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Research article

Nutritional composition of chicken (*Gallus gallus*, *Gallus domesticus*) and duck (*Anas platyrhynchos*) egg powder

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A B S T R A C T

The study aimed to assess the raw weight and nutrient composition of different parts of chicken (exotic and native) and duck egg powder. Nutrient composition including proximate, mineral and vitamin were analyzed according to AOAC methods. Descriptive statistics and ANOVA were performed and p <0.05 was considered as significant difference. Weight of raw whole egg (p<0.05) and yolk of duck (p<0.05) was found higher than chicken egg. Native chicken's egg weight was found lower than other two types of eggs but contain almost same proportion of albumen and egg yolk. Proximate analysis of albumen showed highest protein in native chicken (84.58%), in duck (81.84%) and in exotic chicken (81.43%), respectively. In yolk, duck egg had higher protein (38.5%) as compared to layer chicken egg (36.52%) and native chicken egg (36.16%), consecutively. Native chicken egg albumen possesses higher amount of calcium (2.87mg/gm), magnesium (1.30mg/gm), phosphorus (6.26mg/gm) and potassium (2.48mg/gm) compared to other two types of exotic chicken and duck egg. While, native chicken's egg yolk contained higher amount of magnesium (0.62mg/mg), phosphorus (17.78mg/mg) and potassium (4.28mg/mg) than other two types of egg. This study showed higher weight of duck egg than egg of both native and exotic chicken. In dried condition, native chicken's egg albumen contained high amount of nutrients while in dried yolk of exotic chicken having high amount of nutrients.

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1. INTRODUCTION

Egg plays pivotal role to fulfill the daily nutrient protein requirements of human being. Poultry eggs, especially chicken and duck eggs are one of the most commonly available delicious food items to the consumer world. Egg is a good source of protein with high biological value. The protein quality of the egg is often considered as the standard for measuring the quality of all other food proteins. Egg also contains an important source of essential fatty acids (linoleic, oleic acid), minerals (iron, phosphate) and necessary vitamins. Egg comprises 11% of fat, 12% of protein and other important components of minerals and vitamins (Panda, 1995).Egg contributes significantly to the body's nutrient demands for the growing children and teenagers. Moreover, egg provides a well-balanced source of nutrients for all ages of person (Stadelman and Cotterill, 1995), and offers a rich source of lipids including triacylglycerols, phospholipids and cholesterol (Watkins, 1995).

The main functional properties of egg are stabilization of emulsion, foam ability and build up firm gels. It is also used as colorants (Stadelman and Cotterill, 1995). These natural qualities of eggs are very effective in bakery industry, bakery mixer, mayonnaise dressing, confections, ice cream, pasta and many other food items (Stadelman and Cotterill, 1995). Apart from the uses of egg in the different food industries, the eggs are also used as sources of raw materials for the pharmaceutical and cosmetic industries across the world (Ternes and Leitsch, 1997). It is reported that fresh raw eggs are difficult to transport easily due to its various characters say bulkiness, breakage, crackage or fragility, spoilage, highly vulnerability, perishability nature etc., to the surrounding environment (Jay, 2000). Jayaramanet al. (1976) reported that considerable loss about 2.5% occurs due to breakage while transporting fresh raw egg.

Day by day the commercial egg production has been increasing in Bangladesh, however, the price of eggs fluctuates very often- an emerging challenge or obstacle for the growth of poultry industry. The producers face problems in preserving the raw eggs. As a result, the wastage of eggs incurs huge economic loss. Therefore, eggs have to be utilized to greater extent possible to reduce wastages and to protect price structure. Because of the increased production and the difficulties in the storage of whole egg, there is a need to preserve the egg for domestic consumption and to promote export (Rao et al., 1995).

The peoples are becoming aware of regarding the health and they are more interested to consume different parts of eggs separately. For example, some peoples need only albumen and other needs yolk. To fulfill their requirement, it's essential to explore or produce different forms of eggs say powder form of eggs. However, so far we know, the processing of egg powder production and their nutritional quality were not done in the contexts of Bangladesh. Another important point is that, the people consume different types of poultry eggs. But there is limited information regarding the nutrient levels among different types of poultry eggs.

Dehydrated egg products offer many advantages: longer shelf life, lower storage and transport costs, and specific functional properties. Egg powder is mostly available in bakery industry due to its ability of air trapping while its incorporation with other material, which gives the characteristic spongy texture to the product, and to produce stable foam. Considering the above, the present study was undertaken to assess the nutrient compositions of different types of eggs consumed by the human at raw and dried condition in albumen and yolk powder, respectively. The assessment includes analysis of proximate component and micronutrients (calcium, magnesium, phosphorus, sodium, potassium, chloride, and iron) and vitamin E (Alpha tocopherol).

2. MATERIALS AND METHODS

The experiment was undertaken to manufacture quality egg powder through determining nutrient contents of it. Egg samples were collected from the different local markets of Chattogram, Bangladesh, during April to December, 2019.The study or lab analysis was performed at the different laboratories of CVASU (Physiology, Biochemistry and Pharmacology, and Poultry Research and Training Centre, Department of Applied Food Science and Nutrition; and Department of Food Processing and Engineering Department, Chattogram Veterinary and Animal Sciences University.

Collection of egg and sample preparation

Collection of eggs

A total of 75 eggs of three types of poultry were purchased from Zaotola kitchen market, Chattogram city in April, 2019. Equal number of egg samples of native (deshi) chicken (*Gallus gallus*) (25), exotic chicken (*Gallus domesticus*) (25) and duck (*Anas Platyrhynchos*) (25) were purchased and transported to laboratory.

Samples preparation for yielding of dry egg powder

The collected eggs were cleaned by the water spray and dried at room temperature until drying the surface moisture. The whole weight of the egg was measured using electronic balance. The eggs were broken with spatula, separated egg white (albumen) from yolk carefully, kept in the test tube in previously calibrated test tube individually, and raw egg liquid was inspected visually for any defects or spoilage. Then weight of three different parts (egg white, yolk and shell) was calculated. Later, raw egg liquid was pasteurized at 64˚C for 3 min in a water bath and immediately cooled at 4˚C. The liquid sample was taken in backing paper for drying using cabinet drier at 60˚C. After drying the samples were blend and sieved to get fine egg yolk and egg albumen powder.

Chemical analysis

Proximate analysis

The moisture, protein, fat, carbohydrate, fiber and ash in dried egg albumen and yolk powder were determined separately by The Association of Official Analytical Chemists methods (AOAC, 1990).In brief, moisture content of dried egg powder samples (2g) (both albumen and yolk) was determined using a drying oven at 100°C for about 4h. The moisture content (MC) was taken as the difference between the initial (dried form) and the constant dried samples. Fat content of the yolk samples was determined by exhaustive extraction of 2 g of dried samples with analytical grade petroleum ether using Soxhlet apparatus. The protein content was determined by the macro-Kjeldahl digestion apparatus and estimated amount of nitrogen content, which was multiplied with the factor of 6.25 to calculate protein content.The carbohydrate content, was determined by calculating the difference of Nitrogen Free Extractive (NFE). It was given as the difference between 100 and a sum total of the other proximate components. The formula bellow: % CHO = 100% - % (Protein + Fat + Fibre + Ash + Moisture content). Total ash was determined from the residue remaining after incinerating a 2 g portion of dried samples in a muffle furnace at 550°C.

Estimation of mineral contents

The mineral contents of samples were determined after digestion of 1 g of thedried samples in perchloric acid and concentrated nitric acid, diluted with deionized water in a 100 ml volumetric flask and filtered through Whatman filter paper No. 1. The concentrations of minerals (calcium, magnesium, phosphorus, sodium, potassium, chloride and iron) were analyzed by an automatic biochemical analyzer (Humalyzer 3000®, USA) using commercially available kits.

Randox kits (Randox Laboratories Limited, London, UK) were used for determination of Ca; Chroma test kits (BioAnalyt, Rheinstraße 17, Teltow, Germany) for P, and Mg; Biorex kits (Linear Chemicals, S.L. Mongat, Barcelona, Spain). Elyte 3® kits (Coral clinical system, ALTO SANTACRUZ, GOA-403 202, INDIA) were used to determined Na+, K+ and Cl-.

Determination of vitamin E

Reagent preparation: Absolute alcohol, Aldehyde free, Xylene, Ferric chloride solution (1.20g FeCl3.6H2O/L), Standard solution of DL-α-tocopherol (10mg/L in ethanol), α, α'-Dipyridyl (1.20g/L in n- propanol).

Procedure

At first, three stoppered centrifuge tubes, 1.5ml sample, standard or water (blank) was measured, respectively. 1.5ml ethanol and 1.5ml water was added to the test and blank tubes respectively. Then 1.5ml xylene was to each tube, stopper, mixed well and centrifuged.1.0ml of each xylene layer was transferred into a clean stoppered tube and carefully excluding any protein or ethanol. After that, 1.0ml dipyridyl reagent was added to each tube, stopper and mixed. Then pipetted 1.5ml of the mixture into colorimeter cuvette and read the absorbance (A460) of the test and standard against the blank at 460nm.Then, in turn, beginning with the blank added 0.33ml ferric chloride solution, mixed, set the wavelength to 520nm and 1.5min after mixing read the absorbance (A520) of the test and standard against the blank.

Calculation

Alpha tocopherols (mg/l) = $\frac{A' \text{ of unknown}}{A' \text{ of standard}} \times 100$

Where A'= A520 – 0.29 × A460

Statistical analysis

Data were recorded and entered into the MS Excel-2013 and exported to Statistical Package for Social Sciences (SPSS version 20.0). Descriptive statistics were performed including mean, standard deviation, percentage and results were shown in bar diagram. Comparison for weight distribution of eggs, minerals contents and Vitamin E among different types of eggs were done through analysis of variance (ANOVA). Level of significance was considered at $P \leq 0.05$.

3. RESULTS

Overall weight distribution of different types of poultry egg

Table 1 showed (Mean±SD) of overall weight distribution whole egg and different parts of s of egg of poultry collected from the different markets of Chattogram. The data revealed that all forms of egg of different categories of poultry differed significantly ($P<0.0001$) between treatment. It is evident from the data that the whole egg weight of duck had the highest ($P<0.0001$)weight (65.30±6.65) g whereas the weight of native egg being the lowest weight (39.55±2.70) g.In raw egg, the albumin content was found the highest in layer chicken egg (37.29±2.12) g whereas this was found the lowest in native chickens' egg (16.19±3.21) g. Conversely, the yolk and shell weight of duck egg had the highest weight (26.06±3.70; 8.46±1.02) g among other types of eggs. In dried condition, the albumen content was found the highest in layer chicken eggs (4.80±0.40) g while this was found lowest in native chicken eggs (2.25±0.39) g. The highest weight of dried yolk was found in duck eggs (11.49±1.50) g whereas in the native chicken eggs this was found the lowest (6.07±1.04) g.

Table 1. The weightsof different forms of egg retrieved from theexotic chicken, native chicken and duck (Mean±SD)

Types of egg (g)	Raw				Dried	
	Whole	Albumen	Yolk	Shell	Dried albumen	Dried yolk
Exotic chicken	$61.27±2.66^{a}$	$37.29±2.12^{abc}$	$15.88±0.91^{ac}$	$7.65±0.71^{ab}$	$4.80±0.40^{ab}$	$7.14±0.47^{ac}$
Native chicken	$39.55±2.70^{ba}$	$16.19±3.21^{abc}$	$17.31±4.48^{bc}$	$5.22±0.59^{bac}$	$2.25±0.39^{bac}$	$6.07±1.04^{bc}$
Duck	$65.30±6.65^{b}$	$30.03±5.83^{abc}$	$26.06±3.70^{cab}$	$8.46±1.02^{bc}$	$4.40±0.75^{ca}$	$11.49±1.50^{cab}$

Data refer to meanvalues (ME±SD) of ten eggs received from the different categories of poultry; Mean values with different superscripts within a column are significantly difference ($p<0.05$) from each other]

Table 2. Proximate composition indried albumen and yolk ofegg samples per 100 g

Parameters	Exotic chicken		Native chicken		Duck	
	Albumen	Yolk	Albumen	Yolk	Albumen	Yolk
Moisture(%)	13.5	3.36	7.25	6.65	8.87	4.78
Protein(%)	81.43	36.52	84.58	36.16	81.84	38.5
Fat(%)	0.00	51.93	0.5	49.18	0.15	51
Ash(%)	4.46	3.75	5.03	3.91	4.71	3.52
Fiber(%)	0.00	0.00	0.92	0.00	0.00	0.92
Carbohydrate(%)	0.61	4.44	2.17	4.1	4.43	1.28

The proximate components of eggs of exotic chicken, native chicken and ducks are shown in table 2.In layer chicken eggs, dried albumen contains more moisture than the yolk. Albumen had higher protein percentage (81.43%)as compared to yolk (36.52%). The yolk contains higher fat (51.93%) whereas albumen had no fat content in it. Over all yolk contain more carbohydrate (4.44%) than albumen.Ash content found higher in albumen (4.46%) as compared to yolk (3.75%). There was no fiber in any part of dried commercial chicken eggs.

In native chicken eggs, albumin portion contain higher moisture, protein and ash content than yolk portion. The higher and lower protein content found in albumin 84.58% and yolk 36.16% respectively. On the other hand yolk had higher fat percent 49.18% compared with albumin portion. Yolk also had higher CHO content (4.1%) whereas albumen content lower (2.17%). But fiber content found higher in albumen than yolk.

In duck egg's, albumen contain higher moisture, protein, ash and carbohydrate. The higher value of moisture 8.87%, protein 81.84%, ash 4.71% and carbohydrates 4.43% were found in albumen where yolk contain lower moisture 4.78%, protein 38.5%, and ash 3.52% and carbohydrates 1.28%, respectively. But yolk portion contained higher fat content 51% whereas yolk contains only 0.15% fat. In case of fiber content both albumin and yolk contain very little (Table 2).

Mineral composition of different types of poultry egg

The mineral content of different poultry eggs is shown in the table 3 In dried albumen part, potassium content showed significant difference among the commercial layer chicken, native chicken, and duck eggs. Potassium content found higher in native chicken eggs, than ducks and commercial layer chicken, respectively. However, the remaining mineral contents including calcium, magnesium, phosphorus, chloride and iron were not differed significantly among them.

Contents of Mg, K, P and Cl were found significantly different among different types of dried egg yolk. Magnesium, potassium, phosphorus were found higher in native chickens egg yolk than other poultry eggs. However, the chloride content found higher in ducks egg yolk.

Table 3. Mineral composition of commercial layer chicken, native chicken and duck egg at dried condition

Types of eggs	Mineral contents (mg/gm)											
	Albumen						Yolk					
	Ca	Mg	P	K	Cl	Iron	Ca	Mg	P	K	Cl	Iron
Exotic chicken	2.78±1.38	0.94±0.16	6.10±2.65	1.00 ± 0.07^{ab}	8.93±7.08	0.002±0.001	3.38±0.96	0.32 ± 0.10^{ab}	11.16 ± 1.11^{abc}	2.22 ± 0.72^{ab}	5.09±2.92	0.002±0.001
Native chicken	2.87±0.85	1.30±0.40	6.26±1.54	2.48 ± 0.77^{ab}	3.96±0.76	0.001±0.007	3.17±2.01	0.62 ± 0.19^{abc}	17.78 ± 1.66^{ab}	4.28 ± 0.67^{ab}	5.95±1.35	0.006±0.003
Duck	2.30±1.50	0.70±0.41	3.00±0.29	1.80±0.58	5.45±2.55	0.002±0.001	3.24±1.32	0.22 ± 0.10^{bc}	16.78 ± 3.50^{ac}	3.18±0.96	36.37±33.74	0.007±0.012

Values are represented as mean±SD. Values with different superscripts within a column are significantly difference ($p<0.05$) from each other

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Vitamin E in different poultry egg yolk

Vitamin E content in different poultry eggs yolk is shown in table 4. Layer, native and duck egg yolk had different vitamin E content which is 8.26±.21 IU, 8.19±.26 IU and 8.38±.17 IU respectively. Duck egg yolk had the highest vitamin E (8.38±.17) IU and native egg yolk had the lowest (8.19±.26).

Table 4. Vitamin E content

Types of egg	Vitamin E (IU)	*P-value*
Commercial chicken	8.26±.21	0.401
Native chicken	8.19±.26	
Duck	8.38±.17	

4. DISCUSSION

People consume poultry eggs consume all over the world irrespective of ethnicity, religion, and age. Nutrient composition of egg of different genotypes varies widely. Among the various kinds of food sources, the egg is a kind of complete food, which contains almost all nutrients required for human being. In the current study, we found differences in nutrient composition of eggs obtained from three different types of poultry including *Gallus domesticus* (exotic) *Gallus gallus* (native) and *Anas platyrhynchos* (duck). In the current study, the average weights of eggs were found between 40-66 gm. These variations depend on different factors including genotype, species, breed, age and feeds (Washburn, 1990). Considering three poultry species, the duck egg weight found higher compared to other two species egg. We also found that Duck egg had the highest whole egg weight, yolk, shell and dried yolk weight. Owing to the varieties in laying duck species worldwide the duck egg weight ranges from 60–90 g. In addition to the weight probabilities of the eggshell, egg white and egg yolk to that of the whole egg ranged from 11–13%, 45–58, and 28–35%, respectively (Chang, 1992; Chen, 2001). Duck eggs have a relative higher percentage of egg yolk compared to other avian eggs (Lin, 2000a; Congjiao et al. 2017).

In this study, in raw state of egg, the albumen content was 2.3 times higher than yolk whereas in dried condition the content of yolk nearly 1.4 times higher as compared to albumen in hybrid chicken. But, in both native chicken and duck, this proportion was almost same. The variation of albumen to yolk ratio was attributed to breed (Campo, 1995), age (Ahn et al., 1997) and egg size (Marion et al., 1964).The evidence from earlier study suggests that the eggs from native chicken and duck are more favorable for making products from yolk than from consumption as table eggs (Suk and Park, 2001).

On the other hand, we found from analysis native egg had the lowest whole weight, albumin, shell weight, dried albumen and dried yolk weight. The increase in egg weight in the course of everyday production cycle is associated with an age. The percent contribution made by means of the yolk increases at some stage in lay ensuing in a decrease in the percentage of yolk to albumen over time (Terneset al., 1994).

The nutrient composition analysis shows that the albumen portion contains higher moisture content in layer egg compared to others. Duck egg albumen had higher protein, carbohydrates and ash than yolk. And fat content found higher in yolk than albumen. Native chicken egg had higher protein than commercial layer egg. This revealed that albumen contains more protein than the yolk which is in agreement with earlier studies (Bashir et al., 2015; Genchev, 2012). In general, egg yolk possesses higher lipids than egg white. Further, native chicken egg white powder showed slightly higher fat contents compared to the corresponding to layer and duck egg white.

We found that duck egg weight is higher than the other two species but in case of nutritional composition, duck egg had lower nutritional value compared with the native egg. Native egg can be a good protein source where its albumen contains almost 85% protein. It is also found that native chicken egg had higher nutritional component with smaller size compared to other two species.

In the current study, the overall mineral contents were higher in the egg yolk than the egg white. Both egg yolk and egg white contain iron at daily recommended level. The recommended daily requirement of iron for man is 6-40 mg/kg (Bolt and Bruggenwert, 1978). Moreover, the egg yolk contains more iron than the white, which is dissimilar with the previous study (Tanasorn et al, 2013). The reason for this is that iron is present in ferric form and interacts with the phosvitin found in egg yolk. Additionally, the presence of eggs in the diet reduces the bioavailability of iron from other food sources. Combining eggs in the diet with enhancing factors such as vitamin C, citric acid, cysteine-containing peptides or ethanol results in significantly increased bioavailability of iron (Hallberg and Hulthen, 2000).

The recommended dietary allowance value of calcium is 600-1400mg/kg (Bolt and Bruggenwert, 1978). The present study shows that both egg yolk and white powder of commercial layer chicken contain high amount of calcium as compared to the native chicken and duck egg. On the other hand, both native chicken egg albumen and yolk powder contain higher potassium than other two types of poultry egg powder. Moreover, native egg yolk also contain higher Mg and P content compared to others egg powder which is higher than the USDA recommended (1999) value.

We need a minimum amount of vitamins in our everyday life. Egg is a good source of vitamins compared to other food products. Results of the current study showed that the dried eggs of poultry contains considerable amount of vitamin E. Moreover, duck egg yolk powder contained higher vitamin E content compared to commercial layer and native chicken egg powder which is nearly higher than USDA recommended value. The genetics, rate of egg production and it varies with the composition of the poultry diet, which influenced the concentration of vitamins (Leeson and Caston, 2003). As the concentration of fat-soluble vitamins in the feed increases, the content of vitamins also increases in the egg yolk (Sirri and Barroeta, 2007).

Finally, from the above discussion we found that, egg powders of different types of poultry have considerable amount of nutrient. It also found that, each egg albumen powder contains almost 85% protein where yolk powder contains nearly 50% fat content. In case of mineral content, we found, commercial egg albumen and yolk powder had higher calcium. But potassium found higher in both native chicken egg albumen and yolk. However, native chicken egg yolk powder also contains higher magnesium, potassium and phosphorus content than other two types of poultry egg powder. Duck egg had lowest mineral content compared to commercial layer chicken and native chicken egg powder.

We may suggest that egg albumen powder might be good choice for people who are suffered from protein deficiency whereas egg yolk powder could be regarded as good fat source. Native chicken egg powder which yolk part contains almost higher mineral content than other poultry eggs powder. Native chicken egg powder would consider as a good source of minerals.

Eggs are excellent source of high quality protein, lipids, vitamins and minerals. Egg powder is easy to handle, transport and showed excellent functional properties like foaming, firmness. From the investigations of the present work, it can be concluded that the duck egg weight was higher than other two types of poultry egg. There were significance differences in overall weight. Further, all egg powders differed in nutritional composition where native egg albumen powder had the highest nutrient content compared to commercial layer and duck albumen powder. Moreover, in dried yolk, commercial layer egg showed comparatively higher nutritional content. But duck egg yolk had the highest protein compared to native chicken and commercial layer egg. In case of ash (minerals) nativechicken egg yolk powder showed higher content compared to corresponding commercial layer chicken and duck egg yolk powder. Despite lower whole egg weight, the native chicken egg albumen powder exhibited higher nutritional component, minerals than that of corresponding exotic r chicken and duck egg conversely exotic chicken egg yolk powder contained the highest nutritional component.

The strengths of the present study is a initial research on dry egg powder in the context of Bangladesh and we have evaluated the proximate composition and mineral contents (Sodium, potassium, chloride, calcium, magnesium and phosphorus), and vitamin E of three types of poultry eggs namely commercial layer chicken, native (deshi chicken i.e. Scavenging chicken) and duck at raw and dried condition separately. Despite of having several strengths, there are some limitations including less fund to accomplish the study with large number of eggs, assessment other nutrients including amino acids, fat soluble vitamins, and other nutritionally important compounds, assessment of self-life, microbial contents and physical properties before commercialization.

5. CONCLUSION

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