THE INFLUENCE OF ISA BROWN LAYING HEN AGE ON EGG QUALITY IN HUMID TROPICS

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ABSTRACT

This study was conducted to evaluate the effect of hen age on internal and external egg quality indices of Isa Brown hen raised in the tropics. The external egg quality indices studied were egg weight, egg length, egg width, shell thickness, shell ratio and shell weight, while the internal egg characteristics were albumen weight, albumen height, albumen ratio, yolk weight, yolk ratio and Haugh unit. A total of 180 eggs were randomly selected and used for this study. The data were taken biweekly (weeks 31, 33, 35, 37 and 39) each age in weeks represented a treatment group. Data obtained from this study were subjected to analysis of variances and the relationship between egg weights with different egg parameters at different ages were determined by correlation analysis. The results obtained indicated that as the hen age increased, albumen weight, yolk weight albumen ratio, egg weight, egg length, shell thickness and shell weight significantly increased (p<0.05). While, albumen height, yolk ratio, Haugh unit and shell ratio were significantly decreased (p<0.05). The correlation coefficient obtained indicated that egg weight had positive correlations with shell thickness (0.869, 0.110, 0.482, 0.336 and 0.329), shell weight (0.286, 0.004, 0.598, 0.336, 0.723) and albumen weight (1.00, 0.480, 1.000, 1.000, 0.728) for weeks 31, 33, 35, 37 and 39, respectively. It was therefore concluded that the age of the birds affects both the external and internal egg characteristics, the older the hen, the lower the albumen height, yolk ratio, Haugh unit and shell ratio egg quality characteristics.

Keywords: Age, Egg, Quality, Isa Brown Hen, Tropics

INTRODUCTION

Proteins from animal sources are not in sufficient supply for the teeming population in Nigeria, due to rapid increase in human population (Alphonsus *et al*., 2012; Sam *et al*., 2018; Essien *et al*., 2022). The prices of most sources of animal protein (beef, mutton, pork, chevron, chicken) have doubled in the market due to poor economic situation in the country. This has led to increase in the demand for poultry eggs which is the cheapest and most available source of animal protein mostly used to supplement the needed animal protein intake.

Hen eggs are one of the most essential protein sources of animal origin not only in Nigeria but also in numerous other countries as it forms part of many individuals' diets (Zaheer, 2015; Onyenweaku *et al*., 2018). Eggs are source of many indispensable nutrients such as essential amino acids, omega-3 fatty acids, vitamins, minerals and much more (Lesnierowski and Stangierski, 2018). Eggs are also the only food forms of animal origin that acts as a natural storage unit, protecting their inner content and quality for a certain duration.

The decrease in egg quality can be caused by numerous factors and should therefore be considered when assessing egg quality to avoid wastage. The factors affecting egg quality include bird strain, nutrition, diseases, age of the birds, weight of egg, heat stress, temperature and humidity (Kirunda and McKee, 2000; Curtis *et al.,* 2005). Among these, age of layer and egg weight are important and taken into consideration by many researchers. Ledvinka *et al.* (2014) found that egg quality traits were significantly affected by the age of females, with the exceptions of egg shape index and yolk color. In the later stage of laying, egg weight, yolk and albumen weight and shell weight increased whereas Haugh unit (HU) and eggshell thickness decreased (Oloyo, 2003; Bain, 2005; Rizzi and Chiericato, 2005; Johnston and Gous, 2007).

However, hen age is one of the most important factors that influences egg quality and can have substantial effects on the internal and external egg quality characteristics (Akyurek and Okur, 2009). Increased hen age lead to an increase in the total egg weight with a proportional increase in the yolk, while the albumen decreased (Suk and Park, 2001). Egg weight usually increases as the bird age increase, whereas characteristics of the egg white, eggshell quality and hatchability deteriorate (Akyurek and Okur, 2009). Thus, the effects of the age of hens on egg quality should not be overlooked.

Egg quality traits including external (egg weight and shell quality) and internal traits (albumen and yolk parameters) are crucial not only for consumers but also essential for the egg product industry (Song *et al.,* 2000). Several studies confirmed that age of hens has a tremendous impact on external and internal egg qualities characteristics. Egg production may be at serious risk if egg quality characteristics and age of hens are not seriously considered. Poor egg quality is a serious problem in the commercial egg industry. This provides a clear indication of the financial incentive for the farmer and the industry to maintain a higher egg quality for consumers. Therefore, the objective of this study was to evaluate the effect of hen age on internal and external egg qualities of Isa brown hen raised in the tropics.

MATERIALS AND METHODS

Location of the Experiment: This study was carried out at the Poultry Unit of Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa. Obio Akpa is located between latitudes 4º30ºN and 5º00N and longitudes 70º30ºE and 80º00E. The area is characterized with an annual rainfall ranging from 3500 – 5000 mm and average monthly temperature of 27.5 ± 1.5^{0}C, and relative humidity between 60 – 90%. It is in the tropical rainforest zone of Nigeria. The people in the study areas depend on livestock and crop production (AKSG, 2023).

Experimental Birds and Management: A total of one hundred Isa Brown birds between the ages of thirty-one to thirty-nine weeks of age were managed intensively using the deep litter system. Wood shavings were used as litter material instead of saw dust to prevent complications such as respiratory diseases. Commercial feed containing 17% crude protein and 2800 Kcal metabolizable energy and clean water were provided *ad libitum*. Routine management practices in terms of sanitation, medication and vaccination were strictly adhered to.

Experimental Design: Completely Randomized Design (CRD) was used for the research. A total of 180 eggs were randomly selected and used for this study. The data were taken biweekly (weeks 31, 33, 35, 37 and 39) each age in weeks represent a treatment group. Thirty-six eggs were randomly picked biweekly week for internal and external egg quality measurements.

Measurement of the External Egg Quality Traits: Samples of eggs were collected within nine weeks' intervals beginning at 31st to 39th week of age (thirty-six eggs biweekly). A total of 180 eggs were used to evaluate the external egg quality traits. The external egg quality traits studied were egg weight, egg length, egg width, shell weight, shell thickness and shell ratio.

The egg quality traits were measured as follows:

Egg weight: Measured by weighing individual eggs using a Camry portable digital weighing balance in grammes.

Egg length: Measured from the broad end to the other end (longitudinal) using a digital vernier caliper with accuracy of 0.01 millimeter.

Egg width: Measured at the widest point of the eggs (vertically) using a digital vernier caliper with accuracy of 0.01 millimeter.

Shell weight: Egg shell and membranes were dried on open-air and weighed using a digital weighing balance in grammes.

Shell ratio: The shell weight was divided by egg weight to get the shell ratio.

Shell thickness: This was measured using micrometer screw gauge in millimeter.

Measurement of the Internal Egg Quality Traits: The eggs used for external egg quality measurements were also used to measure the internal egg quality traits. The internal egg quality traits that were evaluated include: albumen weight, albumen height, albumen ratio, yolk weight, yolk ratio and Haugh unit. The internal egg quality measurements were obtained by carefully breaking the egg followed by separation of the albumen and the yolk contents. The measurements were taken as follows:

Albumen weight: This was obtained by taking total internal egg weight (i.e. yolk weight + albumen weight) minus yolk weight. All weights were measured using a digital weighing balance in grammes

Albumen height: Measured from the bottom end to the top end of the yolk (vertically) using vernier caliper with accuracy of 0.01 millimeter

Yolk weight: The egg york was separated from the albumin and measured using a digital weighing balance in grammes.

Albumen ratio: This was calculated by dividing albumen weights by total egg weight

Yolk ratios: This was calculated by dividing yolk weights by total egg weight.

Haugh unit (HU): This was calculated according to Haugh (1937) by fitting the average albumen height and weight into the following equation $HU = 100\log(H + 7.57 - 1.7W^{0.37})$.

Statistical Analysis: The data obtained were subjected to analysis of variance (ANOVA) using General Linear Model Procedure of SPSS Version 20 (Lee, 2013). Means with significant differences were separated using Duncan's Multiple Range Test of the same package. The correlation between egg weights with different egg quality parameters were determined using Pearson correlation analysis of the same statistical package.

RESULTS AND DISCUSSION

External and Internal Egg Quality Traits of 31 – 39 Week Old Isa Brown Hen: The result of external egg quality traits revealed that the mean egg weight, egg length, egg width, shell thickness, shell ratio and shell weight were 58.33 ± 0.66 g, 52.71 ± 0.66 mm, 43.64 ± 1.14 mm, 3.88 ± 0.10 mm, 0.08 ± 0.08 and 4.78 ± 0.00 g (Table 1). The mean weight obtained in this study (58.33 ± 0.66 g) was similar to the report of Asuquo *et al.* (1992) who reported egg weight of 58.18 ± 0.01 g, but different from the values (33.85 ± 0.61 – 40.38 ± 1.81 g) obtained by Johnston and Gous (2007). The values obtained for egg length, egg width, shell thickness, shell ratio and shell weight were similar to those obtained by Ukwu *et al.* (2017).

The results of internal egg quality traits were: 34.21 ± 0.93 g, 9.02 ± 0.20 mm, 57.89 ± 0.66%, 18.58 ± 0.00 g, 0.31 ± 0.35 and 79.08 ± 1.48 for albumen weight, albumen ratio, yolk weight, yolk ratio and Haugh unit, respectively (Table 1).

Table 1: Mean values of 31 – 39 weeks old Isa Brown hen egg quality traits

Egg traits	Mean	Maximum	Minimum
External Egg Qualities			
Egg weight (g)	58.33 ± 0.66	65.01	53.59
Egg Length (mm)	52.71 ± 0.66	55.40	43.50
Egg width (mm)	43.64 ± 1.14	59.60	39.40
Shell thickness (mm)	3.88 ± 0.11	4.70	3.10
Shell ratio	0.08 ± 0.08	8.87	7.41
Shell weight (g)	4.78 ± 0.00	4.83	4.74
Internal Egg Qualities			
Albumin weight (g)	34.21 ± 0.93	51.54	30.20
Albumin height (mm)	9.02 ± 0.20	11.40	7.20
Albumin ratio	0.57 ± 0.66	63.90	54.08
Yolk weight (g)	18.59 ± 0.00	18.66	18.54
Yolk ratio	0.31 ± 0.35	0.34	0.28
Haugh unit	79.08 ± 1.48	88.66	62.31

The result obtained from these internal egg traits were similar to reports obtained by Asuquo *et al.* (1992), but lower than those reported by Olawumi and Babatope (2016) for the same strain of layers. The difference in the result may be attributed to the differential expression of genes by different breeds of birds under different management condition.

Effect of Age on Egg Internal Qualities: The effects of age on egg internal qualities showed that the albumen weights were 30.28 ± 0.05, 32.29 ± 0.02, 31.65 ± 0.05, 35.08 ± 0.01 and 40.92 ± 0.02 g for weeks 31, 33, 35, 37 and 39 respectively (Table 2). These values were significantly influenced ($p<0.05$) by age. The weight of albumen increased as the age increases; i.e. as the age of the flock advanced, albumen weight showed an increase. This observation was in line with the result obtained by Akbaş *et al.* (1996). They pointed out that albumen weight was directly proportional to egg weight. There was significant difference ($p<0.05$) in the values of albumen height. Furthermore, albumen height decreased with increase in age. Akyurek and Okur (2009) reported lower albumen height with respect to hens with older age. The values for albumen ratio were 0.51 ± 0.05, 0.54 ± 0.07, 0.57 ± 0.66, 0.58 ± 0.05 and 0.62 ± 0.05 for weeks 31, 33, 35, 37 and 39 respectively

The influence of laying hens age on yolk weight revealed significant differences ($p<0.05$) between the different ages studied. Yolk weight increases (18.55 ± 0.03 – 18.63 ± 0.02 g) as the hen's aged. This result was similar to the findings of Akbaş *et al.* (1996) and Johnston and Gous (2007). Yolk weight also increased as the age of the bird increased, this may equally be dependent upon increase in egg weight.

Haugh unit values (88.64 ± 0.05 – 68.17 ± 0.05) reduces significantly ($p<0.05$) with increase in hen's age. It is worth mentioning that the higher the Haugh unit, the more desirable egg interior quality becomes (Mbap *et al.*, 1996). This result is similar to the observation made by Akyurek and Okur (2009) who reported a decrease in Haugh Unit with increase in age. As stated by Johnston and Gous (2007), egg of high quality usually has Haugh unit of 70% or above.

Influence of Age of Hen on Egg External Quality Traits of Isa Brown Hen: The influences of age on egg external traits indicated that the egg weight values (53.60 ± 0.55 – 62.70 ± 0.25 g) increased significantly ($p<0.05$) with increasing age from week 31 to week 39, except for week 35 and 37 (Table 3). Johnston and Gous (2007) emphasized that the age of laying hen affected the mass which increased with the egg weight of laying hens. On the other hand, Zemková *et al.* (2007) showed that the age of hen has no significant influence ($p>0.05$) on egg weight. The values for egg length with respect to age of the hens were 47.14 ± 0.05, 52.64 ± 0.23, 53.73 ± 0.33, 54.48 ± 0.55 and 54.90 ± 0.20 mm for weeks 31, 33, 35, 37 and 39 respectively. These values significant differ ($p<0.05$) in the different age groups of the hen studied. Egg length increased as the age of hen increases, suggesting that increase in hen's age leads to increase in egg length. There were no significant differences ($p>0.05$) observed in the egg width with respect to the different age group studied.

The results for shell thickness in this study revealed significant differences ($p<0.05$) among the treatment groups (ages).

Table 2: Effect of Isa Brown hen age on internal egg quality traits

Traits	Age of Birds (weeks)				
	31	33	35	37	39
Albumen weight (g)	30.28 ± 0.05^{a}	32.29 ± 0.02^{bc}	31.65 ± 0.05^{ab}	35.08 ± 0.02^{b}	40.92 ± 0.05^{c}
Albumen height(g)	10.55 ± 0.21^{d}	9.26 ± 0.30^{c}	8.98 ± 0.51^{bc}	8.42 ± 0.50^{b}	7.60 ± 0.25^{a}
Albumen ratio	0.51 ± 0.51^{a}	0.54 ± 0.50^{b}	0.57 ± 0.60^{b}	0.58 ± 0.66^{b}	0.62 ± 0.65^{c}
Yolk weight(g)	18.55 ± 0.03^{a}	18.57 ± 0.05^{b}	18.58 ± 0.05^{b}	18.60 ± 0.04^{c}	18.63 ± 0.02^{d}
Yolk ratio	0.34 ± 0.05^{d}	0.33 ± 0.07^{c}	0.31 ± 0.05^{b}	0.31 ± 0.05^{b}	0.29 ± 0.05^{a}
Haugh unit	88.64 ± 0.05^{d}	83.54 ± 0.05^{c}	79.45 ± 0.05^{bc}	77.66 ± 0.25^{b}	68.10 ± 0.05^{a}

$^{a-d}$ Means with different letter superscript on the same row are significantly different (p<0.05)

Table 3: Effect of 31 – 39 weeks old Isa Brown hen on external egg quality traits

Traits	Age of Birds (weeks)				
	31	33	35	37	39
Egg weight (g)	53.59 ± 0.55^{a}	56.28 ± 0.45^{b}	58.41 ± 0.50^{c}	59.78 ± 0.60^{c}	62.70 ± 0.25^{d}
Egg Length (mm)	47.14 ± 0.05^{a}	52.64 ± 0.23^{b}	53.73 ± 0.33^{b}	54.48 ± 0.55^{b}	54.90 ± 0.20^{b}
Egg width (mm)	47.48 ± 0.15	45.20 ± 0.20	42.56 ± 0.15	41.40 ± 1.14	42.10 ± 0.01
Shell thickness (mm)	3.16 ± 0.50^{a}	3.36 ± 0.50^{a}	3.75 ± 0.55^{b}	4.48 ± 0.55^{c}	4.55 ± 0.65^{c}
Shell ratio	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01
Shell weight (g)	4.74 ± 0.01^{b}	4.76 ± 0.01^{b}	4.77 ± 0.01^{b}	4.78 ± 0.01^{a}	4.81 ± 0.01^{b}

$^{a-d}$ Means with different letter superscript on the same row are significantly different (p<0.05)

The shell thickness (3.16 ± 0.50 – 4.55 ± 0.65 mm) decreased with advancing age. This result was in line with the findings of Silversides and Scott (2001) who also recorded a decrease in shell thickness with advancement in age of hen. Hens that were 39 weeks of age had shell weight of 4.81g which was significantly higher (p<0.05) than those from week 31, thus suggesting that shell weight increases with increase in flock age. This result was in line with the report of Suk and Park (2001), who recorded an increase in shell weight with respect to increase in hen's age.

Relationship between Egg Weights with Different Egg Quality Parameters at Different Ages: The correlation coefficient between egg weight and egg length showed a negative association (-0.318) at week 31, but positively correlated at weeks 33 – 39 with the following correlation coefficients 0.528, 0.080, 0.336 and 0.983 respectively (Table 4). Association of egg weight with egg width was negative at weeks 31 and 33 (-0.320 and -0.729), but was positively correlated from week 35 though very low (0.041). High and positive correlations were observed as the age of bird increased (0.873, 0.983 for weeks 37 and 39 respectively).

Yolk ratio was negatively correlated with egg weight from weeks 33 to the end of the experiment, suggesting that in a certain age higher egg weight have lower yolk ratio compared to lower egg weight. This finding was in agreement with the reports of Suk and Park (2001) and Padhi *et al*. (2013).

Haugh unit showed positive correlation (unity correlation) with egg weight at 31 weeks of age but was negative correlated from 33 to 39 weeks which the experiment ended. This indicated that the quality of the egg diminishes as the age of the laying hen increases.

There was a significant and positive correlation between egg weight and shell ratio, a highly significant correlation (p<0.001) with unity correlation coefficient (1.000) was observed at week 35. Egg weight also had a significant (p<0.001) positive correlation with shell thickness and shell weight. This agreed with the findings of Suk and Park (2001) and Silversides and Scott (2001).

Conclusion: From the result of the study, it was observed that the age of the birds significantly affected both the external and internal egg characteristics. The older the hen, the lower the egg quality characteristics within the period studied (31 – 39 weeks).

Table 4: Relationship between egg weights with different egg quality parameters at different ages

Parameters	Age of Birds (weeks)				
	31	33	35	37	39
External Egg Qualities					
Egg length (mm)	-0.318	0.528	0.080	0.336	0.983**
Egg width (mm)	-0.320	-0.729	0.041	0.873	0.983**
Shell thickness (mm)	0.869	0.110	0.482	0.336	0.329
Shell ratio (%)	0.286	-0.998	1.000**	-0.995**	-1.000**
Shell weight (g)	0.286	0.004	0.598	0.336	0.723
Internal Egg Qualities					
Albumin weight (g)	1.000**	0.480	1.000**	1.000**	0.728
Albumin height (mm)	0.214	0.878*	0.398	-0.924**	0.995**
Albumin ratio (%)	0.037	-0.256	1.000**	1.000**	1.000**
Yolk weight(g)	-0.058	-0.472	0.200	0.315	0.855
Yolk ratio (%)	1.000**	-1.000**	-0.996**	-1.000**	-1.000**
Haugh unit	1.000**	-0.960**	-0.240	-1.000**	-1.000**

[**]Correlation is significant at 0.01 level, [*]Correlation is significant at 0.05 level

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