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Comparative Biochemical and Mineral Analysis of Poultry Bird Egg Varieties Found in Assam, India

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ABSTRACT

The study emphasizes on nutrient and mineral composition of poultry bird eggs found in Assam. Four egg varieties viz. Bahuboli, farm chicken, duck and local chicken egg were selected for the study. Standard AOAC methods were used for determination of proximate and nutritional analysis. The study suggested significantly ($p<0.05$) major differences in the nutritional composition among all the egg varieties. Carbohydrate content was found the highest in farm chicken egg (0.43±0.007 g/100 g), followed by duck egg (0.38±0.009 g/100 g), Bahuboli egg (0.31±0.004 g/100 g) and local chicken egg (0.30±0.02 g/100 g) respectively. Lipid content was detected highest in duck egg (36±2.64%), followed by Bahuboli egg (36±1%), farm chicken egg (34±1.5) and least was found in local chicken egg (31±1.7%). Cholesterol was found highest in duck egg (7.20±0.046 mg/g) and lowest in local chicken egg (5.28±0.11 mg/g). Highest calorific value was found in duck egg (201.06±2.916) kcal/100 g and lowest in local chicken eggs (119.06±9.70) kcal/100 g. The findings suggested that duck eggs have significantly ($p<0.05$) higher protein, fats, lipid and cholesterol content. In the mineral analysis, the concentration of zinc showed highest in Bahuboli egg (28.06 mg/100 g) and sodium, potassium, magnesium and calcium were found the highest in local chicken egg variety.

Keywords AOAC, Bahuboli egg, Cholesterol, Farm egg, Local chicken egg, Mineral, Nutrient.

INTRODUCTION

Bird eggs are a comparatively economical source of essential nutrients consumed by humans for many years. In many parts of the world, eggs are a readily available and inexpensive food. Many studies have proposed that eggs contain several multivitamins and minerals that are vital parts of a healthy diet. This means that eggs can be used to solve the problems of protein and micronutrient deficiencies. Eggs are a particular interest from a nutritional point of view, gathering essential lipids, proteins, vitamins, minerals and trace elements. Eggs have been recognized to

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signify the lowest – cost animal source for proteins and various forms of vitamins. As well as the second lowest cost for Zinc and Calcium (Drewnowski 2010). In addition to providing well- balanced source of nutrients for adults including infants, egg contains numerous biologically active components. Egg white proteins are the principal solutes present in egg white, making up approximately 10% of its weight (Stevens 1991). Thus, at a time while there is increased concentration in eating healthy, unmodified food, eggs can be widely considered.

Egg is also recognized as a condensed source of macro and micronutrients that meet all requirements to support embryonic development until hatching. The perfect balance and diversity in its nutrients and its affordable price have put the egg in the spotlight as a basic food for humans. In parallel, there is compelling evidence that egg also contains many and still-unexplored bioactive compounds, which may be of high interest in preventing and curing diseases (Rehault *et al.* 2019).

In Assam, eggs come in various sizes, ranging from small to large eggs, chicken eggs are the most commonly consumed eggs in this state. Till date studies have been conducted on different egg varieties of bird but studies on comparative biochemical analysis including the locally available Bahuboli egg is limited. Hence, this study was conducted with an aim to determine the proximate nutrition and mineral analysis of four bird egg varieties: Bahuboli, farm chicken, duck and local chicken egg ; such as to enhance the food security and improve nutritional status. The study might contribute to nutrient composition catalog which might be useful in the valuation of nutritional intake of individuals and solve the problem of malnutrition in the region.

MATERIALS AND METHODS

Study area

Four fresh egg samples–Bahuboli, farm chicken, duck and local chicken were purchased from the study area in Guwahati (Fig. 1). They were then transferred to the laboratory of Zoology department, B. Borooah College, Guwahati for further investigation.

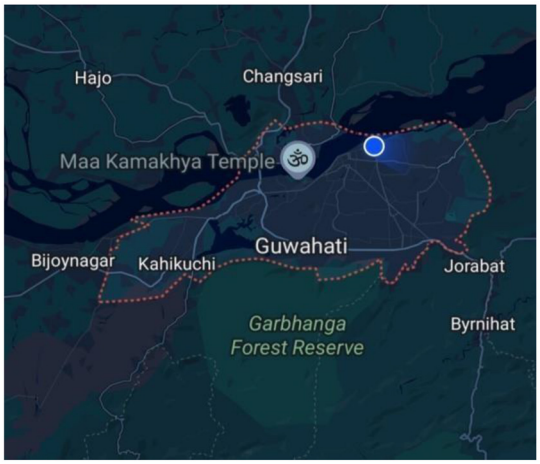

Fig. 1. Map of Guwahati.
Source: https://www.worldmap.cc/map/c-101/states-4027/city-132039.html

Homogenate preparation

The fresh eggs were cleaned, labelled and boiled by putting them in tap water already boiling at 100 degrees Celsius. The tap water was enough to cover the eggs in the beaker. The eggs were left to boil for 10 minutes, immediately after which they were removed and allowed to cool in tap water at room temperature. The collected eggs were boiled separately and then shelled after they had cooled. The boiled eggs were placed in clean, labeled beakers and sealed with paraffin prior to undergoing further biochemical analysis. The boiled, whole (shelled) eggs were mashed and then dried properly. All the moisture removed from the samples for preventing microbe growth, and the samples were kept in an air tight container for future biochemical analysis. The dried samples were milled to give fine powder, using laboratory miller. Milling was done under very low temperature. After milling 50 gram of each sample was refrigerated in labeled, air tight sample glass containers, until ready for analyses.

Proximate analysis

Proximate analysis of the collected egg samples was done following the AOAC methods (1995).

(1) Moisture content (%)—In brief, moisture con-

tents were determined by taking a 1 gram of all the samples of the eggs (egg whites and egg yolks separately), then they were dried in the incubator at 70 degrees celsius. After that samples were cooled down and weight again. Moisture content was calculated from the difference between the wet and dry weight using the formula :

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

(2) **Ash content (%)** —A portion of dried samples was taken and the samples were then kept in in a porcelain dish and heated in microwave at 300 degrees celsius for 2 hrs. Ash content was then calculated using the formula :

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of dried sample}} \times 100$$

(3) Crude fat content (%)—1 gram of all the samples were taken then they were kept in Diethyl ether for 2 hrs at 90 degrees celsius. After the extraction, the sample was kept for 30 minutes at 70 degrees celsius. Then the samples were cooled and weighed. The solvent evaporated. The non-polar solvent readily dissolves non-polar lipids like fats, thus during evaporation the diethyl ether evaporates along with fats.

The crude fat content of the samples was then calculated using the formula :

$$\text{Crude fat \%} = \frac{\text{Original weight of sample} - \text{Weight of sample after extraction}}{\text{Original weight}} \times 100$$

(4) Crude fiber content (%)— Crude fiber content is determined through a laboratory analysis where the food sample is treated with acid and alkali to remove non-fiber components, leaving behind the fiber residue which is then weighed.

$$\text{Crude fiber \%} = \frac{\text{Weight of sample after ignition}}{\text{Weight of sample}} \times 100$$

(5) Estimation of carbohydrate

Estimation was done by following the Anthrone method (Dreywood 1946).

For extraction of carbohydrate from the egg samples:

1.5 g of egg yolk was weighted out in a centrifuge calibrated tube containing 2 ml of 30% KOH. The content was then heated in a boiling water bath for 20 minutes with occasional shaking. It was then cooled in ice and 0.2 ml of saturated sodium sulfate was added and mixed properly. The reaction mixture was diluted in 100 ml of distilled water. After that centrifugation was done for 5 minutes. Now, then 4 ml of Anthrone reagent was added to the samples and heated in a boiling water bath for almost 8 minutes.

Calculations

$$\text{Total carbohydrate (mg/100 g)} = \frac{\text{mg of glucose}}{\text{Volume of test sample}} \times 100$$

The carbohydrate contents of the eggs were expressed in the terms of g/100 g of dry weight.

(6) Estimation of lipid by Folch method (Folch *et al.* 1957)

The quantitative lipid estimation was mainly done by following the Folch method of lipid extraction.

Calculations

$$\text{The total lipid (\%)} = \frac{\text{Weight of extracted lipid}}{\text{Weight of the sample}} \times 100$$

(7) Estimation of protein by bradford method (Bradford 1976)

The Bradford protein assay is a commonly used method for estimating the concentration of proteins in a sample. The amount of protein in a sample is determined spectrophotometrically by measuring the absorbance of the blue-colored solution at 595 nm and comparing it to a standard curve generated using known concentrations of protein.

(8) Estimation of cholesterol

Erba Mannheim Cholesterol kit was used for cholesterol detection. Egg yolk (1g) was taken in a centri-

fuge tube and mixed with 10 ml chloroform and 5 ml methanol (2:1) solution and shaken well for 12 times by hand. The aqueous methane layer was removed and discarded. The chloroform layer remaining was kept over water bath to evaporate chloroform. The egg samples were then tested for cholesterol using Erba Mannheim Cholesterol kit.

The standard was prepared by mixing 1000 µl working reagent with 20 µl cholesterol standard, test solutions were prepared by mixing 20 µl extracted cholesterol sample in 1000 µl cholesterol working reagent, a blank is prepared by mixing 1000 µl cholesterol reagent with 20 µl distilled water. The absorbance of standard and each test was read against blank at 505/670 nm. The basic assay procedure is given below :

Pipette into tubes marked	Blank	Standard	Test
Working reagent	1000 µl	1000 µl	1000 µl
Distilled water	20 µl	----------	----------
Standard	----------	20 µl	----------
Test	----------	----------	20 µl

Calculations

$$\text{Cholesterol (mg/g)} = \frac{\text{Absorbances of test}}{\text{Absorbance of standard}} \times \text{Concentration of standard}$$

(9) Computation of calorific value

Caloric value was estimated using the following equation (FAO 2003).

Calorific value (kcal/100 g) = [4× protein (%)] + [9×fat (%)] + [4×carbohydrate (%)]

The total caloric value is expressed as kcal/100 gram of weight.

(10) Mineral analysis

1 gram of each dried egg sample was processed using acid digestion method. 65% Nitric acid and 37% Hydrochloric acid were mixed in the ratio of 1:3 to form Aqua regia. Then 9 ml of freshly prepared mixture was added to the dried samples. Then the mixture was boiled gently over a water bath at 95 degrees Celsius for 4-5 hrs or till the samples had completely dissolved (Ang and Lee 2005 and Palma *et al.* 2015). Then it was cooled and filtered with distilled water making up to a volume up to 50 ml.

Then the digested samples were sent to Guwahati Biotech Park, Amingaon for the mineral analysis by ZEE nit 700 P Atomic Absorption Spectrophotometer (AAS) method.

Statistical analysis

Each experiment was replicated thrice and the statistical data was analyzed using Microsoft Office Excel (2016). Values are expressed as mean ± standard deviation.

The results obtained were statistically analyzed using one-way analysis of variance (ANOVA) in the Statistical Package for Social Sciences (SPSS), version 20 at 5% significance level.

RESULTS

The findings of the study have been recorded and the analysis was conducted.

Table 1 showed the preliminary observations of egg weight and egg components of fresh and boiled eggs of Bahuboli, farm, duck and local varieties. The preliminary observations showed that the Bahuboli egg had the highest weight in both raw and boiled stage. Bahuboli egg also showed the highest weight of albumen (egg white) and egg yolk as compared to other egg varieties; however, local egg showed the lowest weight in both raw and boiled stage. This variety also showed the lowest weight of egg albumen and egg yolk among all the collected varieties. It was also noticed that the farm egg varieties had a white colored shell but the local egg variety had a brown-colored shell.

Proximate composition

Proximate composition of egg samples: Bahuboli egg, farm chicken egg, duck egg and local chicken

Table 1. Preliminary observations and measurements of the collected egg samples.

Sl. No.	Egg sample	Raw weight	Weight of boiled egg	Egg white weight (boiled)	Egg yolk weight (boiled)	Shell weight	Shell color
1	Bahuboli	65.86 g	65.73 g	28.26 g	22.30 g	12.61 g	White
2	Farm egg	58.95 g	60.59 g	25.80 g	20.4 g	11.67 g	White
3	Duck egg	59.37 g	60.01 g	27 g	19.2 g	10.8 g	White
4	Local chicken egg	36.52 g	36.50 g	18.94 g	15.10 g	8.56 g	Brown

Table 2. Experimental values of moisture and ash contents of egg whites and egg yolks of the egg samples expressed as mean ±SD.

Parameters	Moisture content (%)		Ash content (%)	
Egg samples ↓	Egg white	Egg yolk	Egg white	Egg yolk
Bahuboli egg	87.43±0.06	54±2.02	1.3±0.3	2.8±0.23
Farm chicken egg	89.87±1.03	58±1.0	1.2±0.2	2.79±0.18
Duck egg	86.83±0.73	55±1.0	1.6±0.2	3.3±0.30
Local egg	90.3±1.52	53.6±1.5	1.16±0.15	1.7±0.1

Table 3. Table showing mean ±SD and the presence of significant difference between each parameter of nutritional composition of the egg varieties after ANOVA test was performed.

Parameters Egg samples ↓	Fiber (%)	Carbohydrate (g/100 g of dry weight)	Protein (mg/g of dry weight basis)
Bahuboli egg	00.00	0.31±0.004*	12.986±0.27
Farm chicken egg	00.00	0.43±0.007	12.985±0.075
Duck egg	00.00	0.38±0.009	13.21±0.15
Local egg	00.00	0.30±0.02*	9.21±0.156

Table 4. Table showing mean ±SD and the presence of significant difference between each parameter of nutritional composition of the egg varieties after ANOVA test was performed.

Parameters Egg Samples ↓	Fat (%)	Lipid (%)	Cholesterol (mg/g)
Bahuboli	12.6±0.57	36±1	5.56±0.04*
Farm chicken egg	12.6±1.52	34±1.5	5.68±0.12
Duck egg	16.3±0.57	36±2.64	7.20±0.046*
Local chicken egg	9±1	31±1.7	5.28±0.11

eggs were determined in dried conditions. Experiments were conducted in triplicates represented as mean±SD.

Table 2 showed the moisture and ash contents of the selected egg varieties. From the tabulated data, moisture in egg white was found highest in local egg (90.3±1.52%) and moisture content in egg yolk was found highest in farm egg (58±1.0%). Ash content in both egg white and egg yolk was found highest in duck egg (1.6±0.2% and 3.3±0.30% respectively).

Datas in Table 3 showed the carbohydrate content to be highest in farm egg (0.43±0.007 g/100 g) followed by duck egg (0.38±0.009 g/100 g), Bahuboli (0.31g/100 g) and local egg (0.30±0.02 g/100 g) respectively. Egg white showed the highest concentration of protein in duck egg (13.21±0.15 mg/g) followed by Bahuboli egg (12.986±0.27 mg/g), farm egg (12.985±0.075 mg/g) and local egg (9.21±0.156 mg/g) respectively. The study also showed that the egg yolks do not contain any crude fiber or dietary fiber.

Table 4 showed the fat, lipid and cholesterol

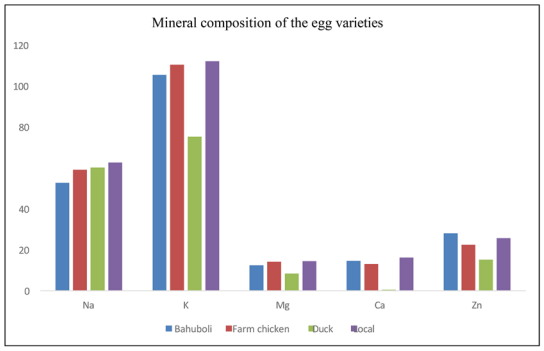

Fig. 2. Graphical representation of mineral composition of the egg varieties.

Table 5. Calorific values of bird egg varieties.

Sl. No.	Sample	Calorific value (kcal/100 g)	Energy (KJ)
1	Bahuboli egg	166.584 ± 6.23	697.4
2	Farm chicken egg	165.9 ± 14.00	694.6
3	Duck egg	201.06± 2.916	841.83
4	Local chicken egg	119.06 ± 9.70	498.50

contents of the selected egg varieties. From the above table it was observed that the duck egg contained the highest amount of fat (16.3±0.57%), lipid (36±2.64%) and cholesterol (7.20±0.046 mg/g), however the local egg variety contained the lowest amount of fat (9±1%), lipid (31±1.7%) and cholesterol (5.28±0.11 mg/g).

All values are in triplicates. Values are expressed as mean±SD

Table 5 shows the calorific value of the egg varieties, calculated calorific values ranged from (119.06 ± 9.70) kcal/100g to (201.06± 2.916) kcal/100 g and varied greatly among the egg species with duck egg (201.06±2.916)kcal/100g recording the highest value, followed by Bahuboli farm egg (166.584±6.23) kcal/100g, farm chicken egg (165.9±14) kcal/100g and local chicken eggs (119.06±9.70) kcal/100 g respectively.

Mineral analysis of egg samples (Table 6, Fig 2) showed the amount of minerals in the egg yolks of the

Table 6. Experimental values of mineral composition of the egg varieties after ANOVA test was performed.

Sample (mg)	Bahuboli	Farm chicken	Duck	Local
Na	52.78*	59.14	60.2	62.61
K	105.5	110.5	75.3*	112.2
Mg	12.42	14.20	8.4*	14.50
Ca	14.56	13.10	0.5*	16.24
Zn	28.06	22.51	15.2*	25.73

selected egg varieties. Essential elements like Na was found highest in local chicken egg and lowest in farm egg, K was found highest in local chicken and found lowest in duck egg, Mg was found highest in local and duck egg and Ca was found highest in local chicken and lowest in duck egg. In the analysis the amount of Zn was found highest in Bahuboli egg which was followed by farm, local and duck egg.

DISCUSSION

Egg quality is typically indicated by the biochemical make up of it. Therefore, determining the nutritional and edible values is aided by knowing its approximate biochemical composition. Results of this present study suggested that all the egg varieties contain various nutrients in different composition. Also, many previous studies have shown that nutrient content varies among species to species. Proximate chemical analyses of the studied eggs are represented in Table 2, 3, 4 and 5. Results are expressed on dry weight basis. From the tabulated data, moisture is found the major component of all examined samples as it reached to 90.13±1.52%, 89.87±1.03%, 87.43±0.06% and 87.83±0.73% for whole egg whites of local chicken, farm chicken, Bahuboli and duck eggs respectively. The variations in the moisture content in the samples were less than 10%. Local chicken egg had significantly higher moisture content than all the other egg varieties. The variability in moisture content of egg may depend on several factors, but is mainly dependent on the breed, environmental condition, size of the egg and rate of production, similar finding was obtained by Sharaf (2011), Ali and Abd El-Aziz (2019) and Chaiyasit *et al.* (2019).

Ash content was noticeable in the duck egg yolk (3.3±0.30%) compared to other species at dry weight basis, while when compared at dry weight basis the local chicken eggs had lower ash content among the studied species. This result corelated with the study reported by Sun *et al.* 2019. Total carbohydrate content was significantly lower than the other essential nutrients. However, the carbohydrate content of farm eggs was significantly reported higher than the other egg varieties, which was similar with the study as reported by Onyenweaku *et al. (*2018).

Besides, protein, crude fat, lipid and cholesterol constitute the major nutritious components of the solid matter of all studied eggs. The highest values of protein content were found in duck eggs (13.21±0.15 mg/g) on dry weight basis, where the significantly lowest values were given by local chicken eggs (9.21± 0.156 mg/g). Moreover, the duck and Bahuboli eggs had significantly higher crude fat and lipid content than the other studied egg varieties, such result was similar to Onyenweaku *et al.* (2018) and Chaiyasit *et al.* (2019).

The average cholesterol content in duck egg yolk was significantly higher (7.20±0.046 mg/g) than farm, Bahuboli and local chicken egg yolk with (5.68±0.12), (5.56±0.04) and (5.28±0.11) mg/g respectively, the results obtained were numerically similar to Jalaludeen and Churchil (2006).

Calculated energy values ranged from (119.06 ±9.70) kcal/100 g to (201.06±2.91) kcal/100 g and varied greatly among the egg species with duck egg (201.06±2.916) kcal/100 g recording the highest value, followed by Bahuboli farm egg (166.584±6.23) kcal/100 g, farm chicken egg (165.9±14) kcal/100 g and local chicken eggs (119.06±9.70) kcal/100 g respectively, similar trend was showed by Onyenweaku *et al.* (2018).

As shown in Table 6 essential elements like Na was found highest in local chicken egg and lowest in Bahuboli egg, K was found highest in local chicken and found lowest in duck egg, Mg was found highest in local and lowest in duck egg and Ca was found highest in local chicken and lowest in duck egg, Zn content was found most predominant mineral in Bahuboli egg followed by local chicken egg, farm egg and duck egg respectively which corelated with the study conducted by Onyenweaku *et al.* (2018). Nutritive analysis of the egg varieties of Assam revealed that eggs are a good source of carbohydrates, proteins, fat, lipid, cholesterol and minerals.

CONCLUSION

The results of the proximate composition and calorific value of the egg varieties showed that it contained a very good amount of carbohydrate, protein, fat, lipid, cholesterol and minerals as well. The results indicated that, the eggs biochemical composition varied within species and might be associated with the different characteristics of the birds and their feeding habits. The study showed that apart from the popularly consumed local chicken egg and farm chicken egg, newly available Bahuboli farm eggs are also highly nutritious with high calorific value. Thus, it can be recommended in the diets of both children and adults as they provide the essential nutritional composition. The study might even contribute to nutrient composition catalog which might be useful in the valuation of nutritional intake of individuals and solve the problem of malnutrition in the region.

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