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Effects of Strain, Age and the Interrelationships between External and Internal Qualities of Eggs in Two Strains of Layer Chickens in Northern Guinea Savannah Zone of Nigeria

Research Article

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ABSTRACT

An experiment was conducted to determine the differences in body weight (BW), feed intake (FI) and some egg production traits of two strains of layer chickens (Isa Brown and Nera Black) and correlate the relationships between the tested traits. The study commenced when the layers were 26 weeks old and a total of 200 (100 of each strain) were used. Sixty fresh eggs (30 from each strain) were collected at 26th, 32nd and 38th weeks of lay. The results of analysis of variance for main effect of strain revealed significant ($P<0.05$) differences in BW with Isa Brown (IB) weighing heavier (1978 g) than Nera Black (NB) (1887 g). There was however no strain effect on FI. The values for the external egg quality traits for egg weight, shell weight and shell thickness were found, respectively as 58.06 g *vs.* 54.26 g, 5.4 g *vs.* 5.00 g and 0.44 mm *vs.* 0.31 mm in favour of IB. While the values for internal egg quality traits for albumen weight, yolk weight and yolk height were found, respectively as 36.46 g *vs.* 33.60 g, 15.60 g *vs.* 12.26 g and 1.86 cm *vs.* 1.62 cm in favour of IB. Other traits tested (egg lenght, egg width, albumin height and haugh unit) were unaffected by strain. Main effect of age showed that most of the internal and external egg traits decreased with increase in age of the layers. Yolk weight increased with increasing age of the layers, which implies that eggs from younger birds would be expected to have lower amount of cholesterol. The correlation analysis for most of the tested traits were positive. BW positively and significantly ($P<0.05$) correlated with FI (0.73) and egg weight (0.54). It was concluded that age numerically decreased most of the tested qualities of egg while srain had significant ($P<0.05$) effect on BW and some egg quality traits with Isa Brown performing better than Nera Black in northern guinea savannah of Nigeria.

KEY WORDS correlation, egg quality traits, layer chicken, Nigeria.

INTRODUCTION

The word 'layer chicken' refers to a female chicken that is more than 20-22 wk of age (Kekeocha, 1984) and are expected to produce less tender but quality meat and can produce up to 300 eggs per year depending on the feed and management (Kabir *et al*. 2006). Egg producing chickens have been bred for maximum egg production rather than meat yield. Chickens have short generation and gestation interval, high prolificacy, fast growth rate and are easy to

raise (Oluyemi and Roberts, 2000; Kabir and Olufemi, 2013). The external and internal quality traits of eggs in hens had significant effects on the hatchability of incubated and fertile eggs (Kabir and Muhammad, 2011) as well as the weight and development of the embryo (Kabir *et al.* 2007). It was further reported by Kabir and Muhammad, (2011) that reproduction in egg shell quality depressed hatchability and results in weakening of the embryo. It is generally accepted that all characteristics of egg quality have genetic basis and according to Stadelman (1977) egg quality refers to the characteristics of an egg that will affect its acceptability to the consumé. Several factors that affect egg quality include egg size (Butcher and Miles, 2003), age of the bird (Coutts and Wilson, 1990), genetics and diseases (McFerran and Adair, 2003; Jones, 2006), stress (Solomon, 1991), environmental temperature (Koelkebeck, 1999), nutrition and water quality (Boorman *et al*. 1989). Stadelman (1977) stated that the hens' egg consists of the yolk (30-33%), albumen (55-60%) and the shell (9-12%). Egg quality has significant impact on the reproductive fitness of the parent and according to Bennett (1992) thin shelled egg was 3-9% lower than the thicker shelled eggs.

The production of high quality eggs is the responsibility of the poultry and egg producers and such quality must be preserved for consumers' acceptability. Hence this study intends to investigate the effect of strain and age on both external and internal quality traits and correlate the relationships between the tested traits in two different strains of layer breeder chickens in northern guinea savannah zone of Nigeria.

MATERIALS AND METHODS

Site, experimental birds and management

The experiment was carried out at the Teaching and Research Farm, Department of Animal Science, Ahmadu Bello University, Zaria. The site is geographically situated between latitude 11˚ and 12' and longitudes 7˚ and 33' E at an attitude of 640M above sea level. It is located 22km Northeast of Zaria city and vegetationally in the northern guinea savannah zone of Nigeria.

Detailed information on temperature, precipitation and other climatic description of Zaria has been given elsewhere by Kabir *et al*. (2010). Total of 200 (100 of each) two distinct strains of layer birds (Isa Brown and Nera Black) were used.

The Nera Black chickens are primarily egg-producing strain of domestic chicken in Nigeria (Adene and Oguntade, 2006). They are one of the most popular strains of layers in Nigeria because of their high level of production (between 80% and 85% throughout their laying period) and the high market value of the old layers compares with the local chickens (Adene and Oguntade, 2006).

The Isa Brown on the other hand, is an exotic layer strain of reference for more than 30 years and adapts herself to all climates and environments of the world (Nwankwo and Omeje, 2009).

They are excellent layers with a quiet temperament able to produce between 300-350 eggs per hen in the first year of lying. The study commenced when the birds were 26 weeks old and they were subjected to the same management practices with feed and clean drinking water provided *ad libitum*. They were intensively managed in a 2-tier battery cage having a dimension of 25 cm × 45 cm × 42 cm. The crude protein and energy content of the diet were 16.45% and 2470 kcal/kg ME.

Parameters considered and data collection

Total of 60 eggs (30 from each strain) were collected every week and analyzed for external egg qualities [egg weight (EW), egg length (EL), egg width (EWd), shell weight (SW) and shell thickness (STh) and internal egg qualities yolk weight (YW), yolk height (YH), albumen weight (AW) and albumen height (AH)]. Other parameters measured were body weight (BW) and feed intake (FI). The above traits were taken at 26, 32 and 38 weeks of age, respectively.

Weight measurements were determined using Mettler® top loading digital scale while length and width were measured using a vernier caliper and the STh was measured to the nearest 0.01 mm. Yolk and albumen measurements were determined using standard methods as described by Olawumi and Ogunlade (2009). The Haugh unit was calculated using the values obtained for the egg weight and albumen height using the formula given below:

$$\text{Haugh unit (HU)} = 100 \log (H + 7.5 - 1.7W^{0.37})$$

Where:
H: albumen height in mm.
W: egg weight in gram.

Statistical analysis

Data obtained were subjected to a 2 × 3 factorial arrangement comprising of 2 strains of layer chickens (Isa Brown and Nera Black) at 3 different ages (26, 32 and 38 weeks in lay), using the General Linear Model (GLM) procedure of SAS (SAS, 2002). Separation of significantly different means was carried out using Duncan's Multiple Range Test (Duncan, 1955). The statistical model adopted is shown below:

$$Y_{ij} = \mu + B_i + E_{ij}$$

Where:
Y_{ij}: individual observation.

μ: overall mean.
S_i: effect of the i^{th} strain (i=IB, NB).
E_{ij}: random error.

RESULTS AND DISCUSSION

Main effect of strain on performance traits

Least square means (±SE) for body weight, feed intake, and external and internal egg quality traits in the Nera Black and Isa Brown strains of layer chicken is shown on Table 1. The result indicated no significant (P>0.05) difference in FI between the two strains. But IB weighed significantly (P<0.05) heavier (1978 g) than NB (1887 g). Ayanwale *et al*. (2010) reported FI of 2804 g/bird in the broiler finisher phase of their study, which was similar (P>0.05) to the values (2866 g *vs*. 2733 g) obtained in this work. It also agreed with the values of BW in two broiler strains reported by Kabir *et al*. (2010). The values obtained for BW in this study were higher than the values reported by Nwankwo and Omeje (2009) in exotic (1720 g), alpha (1832 g) and native (1246 g) strains. Strain effect was significant (P<0.05) for all external egg quality traits except for EL and EWd, which were statistically similar in the two strains. The observed values for EW, EL, EWd, SW and STh were lower than those reported by Sogunle *et al*. (2009) but concur with values reported by Nwankwo and Omeje (2009). According to Alex (2001), egg weight is directly proportional to body weight; big bodied birds eat more feed due to their body size and hence lay heavier eggs. Significant (P<0.05) difference was also observed in some internal egg quality traits in the two strains with IB yielding higher AW (36.46 g), YW (15.60 g) and YH (1.86 cm) than NB (33.60), (12.26 g) and (1.62 cm). This agrees with the report of Olawumi and Ogunlade (2009). Differences between the results obtained and the reported literature values might be attributed to variation in genetic groups, environmental factors in terms of diet, water intake, temperature, and humidity and management practices.

Main effect of age on performance traits

As regards main effect of age on the tested parameters (Table 1), the results showed that only BW and YW were affected. As expected however, BW at 38th week in lay (2142 g) was significantly (P<0.05) higher than BW at 32 (1984 g) and 26 (1876 g) weeks in lay. It was also observed that YW significantly (P<0.05) increased with increasing age of the chickens. The implication is that eggs from younger birds would be expected to have lower amount of cholesterol (Ayanwale *et al*. 2010). These findings concur with the earlier reports of Jones (2006) and Sogunle *et al.* (2009). The STh decreased 0.45 mm at 26^{th} week of lay to 0.40 mm at the 40^{th} week of lay while the egg weight increased from 55 to 57 g during the same laying periods. This conforms with the reports of Butcher and Miles (2003) that smaller eggs have stronger shells than larger ones and that older birds tend to lay bigger eggs which impact more on the shell strength since hens are said to have a finite capacity to deposit calcium in the shell (Clunies *et al*. 1992) and as a result, the same amount of calcium is spread over a larger area. The reduced values of albumen height (3.21 cm) and Haugh unit (59.14) at the 38th week of lay is in agreement with the reports of Coutts and Wilson (1990) and Jones (2006) that albumen height and Haugh unit decreased with increasing age of laying chickens .

Interactive effect of strain and age

The effect of interaction between strain and age on the tested parameters is presented in Table 2. The BW of Isa brown (IB) strain was significantly (P<0.05) higher than that of Nera black (NB) at all ages. The BW attained by IB at 32 weeks of lay (1980 g) was only achieved at the 38^{th} week of lay (1979 g) by the NB strain. The lowest albumen height (AH) of 3.77 cm was obtained for IB strain at 38 week of lay, which also had the highest yolk weight (15.61 g). All the external egg qualities measured for the 2 strains were comparable across all ages. Similar observation was made for internal egg qualities for the 2 strains except for yolk weight, which showed significant (P<0.05) interactive effect of strain and age.

Correlations among traits

Table 3 shows the correlation among body weight, feed intake and external quality traits. There was statistically non-significant (P>0.05) positive correlation in all the parameters tested except between BW and FI (0.73), BW and EW (0.54) and FI and EW (0.37), which were significant (P<0.05). This agrees with the findings of David (1980) and Ricklefs (1983).

The coefficient of correlation between BW and EL, BW and STh, EW and EL, EW and SW were high. These findings indicated a direct relationship among the traits measured and was in line with literature reports (Ozcelik, 2002; Olawumi and Ogunlade, 2009). Significant positive phenotypic correlation between SW and STh was reported by Kul and Seker (2004) in Japanese quail. However, Ojedapo *et al.* (2008) obtained lower coefficient of phenotypic correlation for some of these traits in commercial layer strain.

The coefficients of correlation for BW, FI and internal quality traits are presented in Table 4. Positive coefficients were obtained for all parameters tested except between AH and YH (-0.42), which was not significant (P>0.05). Negative value (-0.02) was also reported for these traits by Ojedapo *et al.* (2008).

Table 1 Main effect of strain (±SE) and age on laying performance of two strains of chickens in Nigeria

Parameters	Strain		Age (weeks in lay)			
	Isa Brown	Nera Black	26	32	38	SEM
Body weight (g)	1978.00±21.05[b]	1887.33±13.11[c]	1876[c]	1984[b]	2142[a]	87.51
Feed intake (g)	2806.67±264.51	2733.33±227.96	2757.41	2792.65	2803.34	153.66
External quality						
Egg weight(g)	58.06±1.08[a]	54.26±1.29[b]	55.18	56.93	57.42	1.35
Egg length (cm)	4.16±0.07	4.12±0.07	4.31	4.27	4.33	0.04
Egg width (cm)	2.92±0.04	2.86±0.04	3.04	2.97	3.12	0.06
Shell weight (g)	5.40±0.19[a]	5.00±0.16[b]	5.23	5.38	5.27	0.13
Shell thickness (mm)	0.44±0.08[a]	0.31±0.09[b]	0.45	0.42	0.40	0.03
Internal quality						
Albumen weight (g)	36.46±1.02[a]	33.60±1.15[b]	34.87	34.50	35.16	1.21
Albumen height (cm)	3.76±0.03	3.79±0.03	3.96	3.72	3.21	0.27
Yolk weight (g)	15.60±0.36[a]	12.26±0.35[b]	13.32[c]	15.04[b]	16.75[a]	0.86
Yolk height (cm)	1.86±0.02[a]	1.62±0.03[b]	1.73	1.72	1.70	0.90
Haugh unit	61.73	60.84	60.32	59.96	59.14	3.33

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SE: standard error and SEM: standard error of mean.

Table 2 Interaction effects of strain and age on laying performance of two strains of chickens in Nigeria

Strains	Isa Brown			Nera Black			
Weeks in lay	26	32	38	26	32	38	SEM
Body weight (g)	1955.29[c]	1980.53[b]	2138.27[a]	1860.18[d]	1951.61[c]	1979.84[b]	96.85
Feed intake (g)	2859.47	2828.11	2848.84	2777.63	2759.24	2800.90	163.21
External quality							
Egg weight (g)	56.17	55.48	55.34	55.26	56.63	55.16	1.07
Egg length (cm)	4.34	4.27	4.31	4.06	4.37	4.44	0.05
Egg width (cm)	2.84	2.81	2.79	2.80	2.82	3.00	0.08
Shell weight (g)	5.43	5.16	5.29	5.19	5.36	5.27	0.11
Shell thickness (mm)	0.41	0.43	0.39	0.39	0.40	0.42	0.05
Internal quality							
Albumen weight (g)	35.73	34.29	35.82	34.47	35.55	35.37	1.06
Albumen height (cm)	3.81	3.83	3.77	3.83	3.92	3.91	0.22
Yolk weight (g)	13.51[d]	14.96[b]	15.61[a]	13.43[d]	14.58[c]	15.00[b]	0.83
Yolk height (cm)	1.90	1.85	1.77	1.80	1.86	1.82	0.88
Haugh unit	60.29	60.38	60.17	60.46	59.83	59.34	2.93

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of mean.

Table 3 Correlation coefficients for body weight feed intake and egg external quality traits of two strains of chickens in Nigeria

Parameters	BW	FI	EW	EL	EWd	STh	SW
Body weight (BW)	1	-	-	-	-	-	-
Feed intake (FI)	0.73*	1	-	-	-	-	-
Egg weight (EW)	0.54*	0.37*	1	-	-	-	-
Egg length (EL)	0.33	0.21	0.37	1	-	-	-
Egg width (EWd)	0.23	0.20	0.02	0.03	1	-	-
Shell thickness (STh)	0.33	0.04	0.23	0.17	0.01	1	-
Shell weight (SW)	0.11	0.12	0.34	0.24	0.23	0.37	1

* P<0.05.

Table 4 Correlation ccoefficient for body weight, feed intake and egg internal quality traits of two strains of chickens in Nigeria

Parameters	BW	FI	AH	AW	YH	YW
Body weight (BW)	1	-	-	-	-	-
Feed intake (FI)	0.74*	1	-	-	-	-
Albumen height (AH)	0.18	0.06	1	-	-	-
Albumen weight (AW)	0.33	0. 39*	0.29	1	-	-
Yolk height (YH)	0.11	0.14	-0.42	0.20	1	-
Yolk weight (YW)	0.34	0.48*	0.22	0.04	0.22	1

* P<0.05.

Correlation coefficient between BW and AW (0.33), BW and YW (0.34), FI and AW (0.39), FI and YW (0.48) were positive and high. This revealed that BW had effect on most of the external and internal egg quality parameters and was in line with the submissions of Abutu *et al.* (2008).

CONCLUSION

The findings of this study indicated that strain had effect on most of the external and internal egg quality investigated. This means that genetic factor plays a vital role in influencing both external and internal quality of an egg. The Isa Brown strain was superior to Nera Black strain as it was heavier, laid heavier eggs with stronger shells. Good shell thickness is desirable as it is an important biochemical trait that confers strength against crack and breakages during egg handling. The study further confirmed that age of the layer chickens decreased significantly ($P<0.05$) most of the internal and external qualities of egg. Body weight was positively and significantly ($P<0.05$) correlated with feed intake and egg weight.

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