Chicken age and egg morphometric measures on eggshell thickness

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SUMMARY

In Nigeria, most poultry farms are located away from city centers where their products are mostly consumed. The major challenge is transportation, accentuated by bad road network, and aggravated by low quality egg shell, resulting in more cracks and breakages during transportation of eggs and consequently financial losses. This study was performed to investigate the effects of hen’s age and other egg measurements on egg shell thickness. A total of 300 eggs from Harco Black commercial layers, comprising sixty eggs each from five groups of hens at various ages was tagged and measured for weight, length, width, shape index, shell weight and shell thickness. With the exception of egg length and shape index, all other egg variables (P<0.05) and hen’s age (P<0.01) were significant predictors of shell thickness. Eggs from hens aged between 33-43 weeks and 44-54 weeks had thicker shells than eggs from 22-32, 55-65 and 66-76 weeks age groups (P<0.01). In summary, eggs from very young and very old layers should be more carefully handled during transportation due to its fragile shell characteristics.

Keywords: Table egg, egg transportation, shell thickness, hen’s age; Nigeria

INTRODUCTION

The location of poultry farms away from city centers in Nigeria, and the need for the transportation of eggs from the farm to the consumers in the cities, has called not only for efficient and effective transportation system but also for eggs of high quality that can withstand the rigors of transportation, especially in an under-developed economy like Nigeria. The very bad state of the roads and general state of disrepair of existing road network impacted negatively on the ability of eggs to travel such distances without a crack or break (Kpossu, 2007). The quality and storability of cracked eggs becomes compromised and this directly affects the acceptability and marketability of

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eggs with consequent financial losses to the farmer. Moreover, consumption of cracked eggs may increase risk for public health, thus ensuring that the quality of eggs and its internal content is not compromised becomes imperative.

Egg shell is produced by the shell gland (uterus) of the oviduct, and has an outer coating, the bloom or cuticle. The cuticle somewhat seals pores and is useful in reducing moisture losses and in preventing bacterial penetration of the egg shell (Jacob, et. al., 2000). The shell thickness and porosity help regulate the exchange of carbon dioxide and oxygen (Leslie, 2006).

Farmers / producers should endeavor to practice management strategies that will reduce the overall incidence of cracked and broken eggs because thin shelled eggs have much greater chance of being cracked or broken during handling and transportation. Aside from breed differences, hens’ age and egg physical characteristics, egg shell quality can be generally manipulated through nutrition, and disease in laying birds may adversely affect egg shell quality, thus farmers should improve on all these factors for improvement in egg shell quality.

The primary objective of this study is to investigate egg shell thickness along with other egg parameters, estimate the degree of relationship between the different variables and study the influence of hen’s age on egg shell thickness. This study also aims at investigating the significance of egg shell thickness in egg transportation by assessing the condition of the eggs after collection from farm and during measurements post transportation.

**Material and Methods**

*Experimental site*

The eggs were derived from five groups of Harco Black breed of commercial layers at different ages in lay from Ibukun Farms Limited, a private commercial poultry farm situated at 6.6615N and 3.2800E on the fringes of Lagos State, near Ogun State, Nigeria.

*Experimental unit*

For comparative analysis, the laying hens were classified into five ordinal groups based on their ages as A (22 – 32 weeks), B (33 – 43 weeks), C (44 – 54 weeks), D (55 – 65 weeks) and E (66 – 76 weeks). Since the hens are from a single breed and of the same plumage, hens of the same age were housed together in contiguous cages within the same pen house. Sixty eggs were sampled from each of the five age groups with a total of 300 eggs studied.
Experimental design
Ten trays (each comprising thirty eggs) were sourced from the farm with each of the five age groups equally having two trays (60 eggs). The eggs were appropriately tagged and labelled by pasting a masking tape with their appropriate identification on the tape.

Measurements
Egg weight was measured using a digital weighing scale that is sensitive up to one tenth of a gram, while egg dimensions and shell thickness were determined using a digital Vernier caliper (0.00mm).

Shell weight was determined after carefully emptying the content of the eggs and drying the empty egg shell with the shell membrane intact for about two weeks, egg shell thickness was measured at three different points (the sharp end, the equator and blunt end) with the digital Vernier caliper. The mean of the values obtained at the three points was recorded.

Shape index was calculated using Panda (1996) method.

Statistical analysis
Basic descriptive, exploratory and other statistical analyses (correlation, regression and analysis of variance) were done using Minitab (2010) statistical software. Several factors affecting the shell thickness of eggs were studied and the statistical model describing the analysis of variance is given as:

$$Y_{ijklmn} = \mu + A_i + S_j + W_k + V_l + H_m + D_n + e_{ijklmn}$$

Where

- $Y_{ijklmn}$ = observed thickness of the shell
- $\mu$ = overall mean
- $A_i$ = $i^{th}$ fixed effect of age group ($i = 5$)
- $S_j$ = $j^{th}$ Covariate of Shell weight
- $W_k$ = $k^{th}$ Covariate of egg weight
- $V_l$ = $l^{th}$ Covariate of egg length
- $H_m$ = $m^{th}$ Covariate of egg width
- $D_n$ = $n^{th}$ Covariate of shape index
- $e_{ijklmn}$ = residual error

RESULTS AND DISCUSSION

Egg measurements

Egg weight
The egg weight (EGGWT) in the entire study ranged between 42.50 and 67.80 g with a mean of 55.65±0.28. Age group D (55-65 weeks) has the highest (58.12g) mean egg weight which is 13.83% higher than the lowest (51.06 g) mean egg weight value of age group A (Figure 1). The combined mean egg
weight of 55.65 g obtained in this study is close to the 55.85 g reported by Dawkins et al. (2004). Age group was a highly significant (P<0.001) source of variation in egg weight explaining about 25.71% of the total variation in egg weight in this study. There was a consistent increase in egg weight before a decrease at age group E (66-76 weeks), which corroborate the reports of Anderson et al. (2004).

**Figure 1: Box-plots of egg measurements and index.**

**Egg length**

There was a consistent increase in the mean egg length (EGGLT) across the age groups (Figure 1), and this corroborates the findings of Anderson et al. (2004) who reported increases in egg length as the age of hen increased.

Egg length in this study had values between 44.11 and 63.30 mm, with a mean value of 56.09±0.15 mm. Age group E (66-76 weeks) has the highest (57.45 mm) mean egg length which is 6.33% longer than the mean of 54.03 mm recorded in age group A. Monira et al. (2003) reported mean egg length of 57.75 mm which is close to 56.09 mm obtained in this study. The influence of age group on egg length was highly significant (P<0.001) accounting for 22.31% of the observed differences in egg length.

**Egg width**

Age group D (55-65 weeks) had the highest (42.95 mm) mean egg width (EGGWD), which is 3.97% wider than the slimmest (41.31 mm) egg width of
age group A (Figure 1). Egg width recorded in this study varied between 38.92 and 49.50mm. The combined mean egg width of 42.40±0.08 obtained in this study is close to the mean egg width of 41.65mm reported by Monira et al. (2003). There trend of the distribution of egg width across the age groups was inconsistent with slight drops at age group C (44-54 weeks) and E (66-76 weeks). Egg width was highly impacted (P<0.001) by age group effect which was responsible for 15.84% of the total variation in egg width.

**Shell weight**

The values recorded for shell weight (SHLLWT) in this study was between 4.80 and 9.20g with a mean ± SE of 6.46±0.04. After an initial increase in shell weight from age group A (22-32 weeks) to B (33-43 weeks), there was a steady decline in shell weight until another rise at age group E (66-76), which has the highest (6.82 g) mean shell weight that is 12.91% heavier than the lowest (6.04 g) shell weight age group A (Figure 1). Age group accounted for 15.07 percent of the total variation in shell weight in this study. The overall mean shell weight of 6.46 g obtained in this study is different from the 5.54 g reported by Anderson et al. (2004) who worked on historic strains of single comb White Leghorn chickens but closer to the 5.81g reported by Tsokova (2005) who worked with the eggs of alopecia hens. This difference may be due to age of the hens, calcium intake in diet, genetic differences in breeds studied and the prevailing environmental conditions.

**Shell thickness**

Shell thickness (SHLLTKN) varied between 0.25mm and 0.47mm with a mean ± SE of 0.360±0.002 in this study. Age group B (33-43 weeks) had the highest (0.382mm) mean shell thickness which is 11.70% higher than the least (0.342mm) mean shell thickness value of the age group A (Figure 1). It is noteworthy that 16.75 percent of the variation in shell thickness was actually accounted for by the effect of age group which exerted highly significant (P<0.001) influence on shell thickness. The average shell thickness of 0.36mm obtained in this study is the same as that reported by Esonu et al. (2004) who worked on evaluation of Microdesmis puberula leaf meal as feed ingredient in laying hen. Aside from the initial increase in egg shell thickness from age group A to B, there was consistent decrease in egg shell thickness as the hen ages (Figure 1).

**Shape index**

Values obtained for shape index (SHPINDX) in this study was between 64.25 and 93.86%, with a mean ± SE of 75.70±0.20. Influence of hen’s age on shape index though highly significant (P<0.001) accounted for only 7.37% of
the total variation in shape index in this study. Eggs from hens in Age group B had the highest (76.75%) mean shape index. It is 3.46% higher than the lowest (74.18%) mean shape index of the age group E (66-76 weeks) and 1.39% higher than the combined mean shape index. The average shape index mean of 75.70% obtained in this study is close to the 75.59% reported by Anderson et al. (2004) who worked on egg of historic strains of single comb White Leghorn chickens.

Table 1: Correlations amongst variables studied

<table>
<thead>
<tr>
<th>Variables</th>
<th>Egg weight (g)</th>
<th>Egg length (mm)</th>
<th>Egg width (mm)</th>
<th>Shell weight (g)</th>
<th>Shell thickness (mm)</th>
<th>Shape index (%)</th>
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<tbody>
<tr>
<td>Egg weight</td>
<td>1.000</td>
<td>0.728***</td>
<td>0.805***</td>
<td>0.604***</td>
<td>0.137*</td>
<td>-0.144*</td>
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<tr>
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<td>1.000</td>
<td>0.403***</td>
<td>0.488***</td>
<td>0.013ns</td>
<td>-0.730***</td>
<td></td>
</tr>
<tr>
<td>Egg width</td>
<td>1.000</td>
<td>0.506***</td>
<td>0.119*</td>
<td>0.327***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shell weight</td>
<td>1.000</td>
<td>0.345***</td>
<td>0.327***</td>
<td>0.064ns</td>
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<tr>
<td>Shell thickness</td>
<td>1.000</td>
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<tr>
<td>Shape index</td>
<td>1.000</td>
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</tbody>
</table>

* = P<0.05, ** = P<0.01, *** = P<0.001, ns = P>0.05

Correlation amongst variables

The correlation matrix amongst the egg measurements studied is presented in Table 1. In this study, there was high correlation between the egg length and egg weight. Egg length had low correlations with egg width and shell thickness and distant correlations with shell weight and shape index.

Egg weight has high correlations with egg length, egg width, average correlations with egg shell weight, low correlations with egg shell thickness and distant correlations with shape index. Positive correlations between egg weight shell weight and shell thickness has also been reported by Anderson et al. (2004). This provides an indication for better prediction of egg weight and shell thickness for egg weight egg length and width.

Egg width had moderate correlations with shell weight and low correlations with egg shell thickness and shape index. Shell weight had a low correlation with shell thickness and distant correlations with shape index. Shell thickness had a low correlation with shape index.

Shell weight had the largest significant (P<0.001) correlation to shell thickness, followed by egg weight (P<0.05) and egg width (P<0.05). With the exception of egg length and shape index, all other factors (egg weight, egg width and shell weight) had significant (P<0.05) effect on shell thickness, albeit shell weight was the best predictor of shell thickness.
Factors affecting shell thickness

The model only accounted for 31.02% of the total source of variation, with only three of the factors studied (Egg length, Shell weight and Age group) been significant (P<0.05) sources of variation. Age group was the most significant (P<0.001) factor affecting egg shell thickness in the study accounting for 14.22 percent of the total variation and 45.86 percent of the explained sources of variation. This observation confirm the results of Anderson et al (2004) and Esonu et al (2004) who all reported similar findings in their studies.

Shell weight was the second most significant (P<0.001) factor affecting shell thickness in this study, accounting for 11.82% of the total variation and 38.11% of explained sources of variation, while egg length had the third most significant (P<0.05) influence on egg shell thickness, accounting for a meagre 1.60% of total variation and 5.12% of explained sources of variation. This study revealed that age of hen is the largest source of variation in egg shell thickness.

CONCLUSIONS

Based on the results obtained in this study the following conclusions can be drawn and recommendations made about the effect of age group on the six measured egg variables.

i. That as the age of laying hen increased egg weight, egg length egg width increased while egg shell weight and egg shell thickness decreases

ii. That egg length, egg width, shell weight, shell thickness and shape index were correlated with egg weight.

iii. That in the analysis of variance of factors affecting egg shell thickness, only age group, shell weight and egg length of all the factors studied (age group, egg weight, egg length, egg width, shell weight and shape index) significantly influenced egg shell thickness.

It is thus recommended that eggs from pullets and old layers should be given additional care during handling and transportation since they tend to be more fragile and more prone to breakages than eggs from other age groups.

REFERENCES


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