Study on Egg Quality Characteristics of Three Commercial Layer Strains under Different Storage Conditions

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ABSTRACT

A study was conducted with the objectives to determine the quality characteristics of egg of three commercial strains under different storage conditions. For this purpose, a total of 270 eggs of 3 different types of layer strain named Shuvra (S) or BLRI Layer-1, ISA brown (IB) and Bob white (BW) were collected from 3 small-scale commercial poultry farms at the age of 55 weeks. The eggs were stored for 0, 3 and 7 days at room temperature (20-25^{0}C) during the month of October. The egg weight, shell weight, shell thickness, egg width and egg length were studied as external egg quality and the albumen height, albumen width, yolk weight, yolk height were studied as internal egg quality. The study revealed that eggs of Shuvra had higher egg yolk and shell weight ($P<0.01$) than other eggs while the albumen height was found almost similar in all the hens eggs ($P>0.05$). The albumen height ($P<0.05$) and length ($P<0.01$) were also found higher in Shuvra eggs compared to other eggs at all storage periods. The yolk and shell quality of Shuvra eggs were also found better than all other eggs in different storage periods ($P<0.01$). It was also observed that the major egg quality traits like albumin height, length, Haugh unit and yolk quality were significantly $P<0.001$) affected with increasing storage length. The results of the present study suggested that Shuvra egg deserve the better quality for the preference of both the traders and consumers.

Key words: Egg quality, Commercial strain, Storage period

INTRODUCTION

Chicken egg contains all the essential amino acid for human and provides significant amount of several vitamins and minerals including vitamin A, riboflavin, folic acid, vitamin B_6, vitamin B_{12}, choline, iron, calcium, phosphorus and potassium along with 163 calories of energy per 100g egg (Ahsan and Massod, 2002). These significant features led the consumers to demand for some internal and external qualities in this nutrient (Uluocak et al., 1995).The major factors in determining egg quality are egg storage period, condition of storage, strain and age of hen (Tilki and Saatci, 2004). Stadelman (1977) mentioned that egg quality is the characteristics of an egg that affect its acceptability to the consumers. Tumova et al., (2007) observed that the external and internal quality of an egg mainly depends on the breed and its storage condition. Seidler (2003) revealed that the quality of egg and their stability during storage are largely determined by their physical structure and chemical composition. Egg quality in general defines both internal and external quality of egg. External quality is focused on shell cleanliness, soundness of shell, texture, color and shape. These features are important to the processor as superior quality eggs arrive in a better condition for the consumer (Sabbir et al., 2013). The internal quality refers to egg white, relative viscosity of albumen, shape and firmness of yolk, strength of yolk, size of air cell and presence and absent of blood or meat spot. Besides, the egg quality was described in some other means by some researchers. The proportion of yolk and albumen is largely determined by the age and strain of the hen (Akbar et al., 1983 and Ahn et al., 1997). Yolk of fresh egg is round and firm. As the yolk ages, it losses quality by absorbing water and increasing in size and sometime rupturing occur (Sabbir et al., 2013).

Albumen quality is a measurable trait and it is a function of the height for the inner thick albumen, the Haugh unit is an outcome of this measurement (Haugh, 1937), or more properly only the albumen height alone (Scott and Silversides, 2000).The absorption of water occurs from thin albumin surrounding the yolk, while the loss of carbon dioxide through egg shell causes thick albumin to be transparent and watery (Benton and Brake, 1996). The yolk integrity also depends on the strength of vitalline membrane which is inversely proportional to the duration of storage (Jones and Musgrove, 2005). In Bangladesh, qualities of major food products are ignored due to many reasons. But, in recent years the consumers are getting aware for their food items due to health conscious and positive role of different media. On the other hand, BLRI locally developed a new layer strain (Shuvra). Therefore, the egg of Shuvra should be compared with the concurrent layer to convince both the buyer and traders. Considering all these facts, the present study was carried out to investigate differences in fresh and stored eggs of hens from three lines of commercial layers.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Nutrition Laboratory of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. A total of 270 eggs were collected from 3 small-scale commercial poultry farms near Savar, Dhaka in October 2015. The egg sample was collected from the farms where same brand of commercial layer feed were supplied. The studied farms were open sided house and the birds were reared in group cage condition. The birds were apparently healthy in all farms during collection of eggs. The environmental influences are considered same for all studied farm due to location of same upazilla. The eggs were divided into 3 groups and a total of 90 fresh eggs (30 eggs for each strain) were analyzed on the day of egg receiving and rest of the eggs were stored for 3 and 7 days at room temperature (20^0– 25^0c).

The egg quality characteristics were measured after 3 and 7 days. The egg weight, egg length, egg width, albumen length, albumen width, albumen height, yolk height, yolk width, shell weight, shell thickness, Shell to egg mass ratio and yolk to albumen ratio. The eggs were weighed by electric weighing balance; the length and the width of eggs were measured with Vernier Calipers.

Eggs were weighed and broken on to a flat surface where the height, length and width of the albumen and yolk were measured using Vernier Calipers calibrated in mm. The albumen and yolk height measurements were taken using a tripod micrometer screw gauge (Nonga et al., 2010). The yolk was separated from the albumen and weighed. The shells were dried at room temperature for 2 days and weighed according to (Scott and Silversides 2000). The shell thickness was measured from the three different parts of shell in each egg using a micrometer and was averaged and recorded as shell thickness. The thickness of the shell was determined using a micrometer screw gauge calibrated in mm. Haugh Units (HU) were calculated from the values obtained from albumen height and egg weight by employing the formula as proposed by Haugh (1937).

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

Where, HU=Haugh Unit

H=Albumen height in mm and

W=Egg weight in grams

Statistical analysis

All data were analyzed by 3×3 (3 strains and 3 storage periods) factorial arrangement in a CRD by using the general linear model of (SPSS 2006) with strain and storage period as fixed factors. Significant means were separated by the Duncan's Multiple Range Test (DMRT). The statistical model is used as follows:

i) Yijk= μ+Ai+Bj+eijk

ii) Yijk= μ+Ai+Bj+(A×B)ij+eijk

Where:

Yijki= observation on the ith strain, jth storage period

μ = Population mean

Ai= effect of ith strains

Bj= effect of jth storage period

($A_i \times B_{j)}$= two ways interactions of the ith strain, jth storage period, eijk = random error.

RESULTS AND DISCUSSION

Effect of storage period on egg quality characteristics

The least square means and standard errors of external and internal egg quality factors for different storage periods are presented in Table 1. The effects of storage time on almost all the internal egg quality factors were significant while effect on all the external egg quality factors were insignificant. The height of yolk and albumen decreased, while the width of albumen and yolk increased with the increase in storage period. Yolk height of fresh egg was distinctly higher than those of other stored eggs. Shell weight did not alter with the extended of storage period. The results agreed with Ahn *et al*., (1999) who found the same shell weight with different storage period, but, shell thickness was decreased with the increased storage period. This result confirms earlier reports by Scott and Silversides (2000) and Moula et al., (2009) that because the shell is in direct contact with the surrounding atmosphere, drying is considerably fast and the shell becomes drier as storage length increases, thereby making the shell lighter with age. There was no significant difference in percent shell egg (P>0.05). Shell to egg mass ratio was affected by the storage period (P<0.05) while the storage period had no effect on yolk to albumen ratio. The loss of yolk qualities found in the current study also agreed with the finding of Jones and Musgrove (2005) and Raji et al. (2009) who reported decrease in egg qualities as the egg become aged and can be attributed to the losses of carbon dioxide, ammonia, nitrogen, hydrogen sulphide gas and water from the eggs with the increase in storage time (Haugh, 1937). The losses of albumen height also agreed with the work of Alade et al. (2013), who reported decrease of albumen height from 0.65 to 0.54 cm when stored for 12 days. It may be noted that when eggs are stored for long period, the ovomucin layer which is responsible for the firmness of thick albumen becomes weaker. The albumen, therefore, spreads over wide range of area in abnormal manner that causes the increase in albumen length and width and consequently decreased in albumen height (Jadhav and Siddiqui, 2007). On the other hand, increase in yolk width and decrease in yolk height with the increase in storage period may be as a result of weakness of chalazae and vitelline layer that hold the yolk in position and absorb any shocks and jerks to eggs. The statement supported by Alade *et al*., (2013). Jadhav and Siddiqui (2007) also explained that at the long time storage of eggs the vitelline membrane of yolk gets ruptured causing the yolk to lose its round shape then becomes fragile, flattened and eventually get mixed up with albumen. Scott and Silversides (2000), who reported a significant decreased from 9.16-4.75 mm in albumen height (P<0.05) in stored eggs at 10 days. During storage period (Table 1) HU decreased from 80.21 to 52.32 respectively (P<0.001). These results are in agreement with Tona et al. (2004) and Hagan et al. (2013), who reported storage affected HU (P<0.001).

Table 1: Internal and external egg quality factors according to storage periods (days)

Egg quality factors	Storage period (Mean ± SE)days				Level of Significance
	Overall means	0	3	7	
Egg weight (g)	61.83±0.51	62.91±0.73	61.08±0.97	60.81±0.91	NS
Egg Length (cm)	5.73±.01	5.77±.02	5.71±.03	5.69±.03	NS
Egg width (cm)	4.41±.01	4.42±.02	4.40±.02	4.41±.02	NS
Albumen length (cm)	9.8±0.18	8.8^{c}±0.27	9.95^{ab}±0.36	11.22^{a}±0.34	***
Albumen width (cm)	7.39±0.12	6.6^{c}±0.18	7.61^{b}±0.23	8.35^{a}±0.22	***
Albumen height (cm)	5.55±.20	6.76^{a}±.31	5.03^{b}±.41	4.12^{b}±.39	***
Haugh unit (HU)	66.21±1.9	80.21±2.7	66.09±3.5	52.32±3.3	***
Yolk height (cm)	1.55±.01	1.72^{a}±0.03	1.58^{b}±0.04	1.28^{c}±0.03	***
Shell weight (g)	5.820±0.05	6.18±0.10	5.35±0.10	6.04±0.10	***
Yolk width (cm)	4.46±0.03	4.27^{c}±0.04	4.44^{b}±0.05	4.78^{a}±0.05	***
Shell thickness (mm)	0.35±0.006	0.37^{a}±0.008	0.33^{b}±0.01	0.34^{ab}±0.01	*
Percent shell	9.31±0.24	9.4±0.21	8.9±0.28	9.7±0.24	NS
Shell to egg mass ratio	10.70±0.15	10.70^{b}±0.21	11.36^{a}±0.28	10.14^{b}±0.27	*
Yolk to albumen ratio	2.43±0.04	2.45±0.06	2.47±0.08	2.35±0.07	NS

Means on the row with different superscripts are statistically significant; ***= (P<0.001), **= (P<0.01); *= P<0.05, NS= Not Significant

Effect of strain on egg quality characteristics

The least square means and standard error for the external and internal egg quality factors for the 3 different strains of chickens are presented in Table 2. The effect of strain on internal and external egg quality factors was significant for egg weight, albumen length, albumen width, yolk height, yolk weight, percent shell and shell thickness. The Haugh units also differ significantly (P<0.05) among the strain while the yolk index was not differing significantly (P>0.05). The Haugh unit score found little variation to S and IB eggs and this result agreed with the finding of Williams (1992), who reported strain differences in Haugh unit scores. However, Haugh unit score lower in BW strain eggs then other strain eggs may be due to the strain, feed, environment and management and their interaction. However, the argument partially agreed with the finding Williams (1992).

Table 2: Internal and external egg factors according to strain

Egg quality factors	Overall means	Strain (Mean ± SE)			Level of Significance
		S	IB	BW	
Egg weight (g)	61.83±0.51	64.25^{a}±.81	60.73^{b}±.74	60.59^{b}±.85	**
Egg Length (cm)	5.73±0.01	5.78±0.03	5.73±.02	5.67±.03	NS
Egg width (cm)	4.41±0.01	4.43±0.02	4.39±.01	4.40±.02	NS
Albumen length (cm)	9.8±0.18	9.75^{ab}±0.37	9.16^{b}±.33	10.73^{a}±.39	*
Albumen width (cm)	7.39±0.12	7.49^{ab}±0.24	6.84^{b}±.22	8.01^{a}±.26	**
Albumen height (cm)	5.55±0.20	5.89±0.43	5.96±.39	4.62±.46	NS
Haugh Unit	66.79±2.29	72.30^{a}±4.18	72.97^{a}±3.7	59.87^{b}±4.18	*
Yolk height (cm)	1.55±0.01	1.65^{a}±.03	1.60^{a}±.04	1.39^{b}±.05	***
Yolk width (cm)	4.46±0.03	4.56±.06	4.48±.06	4.33±.07	NS
Yolk Index	4.44±0.06	4.5±0.07	4.4±0.06	4.46±0.07	NS
Shell weight (g)	5.820±0.05	6.18^{a}±0.10	5.35^{b}±0.10	6.04^{a}±0.10	***
Percent shell	9.50±0.12	9.68^{a}±0.23	8.80^{b}±0.20	10.01^{a}±0.23	***
Shell thickness (mm)	0.35±.006	0.39^{a}±.007	0.31^{c}±.007	0.35^{b}±.008	***
Albumen weight (g)	39.63±0.56	39.57±1.02	39.49±0.91	39.90±1.05	NS
Yolk weight (g)	16.39±0.15	17.73^{a}±0.27	16.79^{b}±0.24	14.45^{c}±0.28	***

Means on the row with different superscripts are statistically significant; ***= (P<0.001), **= (P<0.01); *= P<0.05, NS= Not Significant. S =Shuvra, IB= Isa Brown, BW= Bob White

Table 2 shows that Shuvra lay big size of eggs and also contain higher amount of egg output. The result got support by the work of Butcher and Miles (2003a), who reported higher egg output from bigger eggs. The results also agreed with the work of Alade *et al*., (2013) who reported higher internal egg output in exotic strain than in local counterparts.

In this study average shell weight of Shuvra (6.18 g) was higher than that of other exotic strain (5.35 and 6.04 g). In local strain shell weight was found 3.41 g, (Alade et al., 2013). This may be attributed to the superior gene in the exotic chicken that aids in the amount of egg shell being deposited during egg formation (Isidahomen et al., 2009). Dietary manipulation that decrease egg size may improve egg shell quality in older hens (Elaroussi et al., 1994) and some supplements are effectives in improving egg shell quality in aging hens (Keshavarz, 2003b). Shell thickness was significantly better in Shuvra strain eggs than brown and white eggs hen. Jones and Musgrove (2005) found that egg and shell weight were greater for the thick shelled eggs.

Interactions between storage time and strain

Storage period and strain interaction on internal and external egg quality traits are shown in Table 3. The interactions between storage period and strain were significant for all egg quality measures. Result from the present study found the significant (P<0.01) interaction effects between strain and storage length with respect to egg weight. This agrees with similar results by Singh *et al*. (2009) that the strain of layers used for egg production and the length of period of storage of the eggs could effects the weight of the egg.

Table 3: Effect of storage period and strain interaction on internal and external egg quality traits

Egg quality factors	Storage period	Strain (Mean ± SE)			Level of Significance		
		S	IB	BW	Strain	Day	Strain* day
Egg weight (g)	Fresh	66.12±0.95	61.04±0.95	62.20±1.51			
	3rd day	62.73±1.51	60.51±1.41	61.04±1.14	NS	NS	**
	7th day	59.59±1.35	59.48±1.14	59.23±1.14			
Albumen length (cm)	Fresh	9.6±0.36	8.12±0.38	8.54±0.45			
	3rd day	9.79±0.54	9.26±0.45	11.38±0.60	***	***	**
	7th day	10.06±0.60	10.56±0.45	12.55±0.45			
Albumen height (cm)	Fresh	6.20±0.66	7.99±0.47	6.24±0.56			
	3rd day	5.98±0.45	5.06±0.56	3.53±0.74	***	*	**
	7th day	5.27±0.74	3.95±0.56	3.63±0.56			
Yolk height (cm)	Fresh	1.73±0.03	1.73±0.03	1.69±0.03			
	3rd day	1.59±0.04	1.69±0.03	1.36±0.05	***	***	***
	7th day	1.51±0.05	1.33±0.03	1.10±0.03			
Yolk width (cm)	Fresh	4.5±0.05	4.21±0.05	3.97±0.06			
	3rd day	4.41±0.07	4.48±0.06	4.39±0.08	***	***	***
	7th day	4.8±0.08	4.87±0.06	4.66±0.06			
Shell thickness (mm)	Fresh	0.42±0.00	0.33±0.00	0.35±0.00			
	3rd day	0.37±0.01	0.32±0.00	0.35±0.00	***	***	***
	7th day	0.36±0.01	0.30±0.00	0.38±0.00			

***= (P<0.001), **= (P<0.01); *= P<0.05, NS= Not Significant. S =Shuvra, IB= Isa Brown, BW= Bob White

The significant interaction effect means irrespective of the strain from which the eggs are obtained, if the eggs are stored over a long period (beyond five days), the value would be compromised Hagan *et al*. (2013). The deterioration of albumen quality of Bob white eggs found worst than Shuvra and ISA brown eggs with the advancement of storage period while it was almost similar for Shuvra and ISA brown eggs. The result partially agreed with the findings of Scott and Silversides (2000), who reported the lower albumen height of IB hens at different storage period. There were significantly dramatic changes in yolk height with extended storage length. These results are in conformity with those observed by Scott and Silversides (2000), Samli et al. (2005) and Raji et al. (2009). Yolk height was higher for Shuvra and in IB fresh eggs than BW hen and it was better at all storage period for Shuvra eggs. The similar trend was observed for yolk width at all storage period. On the other hand, shell thickness was found higher in Shuvra eggs than those of BW and IB eggs. However, there was no available data with such strain like Shuvra to compare with.

CONCLUSION

The current study elicit that the egg weight of Shuvra was higher than other brown and white strain. The internal and external egg qualities of Shuvra also were found better than other strain at different storage period. Therefore, it may be concluded that the consumers should prefer first the Shuvra eggs for their table consumption and the business men may also given priority for trading of Shuvra eggs due to owing stronger egg shell and better storage period which helps for safe marketing, transporting and further processing. Furthermore, due to higher egg size, grading of Shuvra eggs may deserve added value for higher profit.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

REFERENCES

Ahsan-ul-Haq and M Akhtar (2002): Poultry farming. Publisher Higher Education Commission. Islamabad, Pakistan. pp: 323-324.

Alade NK, AN Usman and AA Muhammed (2013): Egg quality Characteristics of two chickens under varying storage conditions and seasons. Advances in Agriculture, Sciences and Engineering Research, vol 3, no 9.

Ahn DU, SK Kim and H Shu (1997): Effect of egg size and strain and age of hen on the solids content of chicken eggs. *Poultry Sci.* 76:914-919.

Ahn, DU, JL Sell, C Chamruspollert, M Jo and M Jeffrey (1999): Effect of dietary conjugated linoleic acid on the quality characteristics of chicken eggs during refrigerated storage. *J. Poultry Sci*. 78:922–928.

Akbar MK, JS Gavora, GW Friars and RS Gowe (1983): Composition of eggs by commercialize categories: Effects of genetic group, age and diet. *J. Poultry Sci*. 62: 925- 933.

Butcher GD and RD Miles (2003a): Concepts of Egg Shell Quality. University of Florida. http://edis.ifas.ufl.edu/pdffiles/VM/VM01300.pdf Benton CE Jr and J Brake. 1996. The effect of broiler breeder flock age and length of egg storage on egg albumen during early incubation. J. Poult. Sci.75: 1069-1075.

Elaroussi MA, LR Forte, SL Eber and HV Biellier (1994): Calcium homeostasis in the laying hens age and dietary calcium effects. Poultry Sci. 73: 1581-1589.

Haugh RR (1937): The Haugh unit for measuring egg quality. US egg poult. Magazine, 43:552-555, 572-573.

Hagan JK, IA Adjei and A Baah. (2013): Effect of extended period of storage and strain of layer on quality of chicken eggs. Journal of Science and Technology. 33(2):1-11.

Isidahomen CE, BM Illori, SO Omoikhoje, MA Adeleke and K Akano (2009): Egg quality traits of indigenous and exotic chicken as influence by specific genes. Proceedings of 14th Conference of Animal Science Association of Nigeria. September 14th 17th, 2009. Ladoke Akintola University of Technology, Ogbomosho, Nigeria. pp: 62-65.

Jones DR and Musgrove MT (2005). Effects of extended storage on egg quality factors. *J. Poult. Sci.* 84: 1774-1777.

Jadhav MV and Siddiqui MF (2007): Handbook of poultry production and management. 2nd Edition. pp: 44-54.

Keshavarz K (2003b): Effects of reducing dietary protein, methionine, choline, folic acid and vitamin B reducing the late stages of the egg production cycle on performance and egg shell quality. Poultry science: 82: 1407-1414.

Moula N, F Antoine-Moussiaux, F Famir and Leroy P (2009): Comparison of egg composition and conservation ability in two Belgian local breeds and one commercial strain. International Journal of Poultry Science, 8(8): 768-774.

Nonga HE, FF Kajuna, HA Ngowi and ED Karimuribo (2010): Physical egg quality characteristics of free-range local chickens in Morogoro municipality in Tanzania. Livestock Research for Rural Development, 22 (12). Retrieved on the 30th of September, 2012 from http://www.lrrd.org/lrrd22/12/nong22218.htm.

Raji AO, JI Aliyu, J webuike and S Chiroma (2009): Effect of storage method and time on egg quality traits of laying hens in a hot dry climate. *J. Agric and Applied Bio* 4(4): 1-7.

Stadelman WJ (1977): Quality identification of shell eggs. In: Egg Sci. & Technol. 2nd ed. AVI Publish. Co. Inc. Westport. Connecticut.

Seidler E (2003): FAO, egg marketing. A guide for the production and sale of eggs. Agric. Services Bullet. 150, Rome, Italy.

Sabbir hossain, Zulfiqar Ahmed, Mohammad Noman Khan and Taseer Ahmed Khan (2013): A study on quality traits chicken eggs collected from different areas of Karachi. Sarhad. *J. Agric.* Vol.29, no.2, 2013. pp: 255-259.

SPSS (2006): Statistical Package for Social Statistics version 16. SPSS Inc. Michigan Avenue, Chicago, USA.

Scott TA and FG Silversides (2000): The effect of storage and strain of hen on egg quality. *J. Poult. Sci*.79: 1725-1729.

Samli HE, A Agma and N Senkoylu (2005): Effect of storage time and temperature on egg quality in old laying hens. Journal of applied Poultry Research. 14: 548-553.

Singh R, KM Cheng and FG Silversides (2009): Production performance and egg quality of four strains of laying fens kept in conventional cages and floor pens. Poultry Science. 88: 256-264.

Tilki M and Inal S (2004): Quality of strain of goose. 1. Effect of goose age and storage time on eggs. Arch. Fir geflu golk. 68: 182-186.

Tumova E, L Zita, M Hubeny, M Skrivan and Z Ledvinka (2007): The effect of oviposition time and genotype on egg quality characteristics in egg type hens. Czech J. Animal Sci.52: 26-30.

Tona K, O Onagbesan, B de Ketelaere, E Decuypere and V Bruggeman (2004): Effects of age of broiler breeders and egg storage on egg quality, hatchability, chick quality, chick weight and chick posthatch growth to 42 days. J. Applied Poult. Res., 13: 10-18.

Uluocak AN, F Okan, E Efe and H Nacar (1995): Bildirein yumurtalarinda bazi dis ve ie kalite ozellikleri ve bunlarin easa gore dsgisimi. Turl. J. Vet. Animal Sci. 19:181-185.

Willium KC (1992): Some factors affecting albumen quality with particular reference to Haugh unit score. World's Poultry Science Journal, vol 48 (1), pp: 5-16.