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Research Article
Investigating the Existence of Artificial Eggs in Bangladesh and the Fact

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Abstract

Background and Objective: Per capita egg intake has been increasing with a significant rate annually here in Bangladesh due to tremendous development of the poultry sector. But, people are in dilemma to intake this high valued biologically standard protein source due to an emerging panic regarding artificial eggs. Thus, the present study was undertaken to investigate the fact regarding existence of artificial/fake eggs in the country's food markets through evaluation of egg quality and proximate composition of collected samples. **Materials and Methods:** Some 3750 table eggs were collected from suspected entry points, local and popular food markets and shopping centres of different localities under 8 administrative divisions of the country. External and internal qualities of egg, proximate composition of egg content and external appearance for egg abnormality determination were done following standard procedures and compared with fresh egg samples from BLRI Poultry Research Farm. All recorded data were analyzed using open source R software. **Results:** After analyzing results, significant differences were found in case of external and some internal properties (height, width and weight of the albumen and the yolk and Haugh unit) of eggs. Non-significant results were found while analyzing proximate composition of whole eggs, egg albumen and yolk. Despite statistical variation of the findings, most of the values resembled the standard ranges of normal eggs. Very considerable percentage (1.25%) of egg abnormalities were also found in this study. **Conclusion:** As the findings of the present study appeared normal, it can be concluded that claim of artificial or fake egg's existence in Bangladesh is nothing but a rumor.

Key words: Egg qualities, proximate composition, egg abnormality, food market, artificial eggs, panic

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Egg, also known as super food, is rich of high quality balance nutrients. A medium size egg of 50 g contains around 6.3 g protein[1] with super quality as standard 100% and having biological[2,3] value 93.7%. It also contains 4.55 g fat, 24.2 mg calcium, 72.2 mg potassium and 0.43 mg iron, 16.1 µg selenium and 245 IU vitamin-A[1]. Egg also has choline and zeaxanthin and lutein which are essential for brain and vision, respectively. It also contains only 213 mg cholesterol which has no relationship with any diseases. Besides, egg contains many micro-nutrients that are highly beneficial for human health irrespective of age[4].

People from all over the world consume eggs due to its high nutritious values readily available at very lower price. Developed country's people consume more than 350 eggs a year while developing nations lag behind in this case[5]. Food and Agricultural Organization (FAO) also made a recommendation for developing country's people to consume the least amount of eggs need to intake in a year for proper nourishment of body and health and for Bangladesh it is 104 in a year meaning 2 eggs a week[6]. It's a matter of hope that due to promising growth and development of poultry sector from last three decades here in Bangladesh, per capita intake of table eggs is increasing steadily[7] and now it is around 93.

Recently, several reports on artificial or fake eggs were published in social networking sites and mass media[8] here in Bangladesh which created a great panic among the common people. The matter not only remained within the media but also led to court premises. According to the newspaper[9], two people from Chattogram were arrested by law enforcers due to their alleged involvement in marketing of artificial eggs. But, existence of fake eggs even in various parts of China, was not confirmed[10]. However, they later freed after investigation. Sensing the issue, the country's lone institute for advanced research on livestock and poultry-Bangladesh Livestock Research Institute (BLRI) has took initiative to eradicate panic through scientific study for the sake of common people. Thus, the objective of the study was to investigate the fact regarding existence claim of artificial/fake eggs in the country's food markets by means of egg qualities (external and internal), proximate composition and egg abnormalities evaluation.

MATERIALS AND METHODS

Collection of eggs: The study was conducted during March, 2017-June, 2018. For the purpose of this study, a total of 3660 table eggs (eggs used for consumption purpose) were collected from a variety of sources which include 8 major land ports (Hilli, Burimari, Benapole, Teknaf, Banglabandha, Tamabil, Biloniya and Dhorshona) and its adjacent markets, eight administrative divisional markets (all city corporation markets and renowned poultry markets in Dhaka city like Kaoran Bazar, Kaptan Bazar, Mohakhali Bazar Amin Bazar, Chankharpul, Hemayetpur, Amin Bazar, Savar Bazar, Nobinagor and Bishmile) and different municipal, upazila and local markets and its adjacent areas under 37 districts of the country. Representative numbers of egg samples (90) were also collected from BLRI Poultry Research Farm to compare with the collected eggs. On the basis of location of collecting eggs, all samples were divided into nine major groups or categories; each group consists of 6 sub-groups. The group names were given as per administrative division's name of the country while BLRI group acts as control one.

Experimental lab location: External, internal quality and abnormality determination of collected egg samples were done in the Poultry Egg and Meat Analysis Laboratory under Poultry Production Research Division of Bangladesh Livestock Research Institute (BLRI). Proximate analysis was done in Poultry Nutrition Laboratory of the same institution.

Egg quality measurement: The eggs were weighed by electric weighing balance and egg length and diameter were measured with digital Vernier Calipers (Mitutoyo, Japan). Then egg shell breaking strength (ESBS) was measured by an egg shell strength tester (Fujihira Industry Co., Ltd., Japan) and expressed as unit of compression force exposed to unit egg shell surface area (kg cm^{-2}). Then, eggs were broken on to a flat glass plate where the height, length and width of the albumen and yolk were measured using the digital Vernier Calipers calibrated in mm and egg quality measurement tripod micrometer (FHK, Japan). Different measurements were taken as per standard procedures and described by Monira *et al.*[11]. Shell weight (with membrane) was determined by electronic precious weighing scale. The shell thickness was measured from the three different parts of shell in each egg using a micrometer screw gauge (Mitutoyo, Japan) and was averaged and recorded as shell thickness. Yolk color was measured by a subjective method using the Roche yolk color fan (Roche Ltd., Basel, Switzerland). Albumen and yolk index were determined using following formula as described by Doyon *et al.*[12]:

$$AI = \frac{AH}{AW} \times 100$$

Where:

AI = Albumen index (%)
AH = Albumen height (mm)
AW = Albumen width (mm)

$$YI = \frac{YH}{YW} \times 100$$

Where:
YI = Yolk index (%)
YH = Yolk height (mm)
YW = Yolk width (mm)

Haugh unit (HU) was calculated from the values obtained from albumen height and egg weight by employing the following formula as suggested by Haugh[13]:

$$HU = 100 \log (H+7.57-1.7W^{0.37})$$

Where:
H = Observed height of the albumen (mm)
W = Indicates weight of egg (g)

Proximate composition: For determining the proximate compositions of egg, the egg white was separated from the egg yolk and the chalazae were removed. The yolk was carefully rolled on filter paper (Whatman No. 4, Whatman International Ltd., Maidstone, UK) to remove chalazae and traces of albumen adhering to the vitelline membrane. The vitelline membrane was then disrupted with a scalpel blade and yolk was collected in a beaker. The whole egg was obtained by manually breaking an egg. Then the egg white, yolk and whole egg were gently mixed by stirring. The proximate composition (moisture, ash, protein and fat content) of whole egg, egg white and yolk were analyzed following the standard procedures of AOAC[14].

Statistical analysis: All the recorded data were analyzed using open source R software[15]. The *post hoc* test among the significant observations were done using Tukey's honestly significance difference (Tukey's HSD) test[16].

RESULTS

External egg quality: The result of external qualities of egg samples collected from different locations of the country was presented in Table 1. Significant differences were found in case of egg weight, egg shell breaking strength-ESBS, shape index, shell thickness, shell weight and shell ratio while comparing with BLRI poultry farm's eggs.

Internal egg quality: In the present study, while comparing internal qualities of collected eggs (Table 2) with BLRI eggs,

Table 1: External qualities of collected egg samples

	Location										
Parameters	BLRI	Dhaka	Rangpur	Rajshahi	Mymensingh	Sylhet	Chattogram	Barisal	Khulna	SEM	p-value
Egg weight (g)	62.83^{a}	59.83^{ab}	56.50^{bc}	55.66^{c}	59.50^{ab}	55.00^{c}	57.50^{bc}	54.50^{c}	54.66^{c}	0.44	0.0001
ESBS (kg cm^{-2})	4.88^{a}	3.85^{b}	4.11^{b}	3.81^{b}	4.26^{ab}	3.80^{b}	3.78^{b}	3.63^{b}	3.70^{b}	0.07	0.0001
Egg width (mm)	43.96^{a}	43.33^{ab}	42.65^{b}	42.51^{b}	43.03^{ab}	42.71^{b}	43.07^{ab}	42.55^{b}	42.73^{b}	0.09	0.001
Egg length (mm)	58.28^{a}	55.50^{b}	55.49^{b}	55.24^{b}	55.96^{b}	55.82^{b}	56.04^{b}	55.32^{b}	55.49^{b}	0.16	0.0001
Shape index (%)	75.44^{b}	78.08^{a}	76.86^{ab}	76.96^{ab}	76.91^{ab}	76.53^{ab}	76.88^{ab}	76.90^{ab}	77.00^{ab}	0.15	0.01
Shell thickness (mm)	0.38^{a}	0.34^{ab}	0.36^{ab}	0.35^{ab}	0.37^{ab}	0.33^{b}	0.34^{ab}	0.35^{ab}	0.33^{b}	0.003	0.001
Shell weight (g)	8.36^{a}	7.57^{b}	7.13^{bc}	6.97^{bc}	7.31^{bc}	6.85^{c}	7.18^{bc}	6.90^{bc}	7.03^{bc}	0.07	0.0001
Shell ratio (%)	13.42^{a}	13.09^{ab}	12.63^{bc}	12.52^{bc}	12.60^{bc}	12.17^{c}	12.47^{c}	12.51^{bc}	12.63^{bc}	0.06	0.0001

^{abdc}Means with dissimilar superscripts are significantly different (p<0.01, p<0.001, p<0.0001), p>0.05 indicates not-significant, value indicates-mean of observations, SEM: Standard error of means

Table 2: Internal qualities of collected egg samples

	Location										
Location/parameters	BLRI	Dhaka	Rangpur	Rajshahi	Mymensingh	Sylhet	Chattogram	Barisal	Khulna	SEM	p-value
Albumen height (mm)	8.21^{a}	6.63^{b}	6.85^{b}	6.81^{b}	6.73^{b}	6.70^{b}	6.80^{b}	6.78^{b}	6.80^{b}	0.07	0.0001
Albumen width (mm)	75.52	66.28	66.12	67.76	67.81	67.18	67.42	67.16	67.20	0.48	0.0001
Albumen index (%)	10.88	10.02	10.37	10.07	9.95	9.97	10.08	10.11	10.12	0.08	0.246
Albumen weight (g)	37.69^{a}	36.48^{ab}	33.78^{bc}	33.36^{c}	36.61^{ab}	32.94^{c}	34.57^{bc}	32.26^{c}	32.24^{c}	0.32	0.0001
Albumen ratio (%)	59.95^{ab}	60.95^{ab}	59.79^{ab}	59.93^{ab}	61.52^{a}	59.86^{ab}	60.12^{ab}	59.18^{ab}	59.97^{b}	0.18	0.03
Yolk height (mm)	18.35^{ab}	16.96^{ab}	17.69^{ab}	18.35^{ab}	18.37^{ab}	16.4^{b}	18.49^{a}	18.52^{a}	17.82^{ab}	0.17	0.013
Yolk width (mm)	41.63^{a}	40.29^{ab}	41.92^{a}	42.24^{a}	42.24^{a}	37.36^{b}	43.29^{a}	43.00^{a}	41.06^{ab}	0.35	0.0001
Yolk index (%)	44.07	42.11	42.25	43.52	43.50	43.95	42.97	43.05	43.41	0.36	0.943
Yolk weight (g)	16.78^{a}	15.76^{ab}	15.57^{b}	15.32^{b}	15.58^{b}	15.2^{b}	15.74^{b}	15.33^{b}	15.39^{b}	0.09	0.0004
Yolk ratio (%)	26.72^{ab}	26.37^{b}	27.57^{ab}	27.53^{ab}	26.17^{b}	27.66^{ab}	27.39^{ab}	28.14^{a}	28.16^{a}	0.14	0.001
HU	89.97^{a}	81.32^{b}	83.75^{b}	83.82^{b}	82.06^{b}	83.31^{b}	83.13^{b}	84.00^{b}	84.02^{b}	0.40	0.0001
Yolk color	6.83	6.16	6.66	6.83	6.50	6.00	6.50	7.00	6.33	0.32	0.144

^{abdc}Means with dissimilar superscripts are significantly different (p<0.01, p<0.001, p<0.0001), p>0.05 indicates not-significant, Value indicates-mean of observations, SEM: Standard error of means

Table 3: Proximate composition of whole egg, albumen and yolk of collected egg samples

	Location										
Parameters	BLRI	Dhaka	Rangpur	Rajshahi	Mymensingh	Sylhet	Chattogram	Barisal	Khulna	SEM	p-value
Whole egg											
Mo (%)	76.00[a]	75.15[b]	75.26[ab]	75.23[b]	75.31[ab]	75.10[b]	75.15[b]	75.25[b]	75.68[ab]	0.06	0.003
CP (%)	12.85	12.85	12.73	12.71	12.78	12.81	12.83	12.80	12.73	0.02	0.842
Fat (%)	7.96	7.81	7.93	7.82	7.91	7.95	7.93	7.91	7.9	0.01	0.467
Ash (%)	1.11	1.09	1.09	1.10	1.11	1.08	1.11	1.10	1.12	0.006	0.95
Albumen											
Mo (%)	85.75	85.98	85.88	85.93	85.86	85.83	85.85	85.85	85.94	0.01	0.205
CP (%)	10.91	10.77	10.73	10.69	10.68	10.79	10.65	10.74	10.80	0.01	0.647
Fat (%)	0.46	0.45	0.45	0.45	0.45	0.51	0.46	0.48	0.45	0.007	0.491
Ash (%)	0.87	0.83	0.85	0.85	0.86	0.84	0.85	0.89	0.85	0.006	0.484
Yolk											
Mo (%)	48.00	48.04	47.95	48.04	47.92	48.01	47.94	47.93	47.84	0.01	0.161
CP (%)	16.01	15.99	15.98	15.95	15.95	15.99	16.00	15.96	15.95	0.01	0.983
Fat (%)	31.79	31.47	31.62	31.62	31.87	31.59	31.71	31.81	31.05	0.05	0.612
Ash (%)	1.86	1.85	1.93	1.86	1.92	1.83	1.91	1.87	1.87	0.01	0.839

[abdc]Means with dissimilar superscripts are significantly different (p<0.01, p<0.001, p<0.0001), p>0.05 indicates not-significant, Value indicates-mean of observations, SEM: Standard error of means, Mo: Moisture, CP: Crude protein

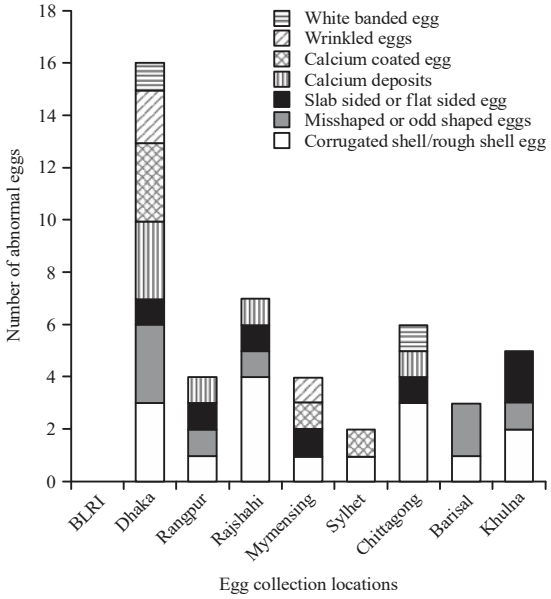

Fig. 1: Observed types of egg abnormalities from collected egg samples

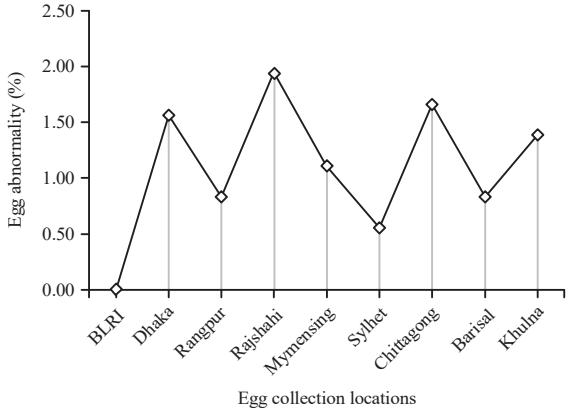

Fig. 2: Observed abnormality percentage of eggs collected from various corners of the country

significant differences were found in case of Haugh unit (HU) and height, weight and ratio of both albumen and yolk. However, non-significant differences were found in albumen index, yolk index and yolk color of the tested egg samples.

Proximate composition of eggs: Proximate composition of whole egg, egg white or albumen and egg yolk of the present research work were shown in Table 3. The current study results revealed non-significant differences among the considered parameters (moisture, protein, fat and ash) except moisture content of whole eggs (p<0.01) while comparing egg samples from across the country to the BLRI counterpart.

Egg abnormality: The results of study regarding abnormal eggs were presented in Fig. 1 and 2. Some 47 eggs out of 3750 total collected samples (1.25%) were identified as abnormal eggs. Corrugated or rough shelled eggs, misshaped or odd shaped and slab sided or flat sided egg abnormalities were found major among the abnormalities including calcium deposited, calcium coated, wrinkled eggs and white banded abnormal eggs.

DISCUSSION

External egg quality: External egg quality parameters considered in the present study were found significant,

although most of the values appeared quite normal as described by many researchers Yildirim[17], Tabidi[18], Lokaewmanee and Meesri[19] and Jin *et al.*[20]. Weight variation of collected large numbers of eggs might be the major cause of the observed significant differences as shape index, shell weight and shell ratio are directly related to egg weight. These results were supported by Tumova *et al.*[21], who stated that egg surface area was highly correlated with egg weight. They also found interaction effect between genotype and housing system for the variation of these parameters. Besides, Lichovnikova and Zeman[22] reported higher eggshell strength in eggs from cages while Hidalgo *et al.*[23] showed the effect of housing on eggshell thickness and strength. The differences in breaking strength (ESBS) and egg shell thickness might be due to type of birds, their rearing system and plan of nutrition as experimental egg samples were collected from a variety of sources irrespective of layer chicken strains.

Internal egg quality: In the current study findings, both significant and non-significant differences were found in case of some major parameters. But, most of the internal quality parameters matched with the normal values as reported by Yildirim[17], Tabidi[18], Lokaewmanee and Meesri[19], Hassan *et al.*[24], Islam *et al.*[25], Attia *et al.*[26] and Khatun *et al.*[27] or even better than some findings[27,28]. The HU, albumen and yolk quality deteriorates with the increase of storage time, temperature[20,29,30] and stress condition of birds[24]. As soon as the egg is laid, its internal quality starts to decrease: The longer the storage time, the more the internal quality deteriorates. Some other research groups[31,32] also opined that the most important factors that affect egg quality during storage are temperature and relative humidity. During storage, some physical and chemical modifications take place in albumen. These are the thinning of the albumen thickness[33], main increase of albumen pH caused by the loss of carbon dioxide from the egg through the pores in the shell[34] and changes occurring in ovomucin[33,35]. A rapid loss of CO_2 leads to a decrease in quality until the state of gas balance is reached between the inside and outside of the egg[18]. As the eggs aged, water migrated from the albumen to the yolk. According to Stadelman and Cotterill[36], the breakdown of carbonic acid makes the albumen watery. The yolk absorbs water from the albumen through the vitelline membrane in an attempt to equalize the concentration (pressure) between the two phases (i.e., egg white and yolk) which leads to the swelling of the yolk which in turn exerts pressure on the vitelline membrane. This pressure eventually causes the yolk to change from a spheroid shape to a round flabby shape mass. Moreover, internal quality of eggs also depends on rearing system of birds[21,23]. Despite of having between the normal range, the variation in internal quality parameters of the current study might be due to unknown duration of storage time and temperature, type of birds, their housing system and plan of nutrition as the experimental egg samples were collected from open market places or glossary shops across the country. Besides, egg samples from BLRI Poultry Research Farm were tested immediately after collection while egg quality determination for other egg samples was done bringing the samples from different parts of the country to BLRI Lab that took 2-3 days or even more time.

Proximate composition of eggs: The present study found significant differences in case of moisture content of whole egg but other parameters were found non-significant. The current result was supported by some previous works Haunshi *et al.*[34] and Chepkemoi *et al.*[37] that found significant differences in moisture content of indigenous and commercial chicken eggs due to differences in storage time of eggs. However, the current study results irrespective of significance level appeared to be in normal range of proximate composition of whole egg, egg albumen and yolk as many previous studies[38-42] stated almost similar values. However, few researchers Radu-Rusu *et al.*[43] and Bashir *et al.*[44] stated greater values than that of the present findings. The differences in moisture content of whole eggs in the present study might be occurred due to weight variation of whole eggs and consequent albumen weight as egg samples were collected irrespective of strains, housing, storage temperature and time.

Egg abnormality: The present study found 1.25% eggs with abnormal shapes. Laying abnormal eggs is a natural phenomenon for hens as they usually lay first few eggs with shell defects since their reproductive tracts are not fully matured. Even in matured stage, egg abnormalities occurred due to disease condition of birds, nutritional deficiency and problems related to egg formation processes in the reproductive tract[45]. Moreover, chicken usually[45] lay about 2% or even more than 4.5% abnormal eggs[46] during its lifetime which supported the present study findings. Nutritional deficiencies especially vitamin D or calcium and phosphorus has direct impact on egg shell formation resulting to abnormalities. Higher calcium levels in ration, deformation of shell segregation gland, age, genetic and illnesses lead to formation of rough shelled eggs. Outer forcing or excessive physical forcing during shell formation lead to formation of body checked eggs[47]. Cherms and Wolff[48] also reported that management factors had significant role on ratio of abnormal eggs. Abnormal eggs were found in the current study might be due to random collection of eggs from the market places

throughout the country. Stress condition, genetic factor or even excess nutrition might also responsible for bad shaped or abnormal eggs found in the present study as some factors like heritability, environment, nutrition, hormones, pathology, flock management, low albumen quality, stress and infectious illnesses might lead to abnormal egg formation.

CONCLUSION

From the above study results, it was found that proximate composition, external and internal quality of egg samples-collected from across the country-appeared as like as normal eggs despite statistical significant levels. Besides, shape abnormalities found in the study was also as usual. Thus, it can be say that the claim of artificial or fake egg's existence in the market of Bangladesh may be nothing but a rumor. Further relevant studies are required in this regard for more confirmation.

SIGNIFICANCE STATEMENT

The study has demonstrated internal, external, proximate composition and abnormalities of eggs collected from various corners of the country and found almost standard values in all the cases. Many previous works used specific condition to determine the above mentioned qualities and compositions of eggs with known layer strains but huge number of egg samples were collected in this study irrespective of such conditions. Thus, the present study will help the researchers to uncover the critical areas of egg quality parameters in a diverse situation that many researchers yet to explore.

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