Assessment of Internal and External Egg Qualities of Some Poultry Species

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Target audience: Poultry farmers, egg consumers, egg marketers, poultry breeders

Abstract

Egg quality is composed of those characteristics of an egg that affect its acceptability by consumers Thirty (30) samples each from a total of fifty (50) freshly laid eggs of duck (DX), guinea fowl (GF), Local chicken (LCX), Broiler (BX) and turkey (TX) bought from reputable farms in Ibadan, were used for this study. Data collected were subjected to analysis of variance to determine the effect of poultry species on egg quality. No significant effect ($p>0.05$) was observed in albumin height, shell index, albumin ratio, yolk ratio and Haugh unit while species had significant effect ($P<0.05$) on other egg quality characteristics considered. Highest estimates were observed in yolk height, yolk weight, albumin weight, yolk index and yolk diameter in DX (16.49 ± 0.42); DX (25.18 ± 0.51); (35.76 ± 1.41); GF (362.28± 13.70) and TX (5.56 ± 0.12), respectively. Highest estimates were observed in DX for egg length (62.59±0.75); in TX for egg weight (68.90±1.63) and shell weight (9.24±0.32). For egg width, shell ratio and shell thickness, highest values were observed in TX (45.96±1.29), GF (16.06±0.21) and GF (0.82±0.09) respectively, while corresponding lowest values were observed in GF (28.59±2.57), LCX (11.56±0.41) and LCX (0.33±0.03). Phenotypic correlations among the egg external characteristics across the species were predominantly not significant and ranged from low to high. The significant differences observed in most of the egg quality characteristics in this study could be attributed to the genetic make- up of individual species.

Keywords: Poultry eggs, species, phenotypic correlation, egg weight, Haugh unit

Description of Problem

Egg plays a significant role in terms of reproduction and continuity of poultry species. Besides, it constitutes an important protein source for a balanced diet. Egg quality standards require that table eggs are clean such that their consumption does not pose any risk for human health and that they remain intact. On the other hand, the quality of hatching eggs bears significance for embryonic development. For, embryonic development depends on the presence of an eggshell of adequate thickness and porosity; the existence of an air-space at the blunt pole of the egg; the nutritional value (wholesomeness) of the egg yolk and the protection provided by the albumen (1,2). The consumption of eggs by the population depends on the quality of the product offered to consumers, determined by a set of characteristics that may interfere with the acceptance of the product on the market. The laying hens' eggs, as well as other animal products is perishable and after laying begins to lose its internal quality, so measures must be taken to ensure the quality of the product (3).

The egg is composed of the shell, the shell membrane, yolk, and albumen. The shell represents 10% of the total weight of the egg, the yolk, 30%, and the albumen, 60% (4). The eggshell is a unique structure, the result of an extraordinary evolution process, whose primary functions include the protection of the egg's internal content against mechanical injuries and invasions of microorganisms (5). The thickness of the shell, as well as the structure of the shell, are fundamental aspects in the quality of the egg since both affect its resistance, so eggs with thicker shell are more resistant to bacterial penetration than eggs with weak shell. Thus, reduces breakage, being one of the main causes of contamination by microorganisms. As the weight of the egg increases, there is reduction in eggshell thickness, consequently, there is a loss of moisture to the environment (6).

Egg quality entails its characteristics that affect its acceptability to consumers. This among others include cleanliness, freshness, egg weight, shell quality, yolk index, albumen index, Haugh unit and chemical composition (7). Egg quality is a general term which refers to several standards which define both internal and external quality. External quality is focused on egg shell cleanliness and thickness, egg weight, height, width and shape whereas internal quality refers to albumen cleanliness and viscosity, yolk quality and absence of blood spots (8 and 9). Unlike external (shell) quality, internal quality of the egg begins to decline as soon as the egg is laid. It was reported by (10) that, although factors associated with the management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer. According to (3), lineage and age of commercial laying hens influence internal and eggshell quality. The differences in colour, size, shape, texture of the eggshell, and quality of albumen and yolk can be determined by the differences between breeds, lineages, families, and individuals. However, the information on egg characteristics has been limited mostly to chicken in Nigeria, more emphasis is laid on the production and importance of domestic fowl to the neglect of other classes of poultry species like the pheasant, quail, guinea fowl, pigeon, turkey, goose and Muscovy ducks (11). Hence, this study was to investigate the internal and external egg quality traits of some poultry species (guinea fowl, turkey, duck and chicken), with the view of identifying the species with outstanding egg quality traits.

Materials and Methods

Experimental eggs

A total of fifty (50) freshly laid eggs each of duck (DX), guinea fowl (GF), Local chicken (LCX), Broiler (BX) and turkey (TX) were bought from reputable farms in Ibadan, Oyo State, Nigeria. The eggs were stored at room temperature and relative humidity.

Evaluation of egg quality

Thirty (30) samples each of poultry fowls' eggs were randomly selected from the fifty (50) freshly laid eggs, numbered and

then weighed on an electronic weighing balance to determine their weights in grams. Egg length and egg width were measured with a Venier caliper in centimeters. Egg shape index was calculated as the ratio of egg width to egg length (%) by the method of (12). After the eggs are broken, egg shell was washed with water and sun - dried in order to clean the remaining albumen as reported by (12) procedure, shell weight (with membrane) was measured using a laboratory scale and the percentage proportion of the shell in the egg was determined. Shell thickness was measured at the sharp poles, blunt poles and equatorial parts of each egg. The shell thickness was obtained from the average values of the three parts. The albumen weight was calculated from the difference between egg weight and the yolk plus shell weight. The percentage proportion of the albumen in the egg was also determined. Albumen index (%) was determined according to (13). On the basis of the ratio of the albumen height (mm) measurement taken, the average of width (mm) and length (mm) of this albumen with 0.01mm accuracy x 100 was determined. Individual Haugh units score (14) was calculated using the egg weight and albumen height. The Haugh unit values were calculated for individual egg using the Haugh equation (15).

HU = 100 log (H – 1.7u0.37 + 7.6)
Where:
HU = Haugh unit
H = observed height of albumen in mm
u = weight of egg in g.

Yolk weight with 0.01 g accuracy was determine using a laboratory scale and its percentage proportion was calculated. Yolk index (%) on the basis of the ratio of the yolk height (mm) to the yolk width (mm) was measured according to (16). Yolk colour was determined by using colour fan.

Albumen ratio (%) was derived by

$$\frac{\text{Albumen weight (g)} \times 100}{\text{Egg weight}}$$

$$\text{Yolk ratio (\%)} = \frac{\text{Yolk weight (g)} \times 100}{\text{Egg weight}}$$

Statistical Analysis

The data collected on the egg quality traits were subjected to one-way analysis of variance (SPSS/24 PC Statistic 24.0 IBM) to determine the effect of species on the egg quality. Significant means were separated using Duncan Multiple Range Test using the model below:

$Y_{ijk} = u + B_i + E_{ij}$

Where Y is individual observation: u is universal mean; Bi is effect of species; eij error:

Results

Table 1 shows the effect of species of poultry on the external quality of eggs. Species of poultry had significant effect ($P<0.05$) on all the parameters considered except shell index. Highest estimates were observed in DX for egg length (62.59±0.75mm); in TX for egg weight (68.90±1.63) and shell weight (9.24±0.32); while lowest values were obtained in GF (41.82±2.14), LCX (38.91±1.81) and LCX (4.49^{d}±0.23), respectively. For egg width, shell ratio

and shell thickness, highest values were observed in TX (45.96^{a}±1.29), GF (16.06^{a}±0.21) and GF (0.82^{a}±0.09) respectively, while corresponding lowest values were observed in GF (28.59^{c}±2.57), LCX (11.56^{c}±0.41) and LCX (0.33^{a}±0.03).

Table 1: Effect of species on external quality of poultry eggs

SPECIES	BX	DX	GF	LCX	TX
Egg length (mm)	57.12^{b}±0.83	62.59^{a}±0.91	41.82^{d}±2.14	51.17^{c}±0.90	62.36^{a}±0.75
Egg weight (g)	56.08^{b}±1.81	64.59^{a}±1.81	41.18^{c}±1.51	38.91^{c}±1.81	68.90^{a}±1.63
Egg width (mm)	44.50^{a}±2.78	44.54^{a}±1.26	28.59^{c}±2.57	36.69^{b}±0.65	45.96^{a}±1.29
Shell index	77.88^{a}±4.64	70.72^{a}±2.46	68.23^{a}±5.51	71.74^{a}±0.95	73.81^{a}±2.41
Shell weight (g)	6.60^{c}±0.40	8.05^{b}±0.21	6.60^{c}±0.20	4.49^{d}±0.23	9.24^{a}±0.32
Shell ratio	11.74^{c}±0.39	12.50^{bc}±0.35	16.06^{a}±0.21	11.56^{c}±0.41	13.31^{b}±0.43
Shell thickness (mm)	0.40^{b}±0.03	0.42^{b}±0.02	0.82^{a}±0.09	0.33^{b}±0.03	0.68^{a}±0.08

abcd, means with different superscripts along the same row are significantly different ($p<0.05$)
DX- Duck egg, TX – Turkey egg, GFX – Guinea fowl egg, BX – Broiler chicken egg, LX – Local Chicken egg

The effect of species of poultry on internal egg quality is shown in Table 2. No significant effect ($P>0.05$) was observed in albumin height, albumin ratio, yolk ratio and Haugh unit while species had significant effect ($P<0.05$) on other internal qualities considered. Highest estimates were observed in yolk height, yolk weight, albumin weight, yolk index and yolk diameter in DX (16.49^{a} ± 0.42); DX (25.18^{a} ± 0.51); (35.76^{a} ± 1.41); GF (362.28^{a}± 13.70) and TX (5.56^{a} ± 0.12), respectively. Corresponding lowest estimates were observed in LCX (14.10^{b}± 0.11), GF (14.17^{c} ± 0.95), GF (20.40^{b} ± 0.83), TX (190.33^{c}± 12.97) and GF (4.08^{b} ± 0.15).

Table 2: Effect of species on internal parameters quality of eggs

Variable	DX	GF	BX	LCX	TX
Yolk height(mm)	16.49^{a} ± 0.42	14.70^{b} ± 0.46	14.41^{b} ± 0.35	14.10^{b}± 0.11	10.58^{c} ± 0.62
Albumen height(mm)	6.24 ± 0.31	5.63 ± 0.34	6.40 ± 1.02	5.25 ± 0.48	6.68 ± 0.40
Yolk weight(g)	25.18^{a} ± 0.51	14.17^{c} ± 0.95	17.50^{b} ±0.55	14.60^{c} ±0.56	24.80^{a} ± 0.68
Albumen weight(g)	33.90^{a} ± 2.20	20.40^{b} ± 0.83	31.10^{a} ± 2.17	21.55^{b} ± 1.79	35.76^{a} ± 1.41
Albumen ratio	51.77 ± 3.05	49.70 ± 1.67	56.27 ± 1.70	52.65 ± 2.70	51.70 ± 0.66
Yolk index	317.26^{ab}± 14.99	362.28^{a}± 13.70	287.20^{b}± 4.91	339.02^{a}± 10.10	190.33^{c}± 12.97
Yolk ratio	38.59 ± 1.35	34.22 ± 1.62	31.91 ± 2.23	36.13 ± 2.71	35.88 ± 0.29
Yolk diameter(mm)	5.06^{a} ± 0.18	4.08^{b} ± 0.15	5.08^{a} ± 0.07	4.16^{b} ± 0.11	5.56^{a} ± 0.12
Haugh unit	75.96 ±2.27	84.22 ±0.76	79.62 ±6.61	78.85 ±3.18	77.91 ±2.95

ab,c, means with different superscripts along the same row are significantly different ($p<0.05$)
DX- Duck egg, TX – Turkey egg, GFX – Guinea fowl egg, BX – Broiler chicken egg, LX – Local Chicken egg

The correlations among the external egg quality characteristics of BX is shown in the upper diagonal of Table 3 while that of DX is shown at the lower diagonal. For the BX, the correlations were predominantly positive, not significant and ranged from 0.029 to 0.990 while DX correlations ranged from -0.690 to 0.797.

Table 3: Correlation coefficients among external quality of poultry eggs (broiler and duck)

	EL	EW	EWD	SI	SW	SR	ST
EL		0.538^{ns}	0.269^{ns}	0.042^{ns}	0.401^{ns}	0.212^{ns}	0.52 ^{ns}
EW	O.450^{ns}		0.701 ^{ns}	0.603 ^{ns}	0.926 ^{ns}	0.756 ^{ns}	-0.143 ^{ns}
EWD	0.262 ^{ns}	0.0738*		0.973*	0.915 ^{ns}	0.990 ^{ns}	0.289 ^{ns}
SI	-0.307 ^{ns}	-0.298 ^{ns}	0.797 ^{ns}		0.856 ^{ns}	0.977*	0.711 ^{ns}
SW	-0.247 ^{ns}	0.431 ^{ns}	-0.159 ^{ns}	0.021 ^{ns}		0.943 ^{ns}	0.029 ^{ns}
SR	-0.682 ^{ns}	-0.619 ^{ns}	-0.246 ^{ns}	0.282 ^{ns}	0.439 ^{ns}		0.156 ^{ns}
ST	-0.449 ^{ns}	0.036 ^{ns}	-0.690 ^{ns}	-0.398 ^{ns}	0.532 ^{ns}	0.524 ^{ns}	

Ewt-egg weight(g), El-egg length(mm),Ew-egg width(mm);SI-shell index, Sw-shell weight(g);Sr –shell ratio, ST-shell thickness(mm). (ns- not significant *P<0.05)

Table 4 shows the correlations among the external egg quality characteristics of GF and LCX. The GF is shown in the upper diagonal while that of LCX is shown at the lower diagonal. The correlations in the GF ranged from -0.689 to 0.932 while the LCX ranged from -0,722 to 0.983. The correlations in TX is shown in Table 5. This ranged from -0.507 to 0.934 and predominantly not significant.

Table 4: Correlation coefficients among external quality of poultry eggs (Guinea Fowl and Local Chicken)

	EL	EW	EWD	SI	SW	SR	ST
EL		-0.246 ^{ns}	0.588 ^{ns}	0.072 ^{ns}	-0.014 ^{ns}	0.637 ^{ns}	-0.003 ^{ns}
EW	0.687 ^{ns}		-0.582 ^{ns}	-0.495 ^{ns}	0.932**	-0.619 ^{ns}	0.009 ^{ns}
EWD	0.728*	0.983***		0.845 ^{ns}	-0.593 ^{ns}	0.277 ^{ns}	-0.521 ^{ns}
SI	0.368 ^{ns}	0.410 ^{ns}	0.367 ^{ns}		-0.669 ^{ns}	-0.127 ^{ns}	-0.689 ^{ns}
SW	0.398 ^{ns}	0.753 ^{ns}	0.749 ^{ns}	0.470 ^{ns}		-0.297 ^{ns}	0.253 ^{ns}
SR	-0.328 ^{ns}	0.248 ^{ns}	-0.237 ^{ns}	0.104 ^{ns}	0.447 ^{ns}		0.523 ^{ns}
ST	-0.381 ^{ns}	-0.722 ^{ns}	0.601 ^{ns}	-0.333 ^{ns}	-0.515 ^{ns}	0.177 ^{ns}	

Ewt-egg weight(g), El-egg length(mm),Ew-egg width(mm);SI-shell index, Sw-shell weight(g);Sr –shell ratio, ST-shell thickness(mm). (ns- not significant *p<0.05; **p<0.001; ***p<0.0001).

Table 5: Correlation coefficients among external quality of poultry eggs (Turkey)

	EL	EW	EWD	SI	SW	SR	ST
EL		0.277 ^{ns}	-0.168 ^{ns}	-0.507 ^{ns}	-0.055 ^{ns}	-0.271 ^{ns}	-0.541 ^{ns}
EW			0.012 ^{ns}	-0.085 ^{ns}	0.461 ^{ns}	-0.378 ^{ns}	0.582 ^{ns}
EWD				0.934**	-0.371 ^{ns}	-0.345 ^{ns}	-0.123 ^{ns}
SI					-0.287 ^{ns}	-0.101 ^{ns}	0.120 ^{ns}
SW						0.701 ^{ns}	0.321 ^{ns}
SR							-0.113 ^{ns}
ST							

Ewt- egg weight (g), El-egg length (mm), Ew - egg width (mm);SI-shell index, Sw - shell weight(g); Sr – shell ratio, ST - shell thickness (mm), (ns- not significant **p<0.001).

DISCUSSION

The significant effect of species of poultry on virtually all the external egg quality characteristics observed in this study is in consonant with the report of (9, 17 and 18) who reported significant effect of species on all the external characteristics considered. However, the nonsignificant effect of species on the egg shell index observed is similar to the report of (18) who reported same among all the species considered except local chicken egg, which was significantly different from others. The highest shell thickness of 0.82 observed in this study for GF is higher than the 0.44 reported by (9). The high shell thickness which could be the reason for the better shell strength known for guinea fowl eggs. This observation is confirmed by earlier findings of (19), who attributed this as advantage over other eggs to withstand cracks and breakages during handling and transportation. The highest egg weights observed in TX and DX could be attributed to the eggs having highest egg length and egg width, more so, the two species are heavier in live weights than other species considered in this study. Though, (20) revealed that live body weight had no effect on egg weight, egg width, shell ratio, shell weight, albumen weight, yolk weight, albumen ratio, and yolk ratio, but on egg length and shell index in White Leghorn Chicken Breed of South Africa. LCX showed the lowest egg weight, which is in line with the report of (21). Variation in egg weight may be as a result of differences in weight of the individual birds. This aligns with the observation of (13), who reported that the weights of egg depend on the weight of the birds. The least shell weight observed in LCX is similar to the observations of (22 and 21). The variation in the external egg quality parameters among species could be attributed to the differences in their genetic makeup (23), season (24), storage (25), and production system (25).

The non-significant effect of species of poultry observed in albumin ratio, albumin height, yolk ratio and Haught units in this study is contrary to the reports of Atte *et al*., (21 and 18). This could be attributed to both genetic and genetic factors. Yolk height was highest in DX and least in LCX, this is in line with the report of (18) who reported no significant difference in yolk height in turkey and duck and least value in local chicken egg. In a similar trend, yolk weight was statistically higher in DX compare with other species except TX. However, least value was observed in LCX. This is in agreement with the report of (18) who observed that eggs from indigenous duck had the highest yolk weight value, which was statistically different from the yolk weight values of eggs from other indigenous poultry strains investigated. Albumin weight was statistically higher in TX compare to GF and LCX, with the least value in GF. These observations are similar to the reports of (18). Higher yolk index values were observed in GF and LCX, which was statistically different to the least value observed in TX, this is in line with (18). Yolk diameter was higher in TX and DX, which are significantly different to

the values in GF and LCX. The reason for the highest values of yolk diameter in TX and DX could be attributed to the observed higher values in their egg weights and yolk weights.

The observed correlations among the egg external quality characteristics across the different species can be compared with the reports of (20). The ranged from low to high, significant and non significant, and from negative to positive. The variations in internal and external egg quality characteristics among the different species of poultry could be attributed to differences in their genetic make- up.

Conclusion and Applications

The study revealed that species of poultry had significant effect on virtually all the variables considered except albumin height, albumin ratio, shell index yolk ratio and haugh unit. However, lower estimates were reported for eggs from guinea fowl and local chicken in most of the parameters considered and higher values in turkey and duck.

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