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SHORT COMMUNICATION

PHYSICO-CHEMICAL ANALYSIS OF EGGS OF NATIVE FOWL, DUCK AND GOOSE REARED UNDER BACKYARD CONDITION

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ABSTRACT: A total of 135 eggs (50 chicken, 50 duck and 35 goose eggs) were collected from farmers' doors from adjoining rural areas of Bhubaneswar for egg quality traits and chemical analysis. The mean values of quality traits of egg weight, volume, albumin weight, yolk weight, shell weight, shell thickness, shape index, albumin index, yolk index and haugh unit score for native fowls were recorded 43.40 ± 3.30 g, 39.70 ± 1.13 cuml, 19.05 ± 0.17 g, 15.14 ± 0.28 g, 9.21 ± 0.13 g, 0.040 ± 0.01 cm, 78.22 ± 0.61, 0.154 ± 0.01, 0.271 ± 0.01 and 85.65 ± 0.18, respectively. The corresponding values for duck eggs were estimated as 73.75 ± 1.86 g, 67.00 ± 1.76 cuml, 35.73 ± 0.66 g, 25.77 ± 0.68, 12.25 ± 0.58 g, 0.071 ± 0.01 cm, 69.19 ± 0.82, 0.124 ± 0.02, 0.388 ± 0.03 and 82.47 ± 0.45, respectively. Similarly, the values for goose were 128.01 ± 1.18 g, 123.61 ± 7.03 cuml, 55.41 ± 0.78 g, 52.11 ± 0.52 g, 20.49 ± 0.21 g, 0.060 ± 0.01 cm, 75.09 ± 0.08, 0.204 ± 0.02, 0.426 ± 0.01 and 106.44 ± 0.60, respectively. The chemical composition of eggs such as moisture, crude protein, crude fat, total ash, carbohydrate, cholesterol, calcium and phosphorous and metabolized energy were also evaluated. The significant variability observed in most of egg quality traits indicated the scope for further genetic improvement.

Key words/phrases: Duck and goose, Egg quality traits, Fowl.

INTRODUCTION

Poultry products such as meat and eggs are amongst the most nutritious foods, and eggs are rated with milk as one of the best balanced protein foods rich in iron (Fe) and vitamins (Oluyemi and Roberts, 2000). The significance of animal proteins in sufficient and balanced nourishment is important for human health with respect to physical and mental development. Among such animal protein sources, poultry species are prominent; particularly domestic chicken have been ranked first followed by duck and goose. In Bhubaneswar, about 80% of rural household is involved in backyard poultry farming, which is characterized by rearing poultry in small numbers in the backyard under free range conditions. The flock size

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of the rural household involved in backyard farming ranges from 5 to 20 in number.

Backyard poultry contributes around 30% of total egg production in India. It is of great importance to the people living in rural areas providing them not only with food, but also economical support. In the past, the poultry products from backyard farming were primarily consumed by the people living in rural areas, but now these products, specifically eggs, have become very popular among the people living in urban areas as it is considered to be nutritious for all ages, an important iron source for children and a low calorie nutrition for adults (Tulin and Ahmed, 2009). The eggs and meat of free range birds are very popular and much in demand among the people living in urban areas of Bhubaneswar as they are considered to be tastier, free of antibiotics, hormones and other harmful chemicals. The birds reared in free range condition are known for their adaptation, superiority in terms of their resistance to endemic diseases and other harsh environmental conditions (Nwakpu *et al*., 1999). Therefore, more attention should be given to the genetic improvement and development of largely neglected native birds in order to ameliorate the present acute animal protein shortage among the people residing in rural areas.

Several studies have been conducted to improve the productivity and management of birds belonging to the order Galliformes (Kumar *et al*., 2008; Yakubu *et al*., 2008; Balbir *et al*., 2009; Yogendra *et al*., 2009). No studies have been carried out to characterize, evaluate and understand the quality of eggs produced by native water fowls belonging to the order Anseriformes (duck and goose) under free range conditions. These birds survive and sustain well under tropical climatic conditions of Bhubaneswar utilizing minimum input in terms of feed, healthcare and management. Scarcity of studies on egg quality of free range birds makes it difficult to establish quality standards and grades of eggs for market levels. It may also be difficult to provide proper advice to farmers on the requirements for the production of good quality eggs. The current study aims to determine egg quality characteristics and chemical compositions of free range eggs produced by native geese, ducks and chickens collected from adjoining rural areas of Bhubaneswar.

MATERIALS AND METHODS

The present study was conducted during August 2010-December 2010 in Bhubaneswar, which is the capital of Odisha state situated in the tropics between 20° 14' 31.81N and 85° 48' 57.28E at 110 feet altitude. Samples were collected from selected farmyards where the birds such as goose (*Anser cygnoides*), duck (*Anas platyrhynchos*) belonging to the Class Aves, Order Anseriformes and Family Anatidae and chicken (*Gallus gallus domesticus*) belonging to the Class Aves, Order Galliformes and Family Phasianidae were at laying stage of 74-77 weeks old. A total of 135 eggs (50 chicken, 50 duck and 30 goose eggs) were collected from 10 different houses of adjoining rural areas of Bhubaneswar with the willingness of the farmers. These farmers had maintained around 15-20 birds of each fowl species, where the birds fulfilled their nutritional requirements by scavenging in the backyard and by kitchen waste. Some farmers fed broken rice to their birds. All the egg samples were labeled and stored in the refrigerator at 4°C during field sampling. The samples were subsequently transported to the laboratory at Central Poultry Development Organization (CPDO), Eastern Region, Bhubaneswar, for physical quality characteristics and Biochemical Laboratory at Orissa University Agriculture and Technology (OUAT), Bhubaneswar, for chemical composition.

Evaluation of egg quality

The weight was measured in an analytical balance, Dhona-200 (AB-204) after removal of contaminants from shell. The volume of egg was measured by water displacement method. The egg length and width were measured with a vernier calliper in centimetre, and egg shape index was obtained by the following formula:

$$\text{Shape index} = \frac{\text{Width of egg}}{\text{Length of egg}} \times 100$$

For internal egg quality traits, individual egg samples were broken out on a flat white tile being cautious not to break the vitelline membrane that encloses the yolk. The parameters measured were as follows:

a. Yolk width was measured at the widest horizontal circumferences with a vernier calliper in centimetre.

b. Yolk height was measured as the height of yolk at the midpoint with a tripod micrometre.

c. Yolk index = $\dfrac{\text{Height of yolk}}{\text{Width of yolk}}$

d. Albumin height was measured from at least three places each with tripod micrometre (Froning and Frank, 1958).

e. Albumin width was measured at the widest horizontal circumference of the thick albumin with a vernier calliper in centimetre.

f. Albumin index = $\frac{\text{Height of albumin}}{\text{Width of albumin}}$

g. Thickness of egg shell was measured with a micrometre screw gauge. The mean of three points (narrow, broad and middle portion) were taken as shell thickness.

h. Haugh unit was determined using the following formula:

$$HU = H + 7.57 - 1.7\,W^{0.37}$$

Where HU=Haugh Unit, H=height of albumin (mm) and W=weight of egg (g). Individual Haugh Unit (Haugh, 1937) score was calculated using egg weight and albumin height (Doyon *et al*., 1986).

i. The yolk was separated from albumin and weighed. Shell weight was measured after the removal of shell membrane using analytical balance, Dhona-200 (AB-204).

j. The weight of albumin was calculated by subtracting the weight of yolk and shell from the weight of whole egg.

Chemical analyses

Chemical analyses were carried out in two accredited laboratories namely the Feed Analytical Laboratory of Central Poultry Development Organization (CPDO), Eastern Region and Biochemical Laboratory of Poultry Science Department, College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology (OUAT) located at Bhubaneswar. In the laboratories, the eggs were kept in refrigerator at 4°C. Energetic value, carbohydrate, cholesterol, crude protein, crude fat (lipid), moisture content, total ash, calcium and phosphorous contents were determined. The cholesterol content was analyzed enzymatically by using Coral Diagnostic Cholesterol Reagent as described by Allain *et al*. (1974). The crude fat content was analyzed by Soxhlet Extraction method as described by AOAC (1990). Similarly, crude protein was estimated by multiplying 6.25 to nitrogen content obtained by Micro-Kjeldahl method as described by AOAC (1990). The moisture content was determined by drying at 100-102°C for 16 to 18 hours as described by AOAC (1990) and ash content was analyzed by incineration in muffle furnace at 550°C as described by AOAC (1990).

Calcium was analyzed by potassium permanganate titration method and phosphorous content was determined by colorimetric method using ammonium molybdate solution as described by AOAC (1990). Energetic value and carbohydrate were calculated computationally using the following formula (Matt *et al*., 2009):

Kcal/100g of edible egg = (g protein x 4.63) + (g lipids x 9.02) + (g carbohydrate x 3.87) and 100% - (protein% + fat% + humidity% + ash%), respectively.

Statistical analyses

In order to find out the significant differences in egg quality characteristics between the species, analyses of variance (ANOVA) was conducted and mean values were compared by Duncan's Multiple Range Test (Duncan, 1955). Statistical analyses were conducted with MSTAT.C.

RESULTS

External egg qualities

Mean and standard errors of external and internal egg quality traits of three avian species of fowl, duck and goose are presented in the Table 1. The colour of the native chicken egg ranged from tinted brown to brown, whereas that of native duck and goose egg colour varied from white to creamy. The weight of goose egg (128.01 ± 1.18 g) was found to be significantly higher ($P<0.01$) than that of chicken egg (43.40 ± 3.30 g) and the duck egg (73.75 ± 1.86 g). Lower volume of fowl egg (39.70 ± 1.13) was estimated in comparison to duck (67.00 ± 1.76) and goose (123.61 ± 7.03) eggs.

The shape of the egg has been expressed in terms of shape index and the shape indices of the eggs of the chicken, duck and goose were 78.22 ± 0.61, 69.19 ± 0.82 and 75.09 ± 0.08, respectively (Table 1) with significant ($p<0.001$, $p<0.05$ and $p<0.01$, respectively) statistical difference. Generally, eggs of birds have oval shape with small differences among species. In this study, eggs of native chicken, duck and goose showed similar conical shape, blunt at one side and pointed at the other end.

Table 1. Mean and standard errors of egg quality traits of three poultry birds maintained at free range condition between 74-77 weeks of age.

Parameter	**Bird**		
	Chicken (50)	**Duck (50)**	**Goose (35)**
Colour of egg	Tinted brown	White to cream	White to cream
Weight of egg (g)	43.40 ± 3.30 [c]	73.75 ± 1.86 [b]	128.01 ± 1.18 [a]
Egg volume (cuml)	39.70 ± 1.13 [c]	67.00 ± 1.76 [b]	123.61 ± 7.03 [a]
Shape index	78.22 ± 0.61 [a]	69.19 ± 0.82 [c]	75.09 ± 0.08 [b]
Albumin weight (g)	19.05 ± 0.17 [c]	35.73 ± 0.66 [b]	55.41 ± 0.78
Yolk weight (g)	15.14 ± 0.28 [c]	25.77 ± 0.68 [b]	52.11 ± 0.52 [a]
Shell weight (g)	9.21 ± 0.13 [c]	12.25 ± 0.58 [b]	20.49 ± 0.21 [a]
Shell thickness (cm)	0.040 ± 0.01 [b]	0.071 ± 0.01 [a]	0.060 ± 0.01 [a]
Albumin index	0.154 ± 0.01 [b]	0.124 ± 0.02 [c]	0.204 ± 0.02 [a]
Yolk index	0.271 ± 0.01 [b]	0.388 ± 0.03 [a]	0.426 ± 0.01 [a]
Haugh unit	85.65 ± 0.18 [b]	82.47 ± 0.45 [b]	106.44 ± 0.60 [a]

Mean carrying different superscripts in a row differ significantly showing the level of significance as (a=$p<0.001$, b=$p<0.01$, c=$p<0.05$); Numbers in parenthesis are number of observations.

Internal egg qualities

Albumin content of duck egg (35.73 ± 0.66 g) was significantly higher than that of native fowl (19.05 ± 0.17 g) and lower than goose (55.41 ± 0.78 g). The yolk weight was also in the same increasing order of albumin with 15.14 ± 0.28 g, 25.77 ± 0.68 g and 52.11 ± 0.52 g for native fowl, duck and goose, respectively. A significant difference ($p<0.01$) was observed for duck albumin and goose yolk content.

The shell weight of the eggs of native chicken, duck and goose were 9.21 ± 0.13 g, 12.25 ± 0.58 g and 20.49 ± 0.21 g, respectively. These differences in shell weight were statistically significant between the three species ($p<0.001$, $p<0.01$ and $p<0.05$, respectively). Significant difference was observed in shell thickness of the eggs of these three species, where the shell of the native duck (0.071 ± 0.01 cm) was found to be significantly thicker than the shell of native chicken (0.040 ± 0.01 cm).

The difference in albumin index was statistically significant, which was higher in the goose egg (0.204 ± 0.02). But, no significant differences were observed in the yolk index of the native duck and goose, whereas significantly lower yolk index was observed in the eggs of native chicken (Table 1). The Haugh unit, which is based on albumin height and egg weight, was 85.65 ± 0.18, 82.47 ± 0.45 and 106.44 ± 0.60 for the native chicken, duck and goose, respectively (Table 1). The Haugh units did not differ significantly between native chicken and duck. However, it was found to be significantly higher in the native goose (P<0.001) (Table 1).

Chemical composition

Analysis of chemical composition of the eggs of native chicken, duck and goose showed significant differences (p<0.001, p<0.01 and p<0.05, respectively) between the species (Table 2). The moisture content was recorded to be significantly higher (p<0.001) in chicken egg (74.10 ± 0.35%) than duck egg (71.42 ± 0.05%) and goose egg (70.58 ± 0.04%). Crude protein was significantly lower in chicken egg, and there was no significant difference between duck and goose. So far, as crude fat content of eggs of these species were concerned, all were significantly different from each other. There was no significant difference for the total ash content of eggs of these three species. Carbohydrate, cholesterol, calcium, phosphorous and energy level of native fowl egg was significantly higher (p<0.01) than that of water fowl, duck and goose. However, there were no significant difference (p>0.05) in these components among the eggs of native duck and goose (Table 2).

Table 2. Chemical composition of whole egg content of three poultry birds maintained at free range condition between 74-77 weeks of age.

Parameter	Birds		
	Chicken (50)	**Duck (50)**	**Goose (35)**
Moisture content (%)	74.10 ± 0.35^{a}	71.42 ± 0.05^{b}	70.58 ± 0.04^{b}
Crude protein (%)	11.20 ± 0.02^{b}	13.06 ± 0.03^{a}	13.42 ± 0.11^{a}
Crude fat (%)	9.83 ± 0.10^{c}	14.15 ± 0.12^{a}	13.20 ± 0.03^{b}
Total ash (%)	1.15 ± 0.10^{a}	1.09 ± 0.03^{a}	2.06 ± 0.15^{a}
Carbohydrate (%)	0.52 ± 0.10^{b}	1.72 ± 0.28^{a}	1.64 ± 0.28^{a}
Cholesterol (mg)	380.80 ± 7.91^{b}	824.40 ± 0.68^{a}	880.20 ± 0.73^{a}
Calcium (mg)	46.14 ± 0.14^{b}	63.00 ± 0.19^{a}	60.04 ± 0.17^{a}
Phosphorous (mg)	178.32 ± 4.06^{b}	204.46 ± 0.97^{a}	208.00 ± 0.01^{a}
Energy (k/cal per 100g)	145.03 ± 0.70^{b}	190.77 ± 0.87^{a}	188.16 ± 0.63^{a}

Mean carrying different superscripts in a row differ significantly showing the level of significance as (a=p<0.001, b=p<0.01 , c=p<0.05); Numbers in parenthesis are number of observations.

DISCUSSION

External egg qualities

The tinted brown to brown colour of eggs from free range backyard chicken are more acceptable than commercial white egg and fetches extra price than commercial egg. Duck and goose egg colour varied from white to creamy, but sometimes dirty eggs were noticed due to aquatic habit, which can be improved by good nest management practices.

The significant difference between weight of eggs of native fowl, duck and goose is due to species differences. Ducks and goose eggs were recorded as 69.92% and 194.95% heavier than chicken eggs. The correlation between birds' body weight and egg weight was positive, which indicates that birds with heavier body weight lay larger eggs than small birds. The volume of native fowl egg was significantly lower than values reported by Dash *et al*. (2011) in Kalinga Brown (48.00 ± 0.37), CARI Shyama (47.67 ± 0.92) and Black Rock (49.33 ± 0.21).

Generally, eggs of birds have oval shape with small differences among species. Despite its small differences, the egg shape is considered to be an important factor in characterizing avian species (Dudusola, 2010). The shape indices of the native chicken egg in the present study was similar to those reported by some authors (Powrie, 1977; Baek, 1990) whereas higher shape index of (76.57 ± 0.58) of native duck was reported by Padhi *et al*. (2009) than the present study.

The weight of albumin, yolk and shell weight were recorded to be significantly higher in the native goose egg due to much higher egg weight of goose. The yolk to albumin ratios of the three species were calculated as 0.79 in native chicken, 0.72 in ducks and 0.94 in goose. Similar results were recorded by Dash *et al*. (2011) in Kalinga Brown (0.81), in CARI Shyama (0.72) and in Black Rock (0.94). The quality of egg shell is one of the most important qualities, monitored in the long term for purpose of selective breeding and transportation. Egg shell quality is described by its actual weight, thickness and strength (Zhang *et al*., 2005).

Albumin index is a criterion to check the freshness of eggs. This was significantly higher in the native goose egg in the present study, whereas Padhi *et al*. (2009) reported lower albumin index of 0.149 in native duck egg than the present study. Yolk index and Haugh unit are indicators of internal egg quality and are reported to be higher in the native goose eggs. The higher the Haugh unit and yolk index, the more desirable is the internal quality of egg (Ihekoronye and Ngoddy, 1985; Imai *et al*., 1986; Ayorinde, 1987; Adeogun and Amole, 2004). Tulin and Ahmed (2009) observed Haugh unit of 85.82 in native chicken egg, which is similar to the present study. Higher Haugh unit and yolk index was reported in the native duck egg by Padhi *et al*. (2009), which were lower in the present study.

Chemical compositions in the present study of chicken egg were in agreement with results of those obtained by USDA (1983) where the moisture content, crude protein, crude fat and ash content were 74.57%, 12.14%, 11.5% and 0.99%, respectively. No species difference in the proximate compositions of albumin and yolk was found in the eggs of native duck and goose, whereas the proximate composition of the native chicken egg differed significantly from the other two species (Table 2). Cholesterol was significantly higher ($p<0.001$) in goose eggs. The cholesterol concentration in eggs depends on breed and age of layers, management and nutrition (Foster and Flock, 1997) and partly on synthesis in liver during the synthesis of lipoproteins.

The results of the present study indicate that all the external and internal egg quality parameters are found within the normal range, and these traits may be used in selection indices for improving the egg quality. More emphasis should be given for conservation of native germplasm. It is also important for the farmers practising backyard farming to adapt better management practices and provide diet formulated with required amount of calcium and phosphorous and monitor the flock from diseases to improve the egg quality and production. The growing demand for egg and low investment in backyard sector provides opportunity for the rural, particularly, women for employment opportunities. Mass production of eggs in backyard sector will facilitate better economy in rural areas.

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