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Research article

Comparative evaluation of egg quality characteristics of three commercial layer strains in Chattogram, Bangladesh

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ABSTRACT

The study was undertaken to assess the comparative egg quality parameters of three different commercial layer strains (Hisex brown, Hisex white & ISA brown) such as Farm1(F1, Hisex brown), Farm2 (F2, Hisex white), and Farm 3(F3, ISA brown), located in the different areas of Chattogram, Bangladesh. Layer farms were selected randomly depending on the number of criteria from the same locality during the month of January to March 2024. A total of 300 egg samples were collected randomly from 3 different commercial layer strains during the study period to assess the egg quality traits or parameters. Farms or strains were regarded as treatment; each treatment replicated ten times and ten eggs per replicate. All the birds were reared in battery cages fed with ready-made feeds under standard management and housing condition. Data revealed that the egg quality parameters such as egg weight, shell weight, shell percentage, albumen weight, albumen weight percentage and yolk weight percentage) were significantly ($P<0.05$; $P<0.01$) influenced by treatment except for yolk weight. The Haugh Unit (H.U) score and albumen index were significantly ($P<0.05$; $P<0.01$) influenced by treatment without showing any differences in shape index and yolk index. Only albumen height differed significantly except for other parameters (e.g egg width, egg length, albumen length, yolk height and yolk length), were measured in this study. It is clear from the result that the significantly highest egg weight, shell weight, albumen weight, yolk weight percentage, albumen height (6.05 mm), albumen index, and H.U score were found in the F3 compared to other farms (F_2 and F_1) in this study. So it can be inferred that, ISA brown (F_3) egg quality appears to be comparatively better than that of other strains, as most of the egg quality characters go in favour of this strain (F3) on the basis of the quality evaluation measured in this study under commercial farming condition.

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1. INTRODUCTION

The poultry industry has been sine qua non of the world food industry, as it supplies palatable food items namely meat and eggs to the maximum people across the globe. The production of poultry products (meat and eggs) is boosting day by day owing to meet the rising demand of animal protein. Egg is the best dish for complete protein essential for human health. Egg is very common and familiar to all people as a favorite food item, because it is packed with natural nutrition for all category of people. Poultry egg is considered as regularly used delicious dish in the

world food industry for its nutritious value and unique functional properties. Furthermore, it increases the consumption of foods for great sources of nutritional value for the little or marginal earning people, as it is considered a low-cost food item for the consumer world. Poultry industrialists, poultry farmers and egg producers, suppliers or dealers are always worried about the quality of egg, because quality eggs fetch a better price as low quality eggs always incur great economic losses (Joshi et al., 2019).

As we know that quality food products are only made from quality foodstuffs. So, ensuring quality of egg is important to supply quality food products for the consumer world safely. Once an egg is received from the hen, its quality might deteriorate in various ways, which incurs a lot of economic loss affecting the producers, consumers and environment. So, it is important to explore the different farms, strains, breeds or sources of egg production how to supply consumer safely with a very delicious food item like egg.

The quality of eggs produced by different commercial layer farms is questionable, which influences both consumer preference and market value of egg. People think that layer farms use many antibiotics and other feed additives in the chicken ration indiscriminately, which might cause health hazard affecting food safety and consumer security (Khan et al., 2018). In Chattogram, a region which is known for its vast agricultural activities, the assessment of the quality of eggs from different farms can provide valuable insights into the farming process.

The great demand for eggs is increasing day by day among the general people, as most of the middle-class people meet their daily requirement of protein and fat by consuming eggs. So, it is essential to retain the egg quality to meet the daily requirement of animal protein for the consumer world. This huge demand of egg by the consumer world is encouraging poultry industry to grow more quality egg to satisfy consumer demand or requirement. For meeting consumers demand, producers started using alternative production systems like rearing birds in battery cages where more birds can be reared in a small area which increased interest among the marginal farmers.

The external egg quality measurements (the freshness of eggs, egg size, and shell colour) are important for consumers' preferences. If the products do not meet the requirements, then the number of customers will decrease (Hosseini Signa et al., 2007). Again, the internal quality of eggs is also very important from the consumers' point of view. The internal quality of an egg can be assessed by measuring the yolk index, albumen index, haugh unit (HU) of the egg and albumen quality (Scott and Silversides, 2001).

This study is aimed to investigate the quality of egg produced by three different commercial strains reared in three different commercial farms located in Chattogram, Bangladesh. The evaluation of egg quality is critical for both consumer satisfaction and the poultry industry's economic viability. Despite the widespread use of commercial layer strains in Chattogram, limited research has compared their egg quality parameters under commercial poultry production systems. Our research targets to provide a comprehensive comparison of egg quality parameters, including egg weight, shell thickness, yolk color, albumen height, and HU score, across these farms. So, the current study was undertaken to assess the comparative egg quality characters (egg weight, shell weight, shell quality, albumen quality, HU score, shell %, albumen %, yolk index, shape index, and albumen index) of different commercial layer chicken farms or strains.

2. MATERIALS AND METHODS

The quality of eggs of layer chickens of different ages from 3 different layer strains was performed at the Department of Dairy and Poultry Science, Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh. Eggs were collected from three different commercial layer farms or strains, and these are: Al-Aqsa Layer Farm (F1); Shikolbaha Layer Farm (F2), and Sakhlika Layer Farm (F3). Farm1 (F1) reared Hisex brown, while Farm2 (F2) and Farm3 (F3) had Hisex white & ISA brown strains, respectively. A randomized sampling method was employed to collect a representative sample of eggs from the different

farms to assess the egg quality appraisal of three strains obtained from the three different commercial layer chicken farms located in Chattogram. The number of birds each farm ranges from 1200 to 1500 of 30 to 35 weeks of ages. Most of the eggs were collected from the shed within 10 to 12 PM. Similar management (housing, feeding) and environmental conditions were maintained at all the farms. Collected eggs were transported by our official vehicles with special care and management and pooled in our Poultry Science lab for three days under room temperature below 20-22ºC before undergoing laboratory analyses. Laboratory activities were performed at the Poultry Nutrition Laboratory, Poultry Science Lab, CVASU, Khulshi, Chittagong, Bangladesh.

Selection of farm and sample collection

Commercial layer farms were selected randomly depending on the number of criteria such as distance, age of bird, laying condition, flock size, strain, number of birds, rearing condition, farm durability, management condition, housing condition, feeding, communication facilities and so on. A total of 300 egg samples were collected randomly from 3 different commercial layer farms or strains during the study period to assess the egg quality parameters. Commercial farms or strains were regarded as treatment (e.g F1, F2, F3), each treatment replicated ten times, ten eggs per replicate group. Egg samples were collected from the 3 different layer flocks or strains differing in ages (30 to 35 weeks). All the birds were reared in battery cages with ready-made feeds under standard housing, feeding management and environmental condition. The eggs were arranged in three different groups (F1, F2, F3) shown in Table 1. Ethical approval was not undertaken for this trial, as the study focuses mainly on the inert materials, so it is not so important to undertake ethical approval for this study.

Table 1. The layout of the experimental design

Treatment	Number of eggs per replicate										No. of egg/ treatment
	R_1	R_2	R_3	R4	R5	R_6	R7	R8	R9	R10	
F1	10	10	10	10	10	10	10	10	10	10	100
F2	10	10	10	10	10	10	10	10	10	10	100
F3	10	10	10	10	10	10	10	10	10	10	100
Total	30	30	30	30	30	30	30	30	30	30	Grand Total =300

[F1 refers to commercial layer chicken farm or strain (Hisex brown), similarly F2 is also layer farm or strain named Hisex white, and F3 is layer farm or strain (ISA brown); R1……R10—replicates]

Data collection

Data and samples were collected from the randomly selected 3 commercial layer farms and or strains by visiting and surveying the farms within the locality of Chattogram poultry zone. Eggs were collected in cages maintaining proper biosecurity with the owner's consent. The age of laying birds from 3 different farms or strains was recorded in a record sheet. After collecting eggs from the farms, the eggs were carried by vehicle in egg cages, then stored, marked properly with a marker, and preserved in a room under room temperature below 20-22ºC with maintaining proper relative humidity 65 to 70% for three days. External and internal characteristics such as egg weight, shell weight, albumen weight, yolk weight, percentage of shell weight, shape index, yolk index and haugh unit (HU) scores etc., were measured in this study. Standardized laboratory procedures were utilized to assess the physical and internal quality attributes of the eggs. Egg weight was recorded by weighing electronic balance, and shell thickness was determined with a micrometer. A tripod micrometer was used to take the albumen height, and the HU score was calculated to provide an overall indication of egg quality.

Egg quality measurement

The egg quality was assessed in the following ways:

1) Weighing balance or scale was used to measure the eggshell weight.
2) The formula of determining shell percentage as follows,

$$Shell\ \% = \frac{\text{Shell weight}}{\text{Egg weight}} \times 100$$

3) Shape index was measured by the following formula,

$$\text{Shape Index} = \frac{\text{Egg width}}{\text{Egg length}} \times 100$$

The following ways egg's internal quality was measured –

i) Yolk height and albumen height were measured by using tripod micrometer, yolk weight and albumen weight were taken by weighing on scale (weighing balance).

ii) Yolk index was estimated from the ratio of yolk height to yolk width.

$$\text{Yolk Index} = \frac{\text{Yolk height}}{\text{Yolk width}}$$

iii) Haugh unit (HU) scores were determined from albumen height and egg weight using the expression below:

$HU=100\log H+7.37 -1.37W^{0.37}$; where, H, albumen height (cm), W- egg weight at measurement (g).

iv) Albumen weight and yolk weight recorded by scale.

v) Albumen % formula -

$$\text{Albumen \%} = \frac{\text{Albumen weight}}{\text{Egg weight}} \times 100$$

vi) Albumen index formula:

$$Albumen\ Index = \frac{\text{The height of thick albumen}}{\text{The width of egg albumen}}$$

vii) Yolk % formula as follows:

$$\text{Yolk \%} = \frac{\text{Yolk weight}}{\text{Egg weight}} \times 100$$

Statistical analysis

All data were analyzed statistically by Minitab software (Minitab, Minitab Version, 16, 2010). One way ANOVA was followed to analyze the collected data by the statistical software mentioned herein. Duncan's multiple range test was used to detect the significance of the means between treatment. The lowest significant level was considered at $P \leq 0.05$.

3. RESULTS

The results of egg quality characters (e.g. egg weight, shell weight, shell weight %, egg width, albumen weight, albumen length, albumen height, albumen weight%, albumen index, yolk weight, yolk weight%, yolk length, yolk index, Haugh unit (HU) of layer hens from three different farms were shown below in the Tables (2-4). Data shown in Table 2 indicate that except for yolk weight, all other egg quality parameters (e.g egg weight, shell weight, shell weight%, albumen weight, albumen % and yolk weight %) were significantly ($P<0.05$; $P<0.01$) influenced by treatment. The yolk weight of layer chicken did not affect ($P>0.05$) by dietary treatment. The results show that the significantly highest egg weight, shell weight, albumen weight and yolk weight% were found in the F3 Data shown in Table 3 revealed that except for shape index and yolk index, the remaining egg quality parameters (e.g H.U score and albumen index), were significantly ($P<0.05$; $P<0.01$) different among treatment. The shape index and yolk index of layer chicken eggs were unaffected ($P>0.05$) between treatment. The result showed that the significantly highest albumen index and H.U score were found in the F3 compared to F2 and F1, respectively. Data of Table 4 revealed that except for albumen height, the remaining egg quality parameters (e.g egg width, egg length, albumen length, yolk height and yolk length), were not significantly ($P>0.05$) different between treatment. The albumen height of layer chicken eggs was not influenced ($P>0.05$) by treatment only. Significantly ($P<0.05$) highest albumen height (6.05 mm) was seen in the F3 compared to others in this study.

4. DISCUSSION

Egg weight, shell weight, shell weight%, albumen weight, albumen weight %, yolk weight and yolk weight % of three different layer farms

It is obvious from the result that the significantly highest egg weight, shell weight, albumen weight and yolk weight % were found in the F3 compared to other farms (F2 and F1) in this study. Egg weight is a necessary and fundamental quality of egg that affects market value and consumer preferences. Along with egg weight, egg size, shell weight, shell weight%, albumen weight, yolk weight and yolk weight% are positively correlated and obviously a matter for quality performance. In this study, we found a notable differences in the afore-mentioned parameters (e.g. egg weight, shell weight, albumen weight and yolk weight %) of egg amongst the 3 commercial farms or strains (F1, F2, F3). Among the 3 different farms or strains, F3 possesses the highest egg quality characters as compared to the others. The variation of egg quality parameters could be attributed by multiple factors which include differences in flock age, crude fibre contents, temperature, storage time, feed consumption, flock size, different strains or breeds, ration, nutritional value, disease incidence, health status including other management practices (Khattak et al., 2015, Attia et al., 2020, Ketta et al., 2020, Tufarelli et al.,2021,Wang et al., 2021, Hamid, 2023). It is reported that egg weight is positively correlated with the age of the bird, so egg weight or size is influenced by the hen's age, with older hens producing larger eggs (Roberts et al., 2004). It is needless to say that, if the egg weight or size becomes larger that will definitely affect other components of the egg say shell weight, albumen weight and yolk weight, respectively.

Table 2. Egg quality parameters or traits of three different layer farms or strains

Trait	Treatment			SEM	P-value
	F1	F2	F3		
Egg weight (g/e/b)	63.95^{c}	69.68^{b}	72.68^{a}	1.584	0.05
Shell weight (g/e)	8.18^{b}	7.80^{c}	9.28^{a}	0.458	0.05
Shell weight %	11.75^{b}	11.03^{b}	12.80^{a}	0.239	0.042
Albumen weight (g/e)	27.25^{c}	34.25^{b}	44.50^{a}	1.461	0.01
Albumen weight (%)	42.57^{c}	46.88^{b}	55.90^{a}	1.399	0.011
Yolk weight (g/e)	16.50	19.75	20.50	0.966	0.252
Yolk weight%	24.82^{b}	25.84^{b}	30.18^{a}	0.694	0.026

[Data refer to mean values of ten replicates of 30 to 35 weeks of aged birds; F1 refers to layer farm 1 or strain Hisex brown, subsequently, F2 is layer farm 2 or strain Hisex white and F3 indicates layer farm 3 or strain ISA brown; ^{a,b,c} Mean values bearing different superscripts in a row differ significantly between treatment at *P<0.05 and **P<0.01; SEM- Standard error mean]

Table 3. Shape index, albumen index, yolk index and Haugh unit (HU) of eggs received from the three different layer farms or strains

Trait	Treatment			SEM	P-value
	F1	F2	F3		
Shape index	0.75	0.81	0.83	0.021	0.341
Albumen index	0.33^{c}	0.502^{b}	0.55^{a}	0.020	0.01
Yolk index	0.32	0.33	0.34	0.015	0.295
HU score	56.0^{b}	70.00^{a}	70.21^{a}	1.752	0.05

[Data refer to mean values of ten replicates of 30 to 35 weeks of aged birds; F1 refers to layer farm 1, subsequently, F2 is layer farm 2 and F3 indicates layer farm 3; ^{a,b,c} Mean values bearing different superscripts in a row differ significantly between treatment at *P<0.05 and **P<0.01; HU-Haugh unit; SEM-Standard error mean]

Shell quality, say shell weight, shell %, shell thickness and strength are very important criteria and critical for hatching, egg safety during transportation, storage and handling. The results

revealed that Hisex brown of the farm (F1) had significantly greater shell weight and shell % which could be stronger and thickest than those of other farms' egg. Dietary nutrients, particularly Ca, P and vitamin D, are important factors contributing to shell quality, so the farm which will have the optimum nutrient supply could have the strongest shell quality (Lenson et al., 2019).

Table 4. Egg width, egg length, albumen length, albumen height, yolk height and yolk length of eggs retrieved from three different layer farms or strains

Trait	Treatment			SEM	P-value
	F1	F2	F3		
Egg width (cm)	4.30	4.50	4.70	0.129	0.479
Egg length (c.m)	4.63	5.95	6.03	0.283	0.130
Albumen length(m.m)	11.00	11.18	12.30	0.453	0.434
Albumen height(m.m)	3.95^{c}	5.53^{b}	6.05^{a}	0.268	0.027
Yolk height(m.m)	1.30	1.40	1.53	0.071	0.465
Yolk length (m.m)	3.80	3.88	4.63	0.104	0.619

[^{a,b,c}Mean values bearing different superscripts in a row differ significantly between treatment at *P<0.05]

It is reported that many factors are involved to influence the eggshell formation, it includes genotype, environment and dietary calcium content (Abdallah et al., 1993, Ketta and Tůamová, 2016, Tufarelli et al., 2021, Wang et al., 2021). Attaining better quality egg shell is closely associated with the dietary supplementation of calcium, phosphorus and vitamin D_3 inclusion in the poultry diet at a proper ratio, amount and proportionate level (Al-Zahrani and Roberts, 2015). Previous investigators reported that a number of factors such as category of breed, gender, birds per se, nutrient inter relationship, laying stage, vitamins (D, C), nutrient content in the ration etc., stimulates the rate of calcium absorption and assimilation in the animal body (Attia et al., 2020; Stanquevis et al., 2021).

Shape index, albumen index, yolk index and Haugh unit (HU) of eggs received from the three different layer farms

The results from the study show that the significantly greater albumen index and H.U score were found in the ISA brown layer chicken egg (F3) than those of other farms or strains (F2 and F1), respectively. The data showed that ISA brown layer egg (F3) had the highest albumen index and HU score as compared to the other farms or strains (F2, F1). It indicates that farm (F3) had superior egg freshness and quality. The albumen thickness was also highest in the farm (F3) compared to the others. The reasons behind this might be due to greater egg weight, flock age, standard management and storage condition (Khattak et al, 2015, Hamid, 2023).

The albumen index, which measures the height of the thick albumen and albumen percentage, is the indicators of egg freshness and quality. Albumen quality depends on the age of egg and the storage condition of egg (Silversides and Hough, 2004, Khattak et al, 2015). The shape index and yolk index were not influenced and found to be identical between the treatment. The shape index is relatively stable as per the report of previous investigator (Nonomura and Roonavv, 2020), but it can vary due to genetic selection and various environmental factors.

The H.U score is a measure of egg quality that combines the albumen height and egg weight. In this study, we found that ISA brown layer egg (F3) had the highest H.U score indicating superior overall egg quality compared to the other farms or strains (F1, F2). Silversides and Scott (2001) indicated that the H.U is highly reflective of egg quality. The highest H.U score in F3 could result from the optimal handling, standard management, special nutrients, and good storage system practices in this farm. We noticed that farm (F3) used to manufacture layer

ration in addition with raw turmeric and black cumin, which might be contributing factors for the greater H.U score and greater quality of the eggs. Moreover, they used to manage the flock, collection egg and store eggs in the environmentally controlled houses with special care and management, which could also affect the egg quality. So to say, good and efficient egg collection and shortage practices and good nutritional management, good genetic selection and good housing conditions might be other vital factors for producing better quality eggs.

Egg width, egg length, albumen length, albumen height, yolk height and yolk length of eggs of different layer farms

It is clear from the data that significantly the highest albumen height (6.05 mm) was found in the F3 as compared to others, without affecting other egg quality traits (e.g. egg width, egg length, albumen length, yolk height and yolk length**)** in this study. The greater albumen height indicates better egg quality, particularly albumen. The freshness of egg, egg size, egg weight, strain or breed, bird age, nutrition, type of ration and other factors could be a resultant for contributing better albumen quality.

The comparative measurement of egg quality from the three commercial layer chicken farms or strains in Chattogram reveals the multifaceted nature of egg production. The good outcomes from these studies might result in a balanced nutritional profile, proper flock management, optimal environmental conditions, and proper genetic selection.

Each farm has a unique approach to different aspect of egg quality. Considerable further research could explore the interactive relationship between these factors to develop comprehensive strategies for enhancing egg quality across different production systems. The study underpins the importance of continuous monitoring and optimization of farming practices to enhance egg quality. We can address the key areas for improvement such as feed quality, housing conditions, and breed selection etc., and farms can potentially increase their productivity and profitability while meeting consumer demands for high-quality poultry products (egg). This comparative analysis of egg quality from three-layer farms in Chattogram would provide valuable insights into the factors influencing egg quality. It would serve as a foundation for future research and offer practical recommendations for farmers and could suggest how to enhance their production standards. The goal is to ensure the delivery of high-quality eggs to consumers, thereby supporting the growth and sustainability of the poultry industry in Bangladesh.

5. CONCLUSIONS

From an overview of the findings found herein reported that, the significantly highest egg weight, shell weight, albumen weight, yolk weight %, albumen height, albumen index, and H.U score were found in the F3 or ISA brown compared to F2 and F1 in this study. So, it can be concluded that F3 or ISA brown layer egg quality appears to be better than that of other farms or strains based on the quality assessment measured in this study under commercial farming condition. Further exploration or research or study could be undertaken regarding the egg quality traits of three different strains or farms to elucidate the present findings.

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