkey meat	Duck meat
1	Retinol (mg)	25	7	24
2	Vitamin D3 (mg)	0.6	0.4	-
3	Vitamin E (mg)	0.15	0.01	0.02
4	Thiamin (mg)	0.11	0.07	0.36
5	Riboflavin (mg)	0.25	0.20	0.45
6	Niacin (mg)	6.5	7.5	5.3
7	Vitamin B6 (mg)	0.3	0.55	0.34
8	Vitamin B12 (mg)	Trace	1	3
9	Panthothenic acid (mg)	1.03	0.69	1.6
10	Biotin (mg)	2.0	2	6
11	Folate (mg)	9	16	25
Source : Chan *et al.,* 1995				

Conclusion

This is the right time to modify the nutrient content of duck egg and meat to provide the quality food for the health conscious consumers.

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EFFECT OF SANITIZERS ON THE BACTERIAL COUNTS OF POULTRY CARCASS

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ABSTRACT

The antibacterial effect of food grade sanitizers on the chicken carcasses was undertaken in the present study. The sanitizers used in the study include lactic acid (1% and 2 %), combination of potassium sorbate (2.5%) and hot water (80 º C), acetic acid (1% and 2%), hot water (80 º C) and combination of lipase (0.5%) and Vitamin C (0.5%). Statistical analysis of data revealed a significant reduction in the total viable count of the treated carcasses. The most effective of all sanitizers used in the study was found to be acetic acid (2%). The complete inhibition of the growth of enterococci was observed on treatment with acetic acid (1% and 2%) and lactic acid (2%). Both the organic acids at 2% level and hot water treatment revealed a significant reduction in the *Escherichia coli* and coliform count. Acetic acid at both concentrations reduced the sulphite reducing closrtidial count significantly. Potassium sorbate and combination of lipase and Vitamin C had a least effect on the bacterial counts of poultry carcass.

Key words: Sanitizers, Antibacterial , Chicken carcass

Introduction

Poultry meat consumption in India has been showing an increasing trend in the recent years. It is very essential to maintain the quality of meat during production and processing. During slaughter operations, the carcass is exposed to extraneous contamination, tropical environment and temperature variation which favour microbial multiplication and subsequent reduction in the shelf life of meat. Several intervention strategies have been developed to reduce the bacterial load on carcass surface. One such strategy that has gained relatively wide acceptance in the meat processing industry is carcass washing and sanitizing. Nowadays, the use of certain generally regarded as safe (GRAS) substances viz. organic acids, certain salts and their combination have received increasing attention as a carcass sanitizer.

In the present study, the effect of various sanitizers on the bacterial counts on poultry carcass has been evaluated.

Materials and Methods

Collection of sample:

During the study, a total of six dressed chicken carcasses were collected randomly from a meat processing plant in Kerala., to detect the antibacterial effect of sanitizer. Equal number of carcasses selected was treated as control samples.

Sanitizers

The sanitizers used in the study include Lactic acid (1% and 2 %), combination of Potassium sorbate (2.5%) and hot water (80 º C), Acetic acid (1% and 2%), Hot water (80 º C), combination of lipase (0.5%) and Vitamin C (0.5%).

Each chicken carcass was dipped in a required concentration of sanitizer solution for one minute and then held in a lifted position for 2-3 minutes so as to drip off the solution from the carcass. The carcass was then transferred in a polythene bag and then the carcass rinse sample was prepared according to the method described by Cox et al (1981).

Evaluation of bacterial counts

The total viable count (TVC) was evaluated as described by Swanson et al (2001), coliform count (CC), *Escherichia coli* count (ECC) Sulphite reducing clostridial count (SRC) and enterococcal count (EC) was estimated as per the procedure described by Downes. and Ito (2001).The data obtained from the above study was subjected to statistical analysis following procedure described by Rangaswamy (1995).

Result

The effect of different sanitizers on the mean bacterial count of poultry carcass is shown in Table.

Table: Effect of sanitizers on the mean bacterial counts of poultry carcass

Sanitizer	Mean bacterial counts in carcass log $_{10}$ cfu /ml				
	TVC	CC	ECC	EC	SRC
Lipase(0.5%) & Vitamin C (0.5%)	5.57 ± 0.34^{b}	2.21±0.09^{b}	1.57±0.15^{b}	2.44±0.04^{a}	1.29±0.12^{a}
Potassium sorbate & Hot water	5.15 ±0.23^{a}	2.32±0.07^{b}	1.11±0.04^{b}	2.21±0.06^{a}	2.59±0.03^{a}
Hot water (80 º C)	3.69±0.22^{a}	1.16±0.11^{a}	0.15±0.08^{a}	1.72±0.25^{a}	2.45±0.14^{a}
Lactic acid (1%)	5.29±0.46^{a}	1.69±0.17^{b}	1.41±0.12^{b}	1.92±0.24^{a}	1.41±0.04^{a}
Lactic Acid (2%)	3.78±0.19^{a}	1.33±0.07^{a}	0.31±0.09^{a}	-	1.15±0.31^{a}
Acetic Acid (1%)	3.39±0.20^{a}	1.44±0.12^{a}	1.10±0.06^{b}	-	0.82±0.17^{a}
Acetic Acid (2%)	2.90±0.33^{a}	1.16±0.19^{a}	0.37±0.09^{a}	-	0.73±0.12^{a}
Control	**6.14±0.27^{a}**	**2.71±0.08^{a}**	**1.80±0.25^{a}**	**4.33±0.03^{a}**	**3.84±0.19^{a}**

- Figures in the same column bearing the same superscript differ significantly
- Figures in the same column bearing different superscript do not differ significantly

The most effective of all sanitizers used in the study was found to be acetic acid (2%) as it brought about a reduction of 3 $\log_{10}$cfu /ml in TVC , 2 $\log_{10}$cfu /ml reduction in SRC and complete inhibition of the growth of enterococci. The complete inhibition in the growth of Escherichia coli was observed on treatment with lactic acid (2%) and acetic acid 1% and 2% levels. The combinations of lipase and Vitamin C and Potassium sorbate and hot water were ineffective on coliforms as the reduction in count was only marginal. However the combination of lipase and Vitamin C produced a significant reduction of EC and SRC. Hot water and acetic acid at 2% level was most effective in reducing the E coli count on the carcass.

Discussion

Statistical analysis of data revealed a significant reduction in the bacterial counts of the treated carcass. The most effective of all sanitizers used in the study was found to be acetic acid (2%) as it brought about a reduction of 3 $\log_{10}$cfu /ml in TVC , 2 $\log_{10}$cfu /ml reduction in SRC and complete inhibition of the growth of enterococci (EC) The complete inhibition in the growth of *Escherichia coli* was observed on treatment with lactic acid (2%) and acetic acid (1%). Significant difference in the *Escherichia coli* count between the control and carcasses treated with hot water, lactic acid (2%) and

acetic acid (2%).Castillo et al (2001) also reported significant reduction in E coli on beef carcass. at higher concentration of lactic acid. The effect of acetic acid on TVC and CC of pork cuts carcass revealed a significant reduction in the counts.(Fu et al (2006). The reduction in counts of different pathogens on treatment with organic acids on beef has been reported by Sakhare et al (1999) .The organic acids at a lower concentration did not significantly reduce the growth of E coli and was in accordance of the study reported by Brackett et al (1994) who reported that lactic and acetic acid at 0.5-1.5% levels was ineffective in reducing E coli on beef. The combination of potassium sorbate had a least effect on the bacterial counts on poultry carcass. However significant reduction in the total viable count was reported on treatment with potassium sorbate which was similar to that reported by Fandos and Dominguez (2007). Treatment with hot water (80ºC) revealed a reduction in the bacterial counts. The combination of lipase and Vitamin C produced a significant reduction of EC and sulphite reducing clostridial counts.

Conclusion

It is concluded from the study that decontamination by sanitizers during processing could minimize the microbial quality of poultry carcasses and improve the quality and shelf life of meat. The sanitizers can also be used in reducing the bacterial load of duck carcasses during slaughter.

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CARCASS AND ORGAN CHARACTERISTICS OF CROOSBRED MALE DUCKS REARED IN SEMIINTENSIVE MANAGEMENT SYSTEM

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Abstract

The present study was conducted to evaluate carcass parameters of crossbred male ducks reared under semi intensive management system. Fifty ducks were slaughtered at the age 20 weeks. The dressing percentage was in the range of 57 to 78% and the average dressing percentage was found to be 64%. The mean weight of gizzard with and without contents was 64g and 52g respectively. The mean weight of liver was 30g and that of heart was 8g. The mean weight of inedible offal's such as intestine, feet, head, blood and feathers was 90g, 30g, 60g , 40g and 108g respectively. The average dressing percentage of carcass when packed along with giblets was 71.81%.

Keywords: Carcass parameters, Dressing percentage, Weights of giblet

Introduction

Ducks are primarily raised for meat and eggs, although, they provide other materials of economic value such as feathers. Each bird may yield around 100g of unprocessed dry feathers.

Ducks are selected for higher meat yield and lower fat (Baeza *et al.,* 2002) and duck meat contains about 20% crude protein and 2% fat (Szasz and Bogenfurst, 1998). Muscovy ducks in particular is a heavy breed mainly used for meat production. This experiment was conducted to assess the carcass and organ characteristics of cross bred ducks reared under semi intensive system of rearing.

Materials and methods

This experiment was conducted at the department of livestock products technology (Meat technology unit) at College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India. Fifty ducks which were reared under semi intensive system of rearing are slaughtered at the age of 20 weeks. The live weights of the birds were taken before hanging in the conveyor. The birds were electrically stunned, bled and were hard scalded. Then the birds were passed through a conveyor to the feather pickers. After picking and pinning, singing has been done to remove filoplumes. The washed carcasses were then eviscerated. The parameters measured were dressing percentage, weights of liver, heart, gizzard, intestine, feet, head, blood and feathers.

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Result

Results of dressing percentage, mean of carcass and live weight were given in Table.

Table 1 Carcass composition of male cross bred ducks

Parameters	
Mean live weight	1.17 Kg
Mean carcass weight	0.75 Kg
Dressing percentage	64 %
Dressing percentage with giblet	72%

Mean weights of giblets and other visceral organs obtained from ducks were given in Table. 2.

Table 2 Mean weights of various organs of cross bred ducks

Parameters	Weight (g)
Gizzards - with content - without content - content	64 52 12
Heart	8
Liver	30
Intestine	90
Feet	30
Head	60
Blood	40
Feather	108

Discussion

The dressing percentage Dressing percentages observed in this study were, however, lower than those reported by Carew *et al.* (1998) in ducks at Lagos metropolis (65%) ,Ola (2000) also in Muscovy ducks in South-western Nigeria (66.66%-68.24%) and Etku *et al*. (2006) in Muscovy male ducks in Nigeria (72%). Dressing percentage when calculated with giblet observed in this study correlate with that of Wawro *et al*. (2004) in cross bred Muscovy ducks (73.5%).

Conclusion

The dressing percentage of cross bred male ducks reared under semi intensive system obtained in this study is 64% and when packed along with giblet it becomes 72%.

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DUCK PRODUCTION SYSTEM OF KUTTANAD REGION IN KERALA

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Abstract

The present study was carried out to investigate duck production system in four locations (Kidangara, Kainakari, Chambakulam and Pallathuruthy) of Kuttanad region, Kerala state, India. Socio economic profile of duck farmers, Housing, Feeding, Breeding and Health management of ducks in Kuttanad region were studied. Data were collected from thirty duck farmers. Two varieties of duck were predominant namely Chara and Chemballi. The mean flock size was 606.833 $\pm$ 222.41 ducks. Most of the farmers(73.33 percent) were over 50 years of age and 76.67 percent of the farmers had only primary education. 83.33 percent of the farmers had less than 30 cents of land. The monthly income of the majority of farmers were in the range between Rs. 5000 to 7500. Majority of the farmers bought ducklings from private hatcheries in and around Kuttanad region for establishing their foundation stock. No well established housing pattern was observed. Feeding was mainly by scavenge feeding in post harvest months and hand feeding during the rest of the year. Marketing was mainly direct type by selling of ducks for meat and table eggs at road side shops. Bleeding from nostrils, drooping, death (locally called as 'attack') and Conjunctivitis, weakness and death (locally called as 'plague') were the two groups of symptoms that caused mortality in the flocks. Regarding the scientific management practices adopted, 53.33 percent of farmers were aware of the common antibiotics and other medication. While 56.67 percent of the farmers were aware of vaccination against Duck Pasteurellosis and 76.67 percent of the farmers were aware of vaccination against Duck Plague.

KEYWORDS: Duck- Farming system- Kuttanad

HOMOEOPATHIC TREATMENT FOR DUCK DISEASES

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Ducks suffer from relatively lesser number of diseases than chicken. Some common diseases of ducks are, Duck Plague (Duck Viral Enteritis),Duck Viral Hepatitis, Duck Cholera(Pasteurellosis), Duck Pox, Antipestifer Infection, Salmonellosis, Botulism, Aflatoxicosis etc. Since ducks are usually reared in small flocks by small farmers, they cannot offer costly vaccination schedule and allopathic treatment for ducks. Hence the author is prescribing homeopathic medicines for various duck diseases for the past three decades, with great degree of success. The following homoeopathic treatment is recommended for various diseases of ducks.

Mercurus corrosives-6 or 12 X is a very effective drug for treating duck plague, dysentery, coccidiosis and ulcerative enteritis. Sometimes the duck plague vaccinated flocks are also affected, with a daily mortality rate of > 10%. They are treated with ***Mercurus corrosives*-6 or 12 X,** depending on the severity of the disease, at 10 ml /1000 birds once or twice daily, mixed in the drinking water for 1 to 3 days. Many flocks showed 100% recovery with in a day and all flocks recovered fully with in 3 days. Use only plain drinking water free from sanitizers like chlorine, during any homeopathic medication. Once the mortality and symptoms disappear, the treatment can be discontinued. In case of sudden acute onset, ***Aconite-12 and Arsenicum album-12*** = 10ml each for 100 birds /day may be given as first dose along with ***Mercurus corrosives.***

Acute duck viral hepatitis may be treated successfully with a combination of ***Chellidonium (Chell)-6 or12X*** and ***Aconite-30,*** each 3-5ml/ 1000ducklings /day for 1-3 days, depending on the severity of the disease and other symptoms. Duck cholera and Antipestifer disease can be treated with a combination of ***Aconite-30, Arsenicum-30 and Aloes-30,*** each 5-10ml /1000 birds / day for 2-3days,depending on the symptoms and their severity.

Duck pox may be treated with a commercial preparation, ***Pulsazon***= 10ml /1000 ducks once or twice daily for 3 days. In case of Gout and other kidney infections, treat the ducks with ***Bryonia-30, Colch-30 and Rhus tox-30*** at 10ml /1000 birds /day for 3 days, through drinking water.

Treat Aflatoxicosis with a combination of ***Chell-6 /12, thuja-200, Colch-12***, each 5-10ml /1000 birds / day for 3-5 days. Withdraw the mouldy feed. Treat all respiratory infections including Avian influenza with ***Cepa-6 or12*** = 10ml, ***Sticta-12***= 10 ml and ***Antimony tartrate-200***= 15ml /1000 birds /day in drinking water for 2-3 days. In case of Duck influenza, give a combination of ***Mercurus corrosives-6 or 12*** = 10ml, ***Cepa-6 or12*** = 10ml and ***Antimony tartrate-200***= 5-15ml /1000 birds /day in plain drinking water for 3 days. Commercial preparations like ***Respomak-T***= 100ml /1000ducks /day for 3 to 5 days is also effective.

In case of frequent infections and breakdown of immunity, try ***Tuja-200*** =15ml /1000 birds /day for 3to 5 days, along with specific treatment for the type of disease; to boost the immunity.

ANTIBACTERIAL EFFECT OF AQUEOUS EXTRACT OF *POLYALTHIA LONGIFOLIA* LEAVES AGAINST DUCK PASTEURELLOSIS

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Duck pasteurellosis caused by *Pasteurella multocida* (*P. multocida*), with its alarming mortality and morbidity, become a major bottle neck in the burgeoning of the industry. Adult ducks show some resistance to the disease but ducklings are very vulnerable. The rapid onset and spread of the disease makes medication practically impossible and ineffective. Rampant use of once effective antibiotics like sulpha drugs has led to the acquisition of drug resistance by the bacteria and the existence of chronic form of the disease adds to the problems of chemotherapy. Thus, curbing the disease by herbal treatment can be chosen as one alternative to save the birds from this malady. The present work was carried out to investigate the effect of aqueous extract of *Polyalthia longifolia* leaves in the treatment of duck pasteurellosis. One month old unvaccinated ducklings were divided into five groups comprising nine in each group. All the birds were inoculated with 3 x 10^0 in 0.05 ml of *P. multocida* inoculum except the normal control. After 48 hours of bacterial inoculation, ducklings in the treatment groups (IV and V) were administered with aqueous extract of *Polyalthia*

longifolia leaves at a dose rate of 100 mg/kg and 400 mg/kg respectively. Group III was kept as reference control which was administered with 30 mg/kg of sulpha trimethoprim combination. Group II was inoculated with 3 x 10^0 in 0.05 ml of *P. multocida* inoculum alone and Group I was kept as normal control. Passive haemagglutination test and hematological parameters like total leukocyte count, packed cell volume, haemoglobin and total erythrocyte count were observed. Biochemical parameters like urea, albumin, serum glutamic pyruvic transaminase were also estimated. Histopathological studies conducted confirmed the absence of lesions suggestive of duck pasteurellosis in any of the treatment groups. Reisolation of *P. multocida* from heart and liver of the sacrificed ducklings showed no bacterial colonies suggestive of duck pasteurellosis. Absence of histopathological lesions and failure of reisolation of *P. multocida* from heart and liver of the sacrificed ducklings suggested that the aqueous extract of *Polyalthia longifolia* leaves were effective against duck pasteurellosis.

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ECOLOGY AND EVOLUTION OF AVIAN INFLUENZA A VIRUSES

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Wild waterfowl and shorebirds (*Anseriformes* and *Charadriiformes*) are the major natural reservoirs of influenza A viruses. Avian influenza viruses (AIV) are maintained asymptomatically in these hosts, although there is some evidence of clinical effects of these viruses in *Anseriformes*. Influenza A viruses found in all other host species, including human pandemic and seasonal influenza viruses, were ultimately derived from avian viruses, however adaptation to domestic poultry occurs most frequently. In this presentation, I consider the origins, ecology and evolutionary strategies that have lead to the rapid spread of highly pathogenic avian influenza (HPAI) H5N1 viruses in Eurasia. The HPAI H5N1 virus is unique in having spread to humans and other mammalian species and represents a continuing pandemic threat. Evolutionary analyses of HPAI H5N1 viruses indicates that the prototype H5N1 virus (A/Goose/Guangdong/1/1996) was most probably introduced from wild birds into poultry as a non-reassortant low pathogenic virus. However, H5N1 genotypes were generated locally in aquatic poultry after the introduction of the Gs/GD prototype virus and did not result from repeated emergence from wild birds. In most cases, novel gene segments that were incorporated into H5N1 virus genotypes originated from various subtype viruses introduced to poultry from wild bird populations. Analyses of population dynamics showed a rapid increase in the genetic diversity of Gs/GD lineage viruses from mid-1999 to early 2000. These results indicate that the transmission of reassortant viruses through mixed poultry populations in farms and markets in China has selected HPAI H5N1 viruses that are well adapted to multiple hosts and reduced the inter-species transmission barrier of those viruses. Global H5N1 genotype distributions and the development of endemicity of H5N1 in eastern states of India (e.g. West Bengal) are also discussed.

CHARACTERIZATION OF ONE INDIGENOUS DUCK BREED IN KALAHANDI DISTRICT OF ORISSA

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ABSTRACT

One breed of duck has been identified in the Kalahandi district of Orissa.This duck is widely distributed throughout the district and popularly known as 'Moti Hansa'. This breed of duck is originated from Muscovy duck. These ducks are very popular because of their large body size, pleasing appearance and mainly used for table purpose.The average flock size varies from 1-30 numbers. The head is fairly large in size and flat at the top and larger in males than females. Crest is present in both the sex. Head width varied from 31.86- 41.56 mm. The caruncles are fairly large and found in both side of the face and eyes. Bill is short with fleshy tubercle at the base of the bill. The plumage colour are mixed white, brown, white and brown, brown and black, white and black and black and blue. It has been reported that black plumage in the wings changed to white during 2nd year. The wing feather which were changed to white with advancement of age includes under and upper wing coverts and axillaries. The standard weight in males are 3.5 kg and in females 2.56 kg. Mainly this breed of duck is used by the ST population of the district for meat purpose and rarely for egg. These are raised in back yard in small holder production system. They lay about 50-60 eggs per year. These ducks are broody, fairly resistant to stress and worm infestation. The Muscovy breed of duck has been raised in the district since long but they have maintained breed characteristics without deliberate attempt of any scientific breeding. The characterization on molecular may be carried out to measure the distance/similarities from muscovy breed.

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DUCK GENETIC RESOURCES OF INDIA

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Ducks occupy 2nd position next to chicken farming in India. They form about 10% of the total poultry population and contribute about 6-7% of total eggs produced in the country. Ducks are mainly concentrated in eastern and southern states of India. Coastal areas of West Bengal, Orissa, Tamilnadu, Andhra Pradesh, Kerala and Certain parts of Assam and Bihar constitute the main breeding tracts of ducks. Most of the indigenous ducks are nondescript which are reared by the farmers under traditional backyard system. One such type called 'Pati" is most common in the Brahmputra valley of Assam. Some of the documented Indian breeds of duck are Indian Runner, Nageswari and Sythet Mete. Nageswari , locally called "Nagi" the snake deity, is popular in Barak valley of Assam bordering Meghalaya, Tripura, Mizoram and the neighbouring country Bangla desh. In Kerala state 80% of the duck population is concentrated in Alleppey, Eranakulam, Kottayam and Trichur districts. The low lying 'Kuttanad' area is actually the home land of desi ducks in Kerala. Mayurbhanja, Kalahandi, Keonjhar, Bolangir, Nawarangpur, balasore, Malkangiri, Koraput, Jagatsingpur and Baragarh are the major duck producing districts of Orissa. To improve the productivity of local nondescript desi ducks, Muscovy exotic breed of duck is being used in Orissa since long time. Duck Breeding Farm under Ministry of Agriculture, Government of India has introduced high yielding exotic breeds of ducks for the benefit of farming community. Introduction of exotic breeds in the country is causing the genetic dilution of the native duck breeds. The economic importance of single- purpose highly productive breeds and lines are distorting the perception of the value of multipurpose breeds that are adapted to the local conditions. The replacement of these local breeds may lead to their extinction and hence to an unrecorded loss of genetic variation. Large no of native ducks are existing in their home tracts which are yet to be documented. It is the high time for evaluation, characterization and conservation of our duck genetic resources for proper utilization. Since last one decade organized work on this line has been initiated in the form of net work projects and a regional centre of Central Avian Research Institute has been established at Bhubaneshwar (Orissa) with main objective for research and improvement of duck.

Key Words: Duck, genetic resource, distribution, India

OBSERVATION OF SOME HAEMATOLOGICAL ARAMETERS IN TWO BREEDS OF DUCKS

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Duck is one of the important livestock reared in aquatic environment mostly costal states of India. Khaki Campbell ducks provides more eggs in comparison to Desiduck. Haematological parameters of these two breeds have been taken to study at the present communication. A total 20 each adult ducks of each breed were selected randomly to screen the haematology. All the ducks were apparently disease free. An amount of 2-3 ml blood was collected from the wing veins into vial containing 10mg of K-EDTA. Blood film was prepared on the spot when collecting the blood.

The blood smear were air dried, heat fixed and stained with Giemsa for cell counting of Lymphocyte, neutrophil, monocyte, eosinophil and basophil. Haemtological parameters like

haemoglobin (Hb gr.%), packed cell volume (PCV%), total erythrocytic count (TEC million/ μL), total leucocytic count (TLC, 10^3/ μL), Erythrocytic sedimentation rate (ESR mm/hour)and differential count of leucocyte were counted.

From the study it was observed that the in Khaki Campbell duck the haematological parameters like Hb, PCV,TEC, TLC and ESR were 10.5±0.05, 37.22±0.06, 4.92±0.06, 13,166±311.26, 3.45 mm and in Desi the same parameters were 9.29 ± 0.06,34.35±0.14, 6.98±0.13, 13,720±168.58,4.2±0.056 respectively.The differential counting of the lymphocyte, neutrophil, monocyte, eosinophil and basophil in Khaki and Campbell ducks were 71.55±0.22, 26.17±0.21, 5.55 ±0.1, 1.1 ±0.06 and 0.03 ±0.02 and in Desi breeds they were 66.06 ±0.47, 31.7±0.42, 4.4± 0.11, 0.8±0.05 and 0.25±0.02 respectively.

From the study it reveals that in Khaki Campbell duck there is higher values in Hb%, PCV, RBC, lymphocyte, monocyte, esinophil and basophil while in Desi duck the remaining values found higher values. It indicates that Khaki Campbell having strong haematological parameters than Desi duck.

Desi	Hb	PCV	RBC	WBC	ESR	L	N	M	E	B
	9.29	34.35	6.98	13,720.00	4.2	66.06	31.7	4.4	0.8	0.25
	0.06	0.147	0.13	168.58	0.056	0.47	0.42	0.11	0.05	0.002
Khaki	10.5	37.22	4.92	13,66	3.45	71.55	26.17	5.55	1.1	0.03
	0.05	0.06	0.06	311.26	0.06	0.22	0.21	0.1	0.06	0.02

PERFORMANCE OF NATIVE DUCKS WITH DIFFERENT LEVEL OF PROTEINS DURING FINISHER STAGE.

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To study the performance of native ducks on different levels of protein during finisher stage a total of 450 ducklings of 4 weeks of age were randomly divided into three treatment group i.e. T_1, T_2 & T_3 having three replicates in each group. Ration containing 16%, 18% & 20% CP were offered to T_1, T_2 & T_3, respectively. Daily feed intake and weekely body weighr were recorded. At the end of the experimental feeding for a period of 4 weeks a metabolic trial was conducted to study the nutrient utilization in different treatment groups. Significantly ($p \leq 0.05$) higher body weight gain was observed inT_3 (424.07±30.73g), than T_2 (350.25±9.47g) & T_1 (209.00±11.80g). The metabolizability of nutrients and nitrogen balances in different groups were given below. Significantly ($p \leq 0.05$) higher DM metabolizability percentage was observed in 20% CP fed group than

16% CP fed group but not from 18% CP fed group. However, no significant difference was observed between 16 & 18% CP fed group. The digestibility of CF was significantly ($p \leq 0.05$) higher in 16% CP fed group than 20% CP fed group. No significant difference was observed between other groups. The significant difference was observed in OM metabolizability and EE digestibility between the treatment groups. Similarly no significant difference was observed in terms of nitrogen retention between the groups. From this experiment it was concluded that the optimum requirement of protein was 20% in the diet of native ducks during 5-8 weeks of age for growth and feed utilization efficiency.

Key words: Native ducks, finisher diet, protein percentage

EFFECT OF DIETARY VITAMIN-E AND SELENIUM ON FERTILITY AND HATCHABILITY OF DUCKS

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ABSTRACT

Fertility and hatchability of eggs play major role for economic viability of commercial production of ducks. With an aim to improve fertility and hatchability, an experiment was conducted with supplementation of dietary vitamin E and Selenium to a flock of native ducks maintained under intensive system of rearing with normal feeding and management practices. A total of one hundred native ducks (80 females and 20 males) of 40 weeks age were randomly divided into two groups with two replicates in each for treatment and control. 5g of vitamin E and 50 ppm of Selenium were added to 100 kg feed for treatment group where as no such addition was made for control. Eggs were collected after two weeks of starting of treatment. Total production of eggs was recorded. Eggs thus collected were incubated in the hatchery. Candling for fertility test was done on 24^{th} day of incubation when they were transferred to hatcher. Discarded eggs on candling were broken to find out the number of dead in germs which were counted for the fertile eggs. Percentage of hatchability (TES & FES) was found out after hatching of the ducklings. Estimation of certain blood parameters like GOT, GPT, Total protein and total cholesterol were done once at the beginning of the experiment and another at the middle i.e 6^{th} wk of treatment. It was observed that there was a significant ($p<0.05$) improvement in percentage of fertility and hatchability (FES and TES) between treatment and control group. Therefore, addition of vitamin E and Selenium in the duck layer ration has beneficial effect on fertility and hatchability of eggs which has much economic importance.

Key words: Vitamin E, Selenium, fertility, hatchability, native ducks.

EFFECT OF MEDICAL FEED ADDITIVES ON GROWTH PERFORMANCE, METABOLIC FUNCTIONS AND ECONOMIC EFFICIENCY OF GROWING MALE DUCKS

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SUMMARY

Ninety one day old, growing male Muskovy ducks were performed to evaluate the effect of adding 0.5% of each source from some medical feed additives (MFA) i.e. Thymus **(***Thymus Vulgaris*), Marjoram, (*Marjorana hortensia*), Ginger (*Zingiben officinale*) and mixture of these previous three herbs to growing Muskovy ducks diet on growth performance, some metabolic functions and the economic efficiency. Birds were divided equally into 5 groups containing 18 birds each. Each group contained 3 replicates, of 6 males. Each treatment of the tested diets contained one source of MFA at level of 0.5% except the 5th treatment contains mixture of these previous three herbs. The control diet had no additions. The experiment was terminated when birds were 60 days old. Body weight, weight gain and feed intake were recorded. Feed conversion and economic efficiency were calculated. At the end of the experiment carcass characteristics were measured. Blood samples were taken at 4 and 8 weeks of age to determine some blood plasma constituents.

The data revealed that, birds fed dietary mixture of MFA recorded greatest ($P<0.05$) body weight, body gain and feed conversion efficiency. Adding different MFA to the control diet slightly ($P>0.05$) reduced the feed intake. No significant differences ($P>0.05$) were detected in dressing percentage as affect of adding all MAF additives to the control diet, however the greatest ($P<0.05$)edible % was calculated for birds fed dietary Ginger (G). Blood samples indicated that birds fed dietary G recorded the greatest ($P<0.05$) values of Total Leukocytes (WBC's), Erythrocytes (RBC's), T3, Glutamic–Pyruvic Transminase (GPT), and Glutamic –Oxaloacetic transminase (GOT), while, birds fed dietary Marjoram (M) recorded the best ($P<0.05$) value of Packed cell volume (PCV)%. Moreover, birds fed dietary mixture presented the highest values of Hemoglobine (HB), T4, T3/T4, and glucose. Adding MFA such as T, M, G, or the mixture to ducks diet presented the lowest ($P<0.05$) value of cholesterol and urea and the highest ($P<0.05$) value of the economic efficiency (Net revenue and percent of net revenue/feed cost) of the diet.

Key words: Medical herbal, performance, metabolic functions, male Ducks

EGG QUALITY CHARACTERISTICS OF *DESI* DUCKS IN PARAMATHI VELUR AREA OF NAMAKKAL DISTRICT OF TAMIL NADU

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Abstract

Paramathi Velur area in Namakkal district is one of the major duck meat and egg marketing centres of Tamil Nadu. A study was conducted to assess both the internal and external egg quality characteristics of *desi* duck eggs collected from this area. The external egg quality characteristics viz. egg weight, specific gravity, shape index, shell weight, shell percentage and shell thickness, as well as the internal egg quality characteristics viz. Albumen unit, Haugh unit, yolk index and yolk color were assessed. The result revealed that the egg weight and specific gravity values were found to be 64.98 ± 3.37 gm and 1.15 ± 0.05 respectively. The shape index was recorded to be 74.61 ± 5.21. The shell was found to constitute about 12.03 ± 0.54 per cent of the egg with an average shell weight of 7.86 ± 0.34 gm. The shell thickness was recorded to be 0.39 ± 0.02 mm. Similarly, the recorded internal egg qualities viz. Albumen unit, Haugh unit, yolk index and yolk color were found to be 0.089 ± 0.004, 82.85 ± 3.73, 0.42 ± 0.04 and 11.33 ± 1.76 respectively.

DNA BASED SPECIES SPECIFIC MARKER FOR IDENTIFICATION OF DUCK MEAT

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ABSTRACT

After chicken, duck is the second most commonly consumed poultry meat in India and it could be misrepresented for other meats such as chicken, turkey meat, mutton, chevon, etc., especially in the processed meat products. In the present study, PCR based method for identification of duck was achieved by developing species-specific marker. Mitochondrial D-loop sequence of duck was retrieved from Genbank (www.ncbi.nlm.nih.gov.org) and species-specific primers were designed using computer software and tested its specificity by blast search in the genbank. DNA samples from duck were extracted from whole blood and meat samples using Phenol – Chloroform-Isoamyl Alcohol (PCI) extraction method. PCR chemistry conditions like template concentration, primer concentration and thermal profile of PCR amplification like annealing temperature and durations, and number of PCR cycles for newly designed primers were optimized. The species-specific PCR products were sequenced to confirm the specificity of the product amplified. The size of PCR product was 292 bp for duck and it was checked for cross amplification with the meat of cattle, sheep, goat, pig, rabbit, chicken, pigeon and turkey. This marker could be successfully amplified from the DNA extracted from fresh meat and the meat that was heated at 80 ^{o}C with the holding period of 30 minutes and autoclaved meat samples. The duck specific DNA marker developed in this study can help identify the species of raw as well as cooked meat of the duck and the process of identification is simple, economical and quick as compared to the PCR-RFLP or sequencing method of species identification.

Key words: Duck, PCR, D-loop, Speciation, DNA marker

STANDARDIZATION OF PROCESS FOR DEVELOPING EGG QUICHE

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Egg quiche is a nutritious and versatile snack food ideal for the breakfast meal. It is a baked product which may be served hot or cold as a snack or appetizer and offers a potential market at growing fast food outlets.

Several trials were conduced to standardize the formulation and processing methodology of egg quiches. Based on the organoleptic evaluation results of initial trails, 3 blends were finally selected which contained blended liquid chicken egg and chicken meat sausage at 60 and 25 (blend I), 65 and 20 (blend II), and 70 and 15% (blend III) levels respectively. Grated cheese, skim milk powder, roasted black gram powder, spice mix and salt were added at 7.5, 3, 2 ,1.5 and 1% levels respectively in all formulations. Liquid egg contents were blended and mixed with grated cheese, skim milk powder, roasted black gram power, spice mix and salt in a bowl and set aside. Fried chicken sausage mixture was spread in a stainless steel bowl (dia 17.5 cm) and blended egg mixture was added onto the sausage mixture and baked in an oven at 160 ^{0}C for 20-25 minutes. Bowl was removed from the oven, shacked lightly to remove air and to level the contents and baked again at 140 ^{0} C for about 45 minutes or until filling was puffed and golden brown. Bowl was removed from oven, top pricked with a knife and allowed to cool for 10 minutes before serving or analysis.

Physico-chemical analysis of egg quiche indicated that moisture, protein and ether extractives ranged from 49.48 to 51.21, 13.86 to 13.97, and 22.59 to 22.85% respectively with no significant differences between blends. No difference in pH was observed between blends and it ranged from 6.93 to 7.06. All groups showed low aerobic counts (log 1.90 to 2.02 cfu/g) with complete absence of coliforms and Staphylococci, although low yeast and mould counts were seen which were significantly ($P<0.05$) lower in blends I and II than in blend III. Sensory evaluation revealed significant ($P<0.05$) differences between blends for flavour, texture and overall acceptability scores. Egg quiches from blend III were liked most by the panelists as evident from highest ratings for all sensory attributes, although they were not significantly different from blend II.

Based on the market price of ingredients used, the cost of formulating one kg of cooked egg quiches was calculated to Rs.104.70 and of one egg quiche weighing about 80 g was estimated to Rs. 8.38. The standardized technology can also be used in developing egg quiche using duck and goose eggs.

Key words: Egg quiche, formulation, processing, acceptability, microbial counts, physico-chemical quality, ingredients cost

SUITABILITY OF NATURAL SOURCES OF BETA GLUCAN AND TOCOPHEROLS IN PROCESSING FUNCTIONAL MEAT SCROLL

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In view of the inadequate information available on processing of poultry meat functional food products necessary for health conscious people, trials were initiated to evaluate the performance of different supplementary levels (w/w) -10, 20 and 30% (Groups A, B and C, respectively) of natural sources of beta glucan (oat flour) and tocopherol (sprouted green gram -Phaseolus *aureus* and sprouted Bengal gram-Cicer *arietinum*) on the quality of functional meat scrolls made with breast/drumsticks deboned broiler meat portions (8±1 cm) long, marinated for 16 h and subjected to hot air oven cooking. Physico chemical, microbial (log_{10}cfu/g) and organoleptic evaluations revealed that pH, moisture, total plate counts(TPC), Yeast and Molds of the samples from Group C containing oat flour or sprouted green gram, were significantly ($P<0.05$) different than other related experimental groups. Sensory evaluations also revealed lowest ranks for group C in either experiment. However, no significant differences for all these traits were observed between groups- A and B. Coliforms and Streptococci were not found in any of the experimental groups. Experiment with sprouted Bengal gram also indicated significantly ($P<0.05$) higher pH , moisture, TPC yeast and molds for group C. Juiciness, tenderness, texture and overall acceptability were adjudged significantly ($P<0.05$) low for groups B and C. Coliforms and Streptococci were not found in any of the experimental groups. Based on these results, inclusion of 10% level (w/w) of Bengal gram proved to be the better choice for processing good quality meat scroll. So, it was evident from this study that supplementation of oat flour/sprouted green gram at 20% (w/w) level or 10% level (w/w) of Bengal gram could be helpful in processing good quality functional meat scroll forming base for further processing of duck/geese meat to render faster marketing developments and growth of water fowl in this country.

Keywords: Beta Glucan, Tocopherol, Functional foods, Health.

COMPARATIVE EVALUATION OF EGG QUALITY TRAITS OF KHAKI CAMPBELL AND NATIVE DUCKS

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ABSTRACT

Duck rearing is an integral part of life of rural and tribal communities in Tripura. A total of 100 eggs of Khaki Campbell ducks were obtained at 40 weeks of age from government duck breeding farm, Agartala, Tripura and another 85 eggs of native ducks at about the same age were collected from local farmers. The eggs were collected over a period of five days. Collection and evaluation of eggs was done on the same day of laying. The mean values for external egg quality traits viz., egg weight and shape index were 57.78±0.73 and 72.71±0.43 for Khaki Campbell and corresponding values for native duck eggs were 52.67±0.41 and 74.16±0.31. These two traits were significantly influenced by the genetic group. The mean values for egg shell thickness (mm), albumen index, yolk index and Haugh unit were 0.319±0.003 and 0.296±0.003; 0.119±0.004 and 0.201±0.003: 0.420±0.005 and 0.415±0.004 and 82.19±0.41 and 86.73±0.36 in Khaki Campbell and native ducks, respectively. All the internal egg quality traits were significantly influenced by genetic group except albumen index, yolk index and percent egg shell.

Key words: Duck, Egg quality, Breeds.

A FARMING SYSTEM PERSPECTIVE OF RURAL DUCK FARMING OF TAMILNADU

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Abstract

A survey was carried out to document rural duck farming systems and techniques from breeding to marketing adapted by the duck farmers in the North Eastern districts of Tamil Nadu. Duck farming was characterized by nomadic and seasonal and still in the hands of small and marginal landless farmers for their livelihood. It was quite interesting to note that it was practiced by generation to generation by certain groups of peoples. Duck farming mainly based on low-input and semi-intensive system of management. The duck farmers are keeping a wide sex ratio of 1:20-25 for breeding ducks and obtaining the fertility rate of 70-80 per cent. They had the habit of rearing the ducks in three stages *viz*. brooding (0-4 weeks), grower (5-16 weeks) and layer (above 16 weeks) periods. In brooding, no artificial warmth was provided except "tent" brooding and the ducklings were allowed to swim in water from 6-7th day of onwards. Growing period was mostly depends upon the availability of water bodies and harvested paddy flocks in day time. During night time low cost materials like bamboo sticks and wire nets are used for making enclosures for confinement and herding. It is also a critical period for ducks and duck farmers since they had faced the problems like disease out break and lack of water and feeding resources. The straight run ducklings were reared up to 20 weeks of age, and then female and male ducks were used for laying and meat purpose respectively. Selection for breeding males based on phenotypic characters and colour pattern. In rural conditions, it was observed that 150-170 eggs/year for layer ducks. Most of the flocks were maintained for 2-3 years for egg production and then disposed for slaughter to the market.

Key words: Duck farming, Management techniques, Rural duck farming

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DUCK PRODUCTION FOR RURAL LIVLIHOOD

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In alternate poultry farming, duck rearing plays a vital role and is being practised in India, especially in Tamilnadu as a traditional system by the rural farmers. Even though, the duck production and genetic potential of indigenous ducks are being untapped by Government or other organized private sectors, still it is continued as the livelihood preposition of several poor rural farmers from time immemorial. The local or indigenous ducks constitute over 92 per cent of the duck population and are mainly distributed in the rice cultivating areas. The extensive water shed areas like ponds, lakes and rivers in Tamilnadu provide excellent natural habitats of ducks. In northern districts of the state, the local

duck varieties like *Arni* and *Sanyasi* are very popular and reared under backyard and extensive water range system.

The size of the duck flock varies from 10 to 25 dozens; mainly thriving on waste grains from harvested paddy fields and aquatic organisms from water ways. Traditional hatching is carried out by few farmers seasonally, synchronized with rice harvesting, with average hatchability of above 60%. Most of the other managemental practices are done under nil-input system except during lean season when the hand feeding of ducks with locally available low cost broken rice, rice bran, palm pith, etc. The marketing of duck eggs is unorganized as the duck farmers are sticking on to the loan lenders who support them financially. Further, the marketing of duck eggs and duck for meat purpose is mainly based on the Kerala market, because the popularity of duck eggs and meat are still in primitive stage in the state.

Therefore, the ducks are exclusively maintained for eggs. Duck meat production as an avocation is non-existent as only spent ducks and drakes contribute to the duck meat. Since ducks are moving from rice field to rice field, canal to canal, pond to pond, etc, sometimes covering many kilometers in search of food which mainly consists of fallen paddy grains, shrimps, snails, small fishes, tadpoles, earth worms, water weeds, insects, etc, the overheads are low and the cost of production becomes negligible. It is therefore imperative to raise the contribution from this unexplored species of waterfowls – ducks – to the natural supply of animal proteins which would automatically uplift the livelihood of the poorest among the rural poor sustainably.

Keywords: Duck, livelihood, Tamilnadu

BACKYARD DUCK PRODUCTION: THE BEST ALTERNATIVE FOR EGG PRODUCTION IN THE NORTH EAST INDIA

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Abstract

The seven Northeastern Indian states viz., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura experiences shortfall in table egg production so much so that the availability of egg is far short of requirement. To meet their demand on an average 25 lakhs of table eggs are daily procured from outside. The departments of animal husbandry of these states have been taking various schemes/programmes to halt the inflow of eggs by increasing local production but with little success. In the state of Assam three alternatives are identified to augment egg production, viz., through commercial chicken production, backyard chicken production or backyard duck production. There are many constraints due to which no significant headway could be made to surge the egg production, the major being, lack of local feedstuffs as well as germplasm, perennial flood problem as well as law & order situation and inadequate infrastructure facilities. However, duck production has more advantages over chicken counterpart, since it requires less feed under open grazing system, adjusts well even in flood situation, does not require sophisticated management and can be reared extensively in rural condition involving self-help groups (SHG). If the unemployed youths and women are engaged in duck rearing not only social problems can be tacked but also women are economically empowered.

Key words: Backyard duck production, egg production, North east India.

Introduction

The northeastern India (NEI) consists of seven states, viz., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. It occupies about 7.98 per cent of total land area with 3.77 per cent human population (3.88 crores) of the country as per National census, 2001. With a total poultry population of 3.056 million this region keeps about 7.39 per cent of national population. The local demand for table eggs in this region is estimated to be 664 crores per annum taking into consideration of the nutritional standard fixed by the Indian Council of Medical Research (180 eggs per person per year), out of which, Assam alone needs 480 crores. As per the estimates of Animal Husbandry department, Govt. of Assam, the local egg production in the state for 2007-08 has been only 55.40 crores, whereas, requirement is whopping 210.20 crores leaving a huge gap of 154.80 crores. To bridge this gap the NEI procures about 25 lakhs of table eggs daily through road or rail ways of which major share (around 70%) has been taken away by Assam. Ever since the first report about the import of eggs was published (Sapcota, 1992) many schemes/programmes have been taken up by the Govt. of Assam to halt this inflow by increasing local production but with little success. On the other hand the import of egg has been increased from 8 lakhs to 18 lakhs in the last 15 years showing 125 % increase! Thus, the NEI has been keeping on draining huge sum of Rs.182.50 crores per annum in importing table eggs. Therefore, this paper studies different alternatives to augment egg production in the state of Assam so as to suggest the best option.

ALTERNATIVE OPTIONS TO INCREASE EGG PRODUCTION IN ASSAM

Option A: Increasing egg production through commercial eggers:

Institutes like College of Veterinary Science, Guwahati; State Institute of Rural Development, Guwahati; few NGOs and Department of Animal Husbandry & Veterinary can play vital role in training farmers on scientific rearing of commercial flocks. The inputs like, land, labour, medicines, vaccines, equipments etc. are available aplenty for commercial chicken farming. Since overwhelming consumers of the state are non-vegetarian, the egg market is good except in summer season wherein, slight slump is experienced for couple of months. However, there are certain points which disfavour commercial chicken production. These are:

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- **Non-availability of local feedstuffs:** Except rice-polish all the other poultry feed ingredients are not available in Assam. Hence these are procured from outside making the compounded feed costly. The local maize production in the state is only 13.23 thousand tonnes, against the requirement of 38.56 thousand tonnes (Table 2) for poultry. If the whole maize produced locally is diverted to poultry production even then there will be a deficit of 191.25 percent. Likewise, there is also a deficit of 32.83 per cent in oil seedcake production. Using such feedstuffs the cost of production of poultry products becomes high. Comparatively, the cost of the table eggs procured from outside are cheaper. For example, the cost of farm-made compounded layer chicken feed in Guwahati market at present is Rs. 15/kg. (Table 3). Using such feed the cost of production of an egg from a small sized layer farm becomes Rs.3.50 to 4.00. On the other hand, the cost of a table egg brought from outside, at Guwahati retail market is only Rs. 3.25 to 3.40. Thus, the local layer farm does not thrive for long due to this '*price-war*'. This is the main reason why layer chicken farms are not flourishing in the state.
- **Non-availability of breeding farms**: Breeding farms for producing commercial day-old chicks (DOC), either in government set up or in private sector are not available in entire NEI due to which this region suffers in getting quality chicks. The regional breeding farm located nearest to this region is that of Bhubaneswar, but produces dual type Kalinga brown chicken only. The breeding farm of VHL located nearest to NEI is also in Bhubaneswar. Further, this place is remotely located to get fresh DOCs to NEI.
- **Inadequate infrastructure facilities**: There are 16 Nos of poultry (chicken) farms maintained by the Animal Husbandry and Veterinary Department, Assam in different locations of the state with limited capacities. These farms are quite old since constructed in 70s and 80s and follow deep litter system (DLS) of management. Looking into the national scenario, where around 90 per cent eggs are produced from cage system the present DLS is obsolete, hence needs to be changed.
- **Law and order situation:** Assam for long is passing through social disturbances. There are *bandhs*, road blockades etc. making the place unreliable and undependable for the investors in establishing large scale commercial farms. Such situations also disturb procurement of farm-inputs or taking out farm-produces.
- **Flood:** There are 27 districts in the state, out of which 26 Nos are flood-affected. Flood havoc not only makes the farm inoperable but also affects the biosecurity in the aftermath.
- **Climate:** In the high humid condition of Assam, especially during the peak summer birds feel discomfort due to difficulty in dissipation of their body heat.

Option B: Increasing egg production through backyard chickens:

The technical know-how, land, labour, medicine, vaccine and market are available as described above for commercial chicken farming too. Feed requirement is partly met because chickens are reared on scavenging. However, there are certain points which disfavour backyard chicken production. These are:

High yielding day-old chicks like Giriraja, Vanaraj, Kuroiler suitable for backyard farming that too in large numbers are not readily available in Assam. Hence, these are to be brought from remote sources, outside the state. The law and order situation and flood problem as described above do not favour large scale backyard chicken farming in the state.

Option C: Increasing egg production through backyard ducks:

- **Flood situation is advantageous for duck farming**: During summer the state of Assam faces havoc of flood which occupies 1.2 to 3.2 million hactre area of the state. However, ducks can be raised even in the flood, provided they are safely secured. After the flood innumerable waterbodies are created in different places of the state which are quite suitable for backyard duck farming. In Assam, the perennial waterbodies occupy around 7.79 per cent (552,000 hectare) of total geographical area of the state. The availability of natural waterbodies like rivers, streams, ponds, marshy lands etc. make the rearing of waterfowl ecofriendly in the state. Further, most of the houses in village keep at least a pond in their backyard wherein fishes are raised along with ducks.
- **Favouring food habit and economy:** Around 95 per cent of the people of Assam are traditionally non-vegetarian (Sapcota and Sarma, 2002) by their dietary choice. Duck eggs are preferred to that of chicken by the consumers despite of the fact that the price is generally Rs. 0.50 higher than that of fowl. Similarly, the duck meat is chosen to treat special guests in most of the villages of Assam. The meat fetches good revenue to the farmers as one pair would cost Rs. 700 to 800, especially in the festive season, whereas, one pair of country-chicken would cost only Rs. 500-600. Further, a high yielding duck lays about 40-50 more eggs than that of a chicken and its eggs are larger by 15-30 g. In Assam the layer duck population represented 36.34 to 41.34 per cent of total layer poultry population in 1994-99 (Table 4). Significantly, during this period the growth of duck

population excelled the chicken counterpart (31.28 *vs* 28.18 per cent) (Table 5).Thus the prospects of duck farming in the state look brighter.

- **Availability of technical know-how:** Farmers of the state are traditionally duck raisers. Most of them generally keep small groups of duck in their households. So they need simple guidelines on scientific keeping of ducks. For this purpose institutes like College of Veterinary Science, Guwahati; State Institute of Rural Development, Guwahati; NGOs and Department of Animal Husbandry & Veterinary can play vital role in training the farmers.
- **Inputs availability**. In comparison to chicken farming the necessity of providing feed is less because duck can supplement their requirements through scavenging. Further, the lands and labours are available aplenty for duck farming. Duck do not require elaborate housing unlike that of chicken, reducing the capital investment. No sophisticated equipments required in raising ducks in backyard. Being hardy, they are resistant to common avian diseases.
- **Better climate:** The state of Assam being located in monsoon sub-tropical zone, experiences good rainfall (25-330 cm/yr) every year. In summer its day temperature reaches up to 37^0C and relative humidity upto 90 per cent. Since ducks thrive well in hot and high humid weather, the climate of Assam is quite suitable for duck farming.However, there are certain points which disfavour backyard duck production. These are:

Pati, the non-descript local variety of duck that are presently reared by the farmers has poor production capacity (70 eggs per annum). Among the improved eggers, i.e., Khaki Campbell is available only in Hessarghatta and Chara-Chemballi is available only in Kerala. Getting hatching eggs or ducklings from these remote locations is not an easy task. Further, common vaccines of duck, i.e., duck plague and duck cholera are not readily available unlike the vaccines of chicken.

THE BEST OPTION TO INCREASE EGG PRODUCTION.

Among the various points discussed above the egg production using commercial chickens has more disfavouring factors. To win the '*price-war*' local agriculture farmers are to be encouraged to cultivate maize, wheat, sorghum, soybean, groundnut etc. whose byproducts can be used in poultry feeding. However, this will be a long and difficult route to reach the success. The law and order as well as flood situations are also not improving as experienced in the last few decades.

The second option that is increasing egg production using backyard chicken is the better option than the previous one. However, due to non availability of required numbers of DOCs of improved and suitable germplasm and flood situation act as stumbling block in the way of egg production. The third option looks to be the best since favouring points are overwhelming. The germplasm of improved varieties of duck and suitable vaccines can be made available with joint effort of Govt. and private sectors. In this regard the commendable job done by the State Institute of Rural Development (SIRD), Assam must be mentioned. In the year 2002-03 it initiated duck farming involving SHGs by bringing improved Chara-Chemballi germplasm from the state of Kerala. Each SHGs, maintained by women, was provided with 10 ducklings which actively took up the job and produce good income. Looking into the success various National and Regional banks came forward and loans were provided with subsidy. Gradually, the number of SHGs swelled to 1600 Nos against the targeted group of only 250 Nos. Within a time frame of 5 years the SIRD provided whopping 7 lakhs Chara-Chemballi ducklings to SHGs. On the other hand the SHGs arranged to hatch fertile eggs produced by them using incubators distributed by the SIRD at different centers spread throughout the state. Eventually, the annual income of 1600 SHGs was increased to Rs. 9.60 crores with more than 2, 00,000 Nos of egg production, daily (Anonymous, 2005-06). The duck rearing project of SIRD has not only given economic empowerment to rural women but also improved nutritional status of the people.

In the light of laudable work done by the SIRD *Nageswari,* a noted egg producing duck of Assam can be used since it has more potentiality (180 eggs/year) as compared to *Pati* counterpart. This is a popular indigenous breed, reared traditionally in Kachar and Karimganj district of Barak valley, Assam.

Conclusions

Looking into the brighter prospects of duck farming the government should come forward to help by sanctioning generous fund for creating more infrastructure facilities. For this, if necessary the ministry of AH and Dairying, Govt. of India may modify its policy so that agencies like Agricultural University, NGOs can obtain direct fund from it, in stead of routing through the state AH Deptt. This will also commensurate the '*look east'* policy adopted by the Central Government. In addition, private sectors like VHL should venture into this hitherto unexplored area since there is promising scope for business in it.

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Table 1 Status of feed ingredients and requirements*

Feed ingredient	Total availability(Human & livestock) (x1000)	Requirements for poultry (x1000 tonnes)	Deficit (x1000 tonnes)	% of deficit
Maize	13.23	38.56	(-)25.33	(-)191.45
Rice Polish	37.89	24.45	(+)13.44	(+)35.47
DORB§	23.00	18.33	(+)4.67	(+)20.30
MOC* + TOC**	9.20	12.22	(-)3.02	(-)32.83

§De-oiled rice bran, *Mustard oil cake, **Til oil cake *Adapted from Sapcota (2005).

Table 2 Average price (Rs./kg) of compounded feeds at Guwahati market

S N0	Categories	Farm-made	Commercial
1	Chick mash	14.45	16.10
2	Grower mash	9.85	13.35
3	Layer mash	10.75	15.00

Table 3 Status of layer poultry population and their table egg production in Assam (x1000 Nos.)

Poultry	**1993-94**		**1994-95**		**1997-98**		**1998-99**	
	Population	Egg	Population	Egg	Population	Egg	Population	Egg
Duck	1519	169700	1364	167300	1349	200000	1399	203100
Fowl	3023	279700	3055	293100	3136	282800	2871	283300
Total	4542	449400	4419	460400	4485	482800	4270	486400

Source: All India Poultry Business Directory, II edn. (2003-04).

Table 4 Status of poultry population in Assam (Nos)

Poultry	**1994**	**% of total**	**1997**	**% of total**	**Growth rate (%)**
Duck	3846188	27.60	5049361	28.08	31.28
Fowl	10087575	-	12930,514	-	28.18
Total	13933 763	-	17979875	-	

Source: 16th Quinquennial Livestock Census, 1997, Govt. of Assam.

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