Nig. J. Anim. Prod. 2018, 45(2): 29 - 39

Influence of strain and production cycle on egg quality traits of two Nigerian indigenous chicken strains

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Abstract

Records obtained from purebred normal feather and naked neck Nigerian indigenous chicken strains were used to assess the influence of strain and production cycle on external and internal egg quality traits. The assessment commenced from first lay to 120 days of lay, classified into four production cycles (PC): PC1 (1-30 days of lays), PC2 (31-60 days of lays), PC3 (61-90 days of lays), and PC4 (91-120 days of lays). Mean egg weight, length and breadth were 4.34% heavier, 2.10% longer and 1.72% wider in the normal feather than in the naked neck ($p<0.05$). No disparity due to strain effect was found in egg shape index. Eggshells from the two strains had similar weight but varied in thickness with shells from the naked neck being 0.02mm thicker than those from the normal feather ($p<0.05$). Eggs from the normal feather were 7.13, 5.76, 5.00, 7.10 and 8.11% superior in albumen weight, yolk height, albumen height, yolk index, and albumen index, respectively compared to its naked neck counterpart ($p<0.05$). Production cycle significantly influenced all external egg quality studied. An increase of 16.21% in egg weight was obtained by PC4. Egg length and breadth increased consistently with each subsequent PC ($p<0.05$) whereas egg shape index decreased with PC ($p<0.05$). Higher values were recorded for yolk weight, yolk and albumen length and width in each subsequent production cycle. Haugh unit, yolk and albumen height had best values at PC2. Our findings indicate that strain type and production cycle highly influenced egg quality traits of Nigerian indigenous chickens with the normal feather showing superiority. Furthermore, the best internal quality was obtained at PC2 (31-60 days of lay). Our findings could be useful in choosing selection criterion traits in breeding plans for the development of different layer lines of normal feather and naked neck.

Keywords: Normal feather, naked neck, egg quality traits, production cycle, purebred, chickens

Introduction

The role of the Nigerian indigenous chicken in meeting the challenge of animal protein intake by the citizenry cannot be overemphasized. The Nigerian indigenous chicken has rich genetic reservoir, and is known to be highly adaptable and resistant to the harsh and adverse climatic and management conditions prevalent in the tropics. Within the past four decades, there have been numerous attempts on genetic improvement of the indigenous chicken by application of different breeding strategies (Nwosu, 1979; Omeje and Nwosu, 1984; Adebambo *et al.*, 1999; Adediji *et al.*, 2006; Oleforuh-Okoleh, 2010; Adeleke *et al.*, 2011). In 1994, indigenous chicken breed development project was launched at the Federal University of Agriculture, Abeokuta using different indigenous poultry breeds sourced all over South-western Nigeria, with the aim of developing pure lines, and improved Nigerian indigenous chickens (Adebambo, 2015). The purebred lines were obtained through intensive selection over six generation using body weight and egg production traits (egg number and egg weight) as selection criterion and pure breeding of the different strains. To promote the production of this stock in other parts of the country as well as to integrate them into the existing commercial production milieu it is imperative to assess and document their performance outside their environment of origin. Such practice is upheld by the assertion of Nimbakar *et al.* (2008) that genetic improvement should cumulate in development of populations/flocks to meet both production and market conditions. This implies that the goal of improving the productivity of any breed/strain should be to integrate it into a viable and competitive economic market.

Various studies on the Nigerian indigenous chicken infer that this chicken show greater potential as the laying type compared to the meat type chicken (Oleforuh-Okoleh, 2013; Ndofor-Foleng *et al.*, 2015). Eggs are complete in their nutrient content and are the cheapest source of animal protein. The quality of the egg is of crucial concern in the efficiency of production and profitability of the egg production, processing and breeding industries, as well as the consumers' acceptability. Egg quality, the condition of the egg whether viable or table egg, is evaluated using traits associated with egg size, shell, yolk and albumen components. These traits are influenced by different genetic and non-genetic factors acting on several biochemical processes controlling them. The genetic factors could arise due to variations in gene actions such as those related to additive, dominance, pleiotropic, direct and maternal effects (Koerhuis *et al.*, 1997; Hartmann *et al.*, 2003; Monira *et al.*,2003), and some non-genetic factors associated with nutrition, production environment, health status, age of hen, etc. (Zaman *et al.*, 2003; Vits *et al.*, 2005; Rajkumar *et al.*, 2009). Bain *et al.* (2016) noted that in improving strains/lines for egg production, the breeder prioritizes not only persistency in lay but also stability in egg quality over a longer period of time. The purpose of this study was, therefore, to assess the influence of strain and production cycle on egg quality traits of purebred normal feather and naked neck Nigerian indigenous chickens.

Materials and methods

Site of study

This study was done at the Teaching and Research farm of the Department of Animal Science, Rivers State University, Port Harcourt between the months of July and November, 2016. The study site is located within longitude 6°55'-7°56'E and latitude 4°75'N. Port Harcourt is in the humid equatorial monsoon climatic region of Nigeria having a mean annual rainfall above 2300mm with temperature ranges of 26-32°C and mean relative humidity of 66-96% (Edokpa and Nwagbara, 2017).

Stock and management

100 birds comprising normal feather (50) and naked neck(50) strain of Nigerian indigenous chicken maintained at the Unit were used for the study. These were progenies from selected parent stock of naked neck and normal feather Nigerian indigenous chicken obtained from about six generations of pure breeding and intensive selection, for improved body weight and egg production traits, at the Poultry Breeding Unit of the Teaching and Research farm of the Federal University of Agriculture, Abeokuta, Nigeria. The pullets were obtained at day-old and raised in deep litter pens using wood shavings as litter material for 18 weeks under *ad libitum* feeding regime using chick mash from day old to 8 weeks and growers mash from 8-18 weeks of age, using the recommendations of Oleforuh-Okoleh *et al.* (2016). At 18 weeks of age they were transferred from deep litter and assigned individually to cells in a three-tier battery cage. They were

placed on *ad libitum* feeding regimen on layers' diet consisting of 17%CP and 2800Kcal $MEkg^{-1}$.Clean drinking water was also provided *ad libitum* throughout the study period. Vaccination was given against Newcastle, gumboro, fowl typhoid, fowl pox and fowl cholera according to the recommendations of National Veterinary Research Institute, Nigeria. Routine medications on vitamins and mineral supplements were also given.

Measurement obtained

Eggs were picked twice daily in the mornings (6.00–7.00hrs) and evenings (16.00-17.00hrs). Evaluation of egg quality traits was done from sexual maturity to 120 days of lay using two fresh eggs per hen on weekly basis. Consequently, 35 eggs were evaluated for each individual. Measurements were done on the following external egg quality traits: egg weight - this was done using a Mettler Toledo electronic sensitive weighing balance with 0.001g accuracy; egg length – the distance from the broad end to the narrow end (along the longitudinal axis) and egg breadth – the circumference of the egg around the middle portion, that is, the equatorial axis were taken using a digital vernier caliper; egg shape index - ratio of the egg width to egg length expressed in percentage; shell weight – this was obtained after pouring the albumen and yolk into a white flat ceramic plate. The shell (with membrane) was gently and carefully washed to remove any adhering egg content, allowed to dry before the weight was obtained; shell thickness – the shell thickness (with membrane) was obtained by taking the average of measurements (in mm) made on the broad, middle and narrow end of the eggshell using a micrometer screw gauge.

To assess the internal quality traits, measurements of the contents poured into the white flat ceramic plate were then taken using a digital vernier caliper. Traits evaluated include - yolk and albumen height, length, and breadth. The values obtained were used to estimate the yolk and albumen indices as ratio of their respective length and breadth expressed in percentages (Kul and Seker,2004). The Haugh unit score was calculated as described in Oleforuh-Okoleh and Eze (2016). Yolk and albumen weight were obtained by carefully separating and placing the yolk and the albumen in different beakers, and their weight obtained with the sensitive weighing balance. Finally, to measure the yolk and albumen pH, each of these contents was thoroughly mixed and their pH determined using a pH meter with 0.01 unit precision (Hanna Inst., Woonsocker, RI 02895).

Data analysis

The records obtained were summarized into four production cycles (days of lay from first egg) identified as – PCI (1-30), PC2 (31-60), PC3 (61-90), and PC4 (91-120). The multivariate analysis of GLM procedure (IBM SPSS, 2013) was used to carry out analysis of variance on all the data (using strain type and production cycle as fixed effects). Means were considered significantly different at $p<0.05$ and separation was done using Duncan's option of the same software.

Results and discussion

The external egg quality traits of the naked neck and normal feather Nigerian indigenous chickens as influenced by the strain type and laying period is shown in Table 1. Variations ($p<0.05$) due to strain effect were observed in egg weight, egg length, and egg breadth, whereas egg shape index was similar ($p>0.05$) for the two strains. Mean egg weight of the two strains in the present study was found to be greater (4.34% heavier) in the normal feather chicken than in the naked neck ($p<0.05$).

Table 1: Effect of strain and laying period on external egg quality traits of Nigerian indigenous chickens

Traits	EW(g)	EL(cm)	EB(cm)	ESI(%)	ST(mm)	SW(g)
Strain						
Naked neck	46.28[b]	5.11[b]	3.99[b]	78.37	0.29[a]	5.67
Normal feather	48.38[a]	5.22[a]	4.06[a]	77.81	0.27[b]	5.45
SEM	0.61	0.03	0.02	0.32	0.01	0.08
p-value	0.001	0.000	0.000	0.085	0.05	0.732
Production cycle (days)						
1-30	42.43[c]	4.96[d]	3.89[c]	78.55[a]	0.24[c]	5.04[c]
31-60	48.33[b]	5.16[c]	4.06[b]	78.84[a]	0.25[c]	5.85[b]
61-90	48.55[b]	5.25[b]	4.06[b]	77.41[b]	0.29[b]	5.72[b]
91-120	50.64[a]	5.34[a]	4.12[a]	77.22[b]	0.32[a]	5.91[a]
SEM	0.70	0.03	0.02	0.42	0.01	0.09
p-value	0.000	0.000	0.000	0.000	0.000	0.000

[abc]Means on the same column, for each effect, followed by different superscripts are significantly different at *p*-values indicated.

Our finding was contrary to Udoh *et al.* (2012) and Egahi *et al.* (2013) who reported about 8.33% and 29. 62% heavier eggs, respectively in naked neck Nigerian local chickens compared to their normal feather counterparts. Eggs from both strains were however heavier than 38g reported by Oleforuh-Okoleh *et al.* (2012) after three generations of selection in a population of Nigerian light local chicken ecotype. Eggs from the normal feather were 2.10% longer and 1.72% wider than naked neck eggs. This was contrary to Yakubu *et al.* (2008) on superior length and width in the naked neck Nigerian indigenous chicken but upholds the findings of Kgwatalala *et al.* (2016) on longer and wider eggs in normal feather chickens in comparison to the naked neck. Differences in egg length and egg breadth as seen in this study affirms the submissionsof Anderson *et al.* (2004) and Markos *et al.* (2017) that these traits are influenced by genetic variations.The superiority observed in the normal feather was not expected given the reports of earlier studies by Peters *et al.* (2004) and Yakubu *et al.* (2008). These authors associated better performance of the naked neck to their possession of thermoregulatory genes which gave them greater adaptation to the hot humid tropical environment. It is imperative to note that our study was done during the peak of rainy season and such environmental condition could have been an added advantage for the superiority of the normal feather.

There was no disparity (p>0.05) in egg shape index of the two strains, which ranged from 77.81-78.38%. Our result was higher than 74.63% obtained by Oleforuh-Okoleh (2016) from a population of Nigerian native chickens but quite close to the value (76.00%) reported by Ewa *et al.* (2005) in some exotic chicken strains. The similarity, in egg shape index between the naked neck and normal feather is in line with Iraqi (2002). Peters *et al.* (2007) however indicated that the naked neck hens produced eggs with better egg shape index than the normal feather. Though North and Bell (1990) suggested that the ideal egg shape index is 74%, our values still indicated that eggs from both strains were oval in shape which ought to be the perfect shape of a chicken egg. Cavero *et al.* (2011) noted that egg shape index is an important trait in poultry breeding and table egg production since rounder eggs tends to have poor hatchability and egg grading status.The mean shape index of the two strains was within the recommended index for packaging in classic commercial cartons (Chatterjee *et al.*, 2007).

Eggshells from the two strains had similar weight ($p<0.05$) but varied in thickness with shells from the naked neck being on average 0.02mm thicker than those from the normal feather ($p<0.05$). The mean shell thickness of 0.29mm obtained in the naked neck chickens is similar to the value obtained by Tadesse *et al.* (2015) and Abdurehman and Urge (2016) from Potchefstroom Koekoek, an indigenous South African chicken, and from ruralchicken in Gorogutu district, Eastern Hararghe, Ethiopia respectively.

Our findings on the external egg quality traits with respect to production cycles affirmed the reports of Silversides *et al.* (2006) and Tůmorvá and Gous (2012) that the age of the hen/laying cycle affects egg quality. Egg weight was least during PC1 but showed 16.21% improvement by PC4. Haunshi *et al.* (2011) also observed that egg weight increased as the period of lay (age) of the hen increased. Generally, our result indicates that eggs from both purebred Nigerian indigenous chickens can be classified as small within the first 30 days of lay and subsequently as medium size using the USDA average egg weight scale. Egg length and breadth increased consistently with age ($p<0.05$) and confirms the observations made by John-Jaja *et al.* (2016) in Nera Black chickens raised in Nigeria. Though egg shape index reduced as production cycle increased ($p<0.05$), much of the variation existed between the first two cycles (PC1 and PC2) and the last two cycles (PC3 and PC4). Johnston and Gous (2007) suggested that variations in the geometry of the egg as the hen ages could be linked with the changes in the weight/size of oviduct**.** Eggshell quality (weight and thickness) improved as the hens aged ($p<0.05$). Shell thickness is important in egg grading since cracked or broken eggshells are of economic concern since they are often unacceptable by consumers and the hatchery industry resulting to huge monetary losses. Some authors inferred that eggs with shell thickness less than 0.33mm are subject to ease entrance of microbes and breakage. Our study indicates that by PC3, the eggs had achieved shell thickness of 0.32+0.01. This suggests that breeding at an earlier age could negatively affect hatchability due to poor shell quality.

Effects of strain and production cycle on yolk and albumen quality traits are illustrated in Tables 2 and 3, respectively. Eggs from the normal feather were 7.13, 5.76, 5.00, 7.10 and 8.11% superior in albumen weight, yolk height, albumen height, yolk index, and albumen index respectively compared to their naked neck counterpart ($p<0.05$). Superiority of the normal feather to the naked neck on these traits was also reported by Kgwatalala *et al.* (2016). The variations observed could be attributed to genetic variations between the two strains since both where subjected to identical management practices (Niranjan *et al.*, 2008; Haunshi *et al.*, 2011).

Table 2: Effects of strain and production cycle on yolk quality traits of Nigerian indigenous chickens

Traits	YW(g)	YH(cm)	YL(cm)	YB(cm)	YI%	YpH
Strain						
Naked neck	15.09	1.47^{b}	4.09	4.07	38.61^{b}	6.46
Normal feather	15.04	1.56^{a}	4.04	3.82	41.56^{a}	6.40
SEM	0.286	0.023	0.045	0.016	0.744	0.076
p-value	0.851	0.000	0.247	0.127	0.001	0.383
Production cycle (days)						
1-30	13.17^{d}	1.49^{b}	3.79^{b}	3.55^{c}	41.13^{b}	7.15^{a}
31-60	14.19^{c}	1.70^{a}	3.80^{b}	3.61^{b}	47.14^{a}	6.40^{b}
61-90	15.88^{b}	1.42^{c}	4.29^{a}	4.06^{a}	35.39^{c}	6.17^{c}
91-120	16.74^{a}	1.51^{b}	4.31^{a}	4.07^{a}	36.84^{c}	6.06^{c}
SEM	0.329	0.027	0.046	0.218	1.057	0.081
p-value	0.000	0.000	0.000	0.009	0.000	0.000

^{abc}Means on the same column,for each effect, with different superscripts are significantly different at *p*-values indicated.

Though the yolk index of both strains were lower than the values obtained by Fayeye *et al.* (2005) in Nigerian Fulani-ecotype chicken, but were still within the acceptable range of 33-50% given by Ihekoronye and Ngoddy (1985). The mean yolk and albumen pH from both strains were similar and within the normal value reported by Heath (1977) and Waimaleongra-Ek *et al.* (2009) for newly laid eggs. A non-significant strain effect was found on yolk weight, Haugh unit, yolk and albumen length, breadth and pH. Similar finding on yolk weight and albumen breadth of naked neck and normal feather Nigerian chicken eggs was reported by Udoh *et al.* (2012). Haugh unit is a key criterion in evaluating egg quality. Though Silversides *et al.* (2006) detected strain differences in this trait, such variations were not recorded in the present study. Average Haugh unit of 79.04 obtained from the naked neck was within the range reported by Padhi *et al.* (1998) for naked neck Desi breeds, while the 80.24% recorded in the normal feather was similar to the value obtained in Kadaknath breed of India (Parmar *et al.* 2006).

Table 3: Effect of strain and production cycle on albumen quality traits of Nigerian indigenous chickens

Traits	AW(g)	AH(mm)	AL(mm)	AB(mm)	AI(%)	ApH	HU(%)
Strain							
Naked neck	24.22^{b}	5.71^{b}	8.80	6.64	7.70^{b}	8.05	79.04
Normal feather	26.08^{a}	6.23^{a}	8.65	6.50	8.30^{a}	8.03	80.24
SEM	0.431	0.013	0.136	0.118	0.270	0.02	0.867
p-value	0.000	0.014	0.291	0.234	0.026	0.240	0.166
Production cycle (days)							
1-30	21.99^{c}	5.96^{b}	7.89^{d}	5.89^{b}	8.85^{b}	8.07^{a}	81.85^{a}
31-60	26.85^{a}	6.37^{a}	8.21^{c}	6.14^{b}	9.12^{a}	8.04^{ab}	82.48^{a}
61-90	25.80^{b}	5.54^{c}	9.09^{b}	7.05^{a}	7.01^{b}	8.02^{b}	77.14^{b}
91-120	26.68^{ab}	5.78^{bc}	9.50^{a}	7.02^{a}	7.03^{b}	8.03^{ab}	78.06^{b}
SEM	0.516	0.170	0.016	0.139	0.380	0.027	1.127
p-value	0.000	0.000	0.000	0.000	0.000	0.045	0.000

^{abcd}Means on the same column, for each effect, with different superscripts are significantly different at *p*-values indicated.

All yolk and albumen traits studied were highly influenced ($p<0.05$) by the production cycle. Higher values of yolk weight, yolk and albumen length and width were recorded with each subsequent period. Zita *et al.* (2013) made similar observations in a population of brown egg laying hens. No peculiar trend was observed in yolk and albumen height, however higher values (1.70cm and 0.64cm, respectively) were obtained at PC2. Albumen index within the period studied was lower than the estimate obtained by Dormus *et al.* (2010) in a Colombian chicken flock, and ranged from 7.03-9.12%. Eggs produced at PC2 had the best internal quality as exhibited by the albumen index (9.12%) and Haugh unit score (82.48%). Our findings showed an obvious decrease (4.42%) in Haugh unit between PC2 and PC4. The decrease in Haugh unit with age of the hen is in line with Ledvinka *et al.* (2012) and Tůmorvá and Gous (2012). Variations in pH value of the yolk and albumen has been associated with factors which influences oxygen consumption, carbondioxide loss through the shell pores, metabolic water and heat production. Decrease in yolk and albumen pH in subsequent periods of lay from PC1 in this study affirms the report of HosseiniSiyar *et al.* (2007) that albumen pH of eggs from younger hens was higher than those from older hens.

Conclusion

Our study indicated that strain type and production cycle influenced most of the egg traits studied, with the normal feather showing superiority over the naked neck. It also suggests that the best internal quality with respect to the yolk and albumen traits was obtained from eggs produced between 31-60days of lay (PC2). The information obtained from our study would be relevant when considering selection criterion traits for breeding programmes aimed at developing different layer lines of the Nigerian indigenous chicken. We recommend that further study on genetic evaluation of these traits be carried out to understand their mode of inheritance.

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Received: 17th November, 2017
Accepted: 2nd March, 2018