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GROWTH PERFORMANCE TRAITS AND EGG QUALITY OF INDIGENOUS YORUBA ECOTYPE CHICKENS CROSSBRED WITH LOHMANN BROWN COCKS

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ABSTRACT

This study evaluates the growth performance, body linear parameters and egg quality of Yoruba ecotype chicken and their F_1 and F_2 crosses using Lohmann brown cocks under a low-input management system. Ten Lohmann brown cocks were mated with thirty indigenous hens to obtain the F_1 progenies. Ten Lohmann cocks were also mated back to thirty F_1 hens to obtain the F_2 progenies. Also, ten indigenous male cocks were mated with 30 indigenous female hens as a basis for comparison. Mating was done at 1:3 in all the groups. Incubation and hatching were naturally done and properly monitored. After hatching, the hens and the chicks were intensively managed for 8 weeks in wooden cages, after which the chicks were transferred to battery cages, where they were raised till maturity. Initial weight at hatching, body weight at 24 weeks, average daily feed intake, body weight at initial egg laying and first egg weight were recorded appropriately, while the body linear parameters (shank length, comb length, keel length, back length, beak length, neck length and drumstick) were measured using standard procedures. Some selected egg quality parameters included egg weight, egg length, egg breadth, shell weight and albumen weight. Weight at hatching, body weight at 24 weeks, average daily feed intake, body weight at initial egg laying and first egg weight were significantly ($P < 0.05$) higher in F_2 birds than in F_1 birds, while F_1 birds had higher values compared to the indigenous birds. The F_2 birds also had significantly ($P < 0.05$) higher egg weight, egg length, egg breadth, shell weight, shell thickness, albumen height, albumen weight, yolk length and yolk weight than F_1 birds. This study showed that the F_1 and F_2 progenies performed better in growth, body linear parameters and the egg quality parameters compared to the indigenous chicken. It can, therefore, be concluded that crossbreeding of indigenous chicken with Lohmann breed is beneficial for improving their growth performance and egg quality parameters, thereby enhancing their productivity.

Key words: egg quality; growth performance; indigenous birds; Lohmann cock

INTRODUCTION

Indigenous chickens are characterized with slow growth rate, small egg size, late maturity and low egg production (Wheto *et al.*, 2004, Amao *et al.*, 2019). The increase in demands for poultry products in the tropics has necessitated an increase in its production. The use of the indigenous strains, though tolerant and resistant to deadly diseases, hardy and adaptable to the environment, has not been able to meet the increased poultry meat demands due to its poor genetic make-up (Adedeji *et al.*, 2015a; Amao, 2019). The use of high-yielding improved strains developed in the temperate countries also has not been able to meet up with the demands due to lower performance, than expected in the tropics, when compared with

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their performance in their countries of origin due to poor adaptability (Stevens, 1991; Adedeji *et al.*, 2015b). Consequently, the demand-supply gap remains unabridged, thus the need to develop and improve Nigerian indigenous chicken strains for improved productivity is still actual (Akinokun, 1990). Moreover, since poultry meat, as compared to many other meat types like red meat, are characterized by relatively low price and lack of cultural and religious barrier (Jaturashita, 2004; Adeleke *et al.*, 2012). Therefore, poultry meat is always in constant demand by the population for consumption.

There have been some efforts at characterizing the Nigerian indigenous chicken. These efforts include classification based on ecotypes, plumage colour and shank colour (Adebambo, 2005; Ikeobi *et al.*, 1996; Sonaiya and Olori, 1990). A substantial amount of qualitative phenotypic diversity for various traits in the indigenous chicken ecotypes of African Sahara is expected because of diverse agro-climates, ethnic groups, socioeconomic, religions and cultural activities (Mogosse, 2007). Indigenous domestic chicken in many developing countries may possess similar appearance in some characteristics. However, great variability in morphological characteristics within local population exists (Horst, 1997). The indigenous chickens have colourful plumage that may be grouped into two classes, sole colour and mixed colours (Nthimo, 2004). Payne (1990) also observed that the indigenous chicken in the tropics possess light covering of weary feathers that are free from down.

The system of managing the indigenous fowl in Nigeria is still at the rudimentary stage, where traditional farmers, including women, allow their birds to roam on free range system and scavenge for feed (Ezeokeke *et al.*, 2009). Traditional method of rearing indigenous chicken usually results in laying of infertile eggs, since they are mostly kept in an extensive system and egg incubation is often done naturally by the hen (Amao, 2020a). Eggs are also prone to dangers caused by several predators, since egg laying and nesting are done by most hen in a secluded place. The incubation place may not be safe, as there can be exposure to rain and/or direct sunlight, which could affect hatchability. Consequently, number of surviving chicks is usually low and generally leading to low returns (Amao, 2020b).

Using the modified traditional rearing system and crossbreeding of indigenous chicken with improved breed, desired improvement can be achieved on the F_1 generation in terms of egg colour, egg weight and body weight of resulting cocks and hens (Ojebiyi and Oseni, 2011; Amao, 2020b). This study is, therefore, designed to assess the growth performance traits and egg quality of indigenous Yoruba ecotype chickens crossbred with Lohmann brown cocks using a low input management system.

MATERIALS AND METHODS

The Site of the Experiment

The experiment was carried out at the Poultry unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, Latitude 8° 10' N and Longitude 4° 16' E.

Pre-Experimental Preparations and Experimental Diet

The cages, feeding and drinking troughs were cleansed and disinfected before the commencement of the experiment. Different feeds were provided at each stage of growth for the birds, at the chick phase (0 – 7 weeks), grower phase (8 – 15 weeks) and layer phase (16 weeks – the end of the experiment). The chick mash contained 2654.95 ME $Kcal.kg^{-1}$ energy and 19.92 % of crude protein, while the growers mash contained 2371.55ME $Kcal.kg^{-1}$ energy and 16.30 % of crude protein. The layer's mash contained 2435 ME $Kcal.kg^{-1}$ energy and 16.53 % of crude protein. Table 1 shows the gross composition of the grower's mash and layer's mash fed to the birds during the period of the experiment.

Experimental Animals and Management

Twenty cocks consisting of 10 Yoruba Ecotype and 10 brown Lohmann cocks with 60 Yoruba ecotype hens were purchased from a reputable farm. Ten Yoruba Ecotype cocks were allowed to mate with 30 Yoruba Ecotype hens at the ratio of 1:3 to obtain the indigenous Yoruba ecotype chicks, while 10 Lohmann cocks were also allowed to mate with 30 Yoruba ecotype hens at the ratio of 1:3 to obtain the F_1 chicks. The mating process was properly monitored in an enclosed total space of 50 m × 25 m for each group in order to have adequate space for successful mating. The spaces were further partitioned for each pair of birds in each group accordingly. The birds (cocks and hens) were left to mate continuously for 2 weeks, before the cocks were separated from the

Table 1. Gross Composition of the Experimental Diets

Ingredients	Grower's mash	Layer's mash
Maize	35	40
Soya bean meal	8	10
Groundnut cake	7	6
Fish meal	2	1
Wheat offal	20	24.2
Corn bran	10	-
Palm kernel cake	8.3	7
Bone meal	3.8	2.5
Limestone	-	3.5
Oyster shell	5.25	5
Salt	0.2	0.25
Methionine	0.1	0.15
Lysine	0.1	0.15
Premix	0.25	0.25
	100	100
Calculated Analysis		
Metabolizable Energy (Kcal.kg^{-1})	2371.55	2435
Crude Protein (%)	16.30	16.53

hens. After successful mating, nests were made and provided for the hens to lay and to incubate thereafter. After laying ceased, the hens incubated all their eggs (150 indigenous chicken eggs and 198 F_1 eggs) by themselves. The natural incubation process was properly monitored for 21 days after which 80 of the eggs hatched from indigenous hens and 95 eggs hatched into chicks from the F_1 eggs.

Immediately after hatching, brooding was done naturally. Feed and water were supplied to them *ad libitum*. The chicks were reared intensively inside wooden cages (60 cm × 50 cm × 85 cm) until eight weeks, after which they were sexed and transferred to battery cages (50 cm × 50 cm per cell), where they were managed intensively till the end of the experiment. Fifty-eight indigenous chicks (35 females and 23 males) and 79 F_1 chicks (44 females and 35 males) survived above 24 weeks. Adult F_1 hens (n = 30) at 24 weeks were selected from the offspring and were allowed to mate back with ten Lohmann cocks. The processes of egg laying, incubation and hatching were completed respectively resulting into 142 F_2 eggs and 89 F_2 chicks, and they were properly monitored and managed following the same procedure as that of the indigenous and F_1 chicks. The weight and linear body measurement of each bird was taken weekly. Out of the 89 F_2 chicks, 70 F_2 chicks (38 females and 32 males) survived above 24 weeks. The experimental design is as shown below:

Table 2. Experimental Design

Experimental crosses	Total eggs produced	Total chicks hatched	Total chicks survived above 24 weeks
10 Ind cocks x 30 Ind hens	150 Ind eggs	80 Ind chicks	58 chicks
10 Loh cocks x 30 Ind hens	198 F_1 eggs	95 F_1 chicks	79 chicks
10 Loh cocks x 30 F_1 hens	142 F_2 eggs	89 F_2 chicks	70 chicks

Ind = Indigenous, Loh = Lohmann

Figure 1. Yoruba Indigenous cock at 24 weeks

Figure 2. Yoruba Indigenous hen at 24 weeks

Figure 3. Lohmann cock at 24 weeks

Figure 4. F_1 cock at 24 weeks

Figure 5. F_1 hen at 24 weeks

Figure 6. F_2 hen at 24 weeks

Data Collection

Growth Performance and Linear body Parameters

Average daily feed intake, total weight gain, total feed intake, average daily weight gain and initial weight at hatching were measured and recorded during the experiment. Eight linear body parameters taken from the birds were: shank length (cm), back length (cm), keel length (cm), comb length (cm), beak length (cm), neck length (cm), drumstick length (cm) and chest girth (cm). A tape rule was used for all the linear body measurements through the procedure described by FAO (2012). Growth and linear body measurement was carried out once a week for a duration of 24 weeks.

Egg quality parameters

The parameters measured for the egg quality were egg weight (g), egg length (cm), egg breadth (cm), shell weight (g), shell thickness (mm), egg colour, albumen height (mm), albumen weight (g), yolk length (cm), Yolk index (mm), Yolk height(cm) and Yolk weight (g). Measuring scale, vernier calliper, micrometer screw gauge, spirometer and other appropriate equipment were used to evaluate these parameters according to the procedure of Amao and Olugbemiga (2016). Egg quality assessment was done once a week for a duration of 12 weeks from the commencement of laying.

Statistical Analysis

Data were subjected to the two-way analysis of variance (SAS, 2000) and means were separated using Duncan Multiple Range Test. Differences were considered significant at $P < 0.05$.

RESULTS

F_2 male chickens had significantly ($p < 0.05$) higher initial weight at hatching, body weight at 24 weeks, total feed intake and total weight gain compared to the indigenous and F_1 male chickens. The Yoruba ecotype male chickens had the least observed values for all these traits assessed.

The initial weight at hatching, body weight at 24 weeks, average daily feed intake, total feed intake, total weight gain, body weight at first egg and weight of first egg were higher in F_2 female chickens compared to the indigenous and F_1 female chickens. The lowest values of these traits were observed for indigenous female chickens.

Table 3. Growth performance of indigenous, F_1 and F_2 of male chicken

Parameters	Indigenous chicken	F_1 chicken	F_2 chicken
Initial weight of hatchlings (g)	24.62 ± 0.903^b	27.28 ± 0.60^b	34.71 ± 1.42^a
Body weight at 24 weeks (g)	1129.00 ± 33.69^c	1428.67 ± 34.30^b	1682.33 ± 63.40^a
Average daily feed intake (g)	90.31 ± 0.21^c	101.89 ± 0.11^b	114.05 ± 6.56^a
Total feed intake (g)	15172.08 ± 0.00^c	17117.52 ± 0.00^b	19160.40 ± 0.00^a
Total weight gain (g)	1104.38 ± 0.00^c	1401.39 ± 0.00^b	1647.62 ± 0.00^a

^{abc}Means with different superscripts along the same row are significantly ($p < 0.05$) different. F_1 = First filial generation, F_2 = Second filial generation.

Table 4. Growth performance of indigenous, F_1 and F_2 of female chicken

Parameters	Indigenous chicken	F_1 chicken	F_2 chicken
Initial weight at hatching (g)	20.62 ± 0.47^c	27.04 ± 0.67^b	34.90 ± 2.46^a
Body weight at 24 weeks (g)	892.31 ± 24.51^c	1203.13 ± 24.50^b	1438.40 ± 63.59^a
Average daily feed intake (g)	86.77 ± 0.79^c	99.74 ± 0.144^b	108.80 ± 0.66^a
Total feed intake (g)	14577.36^c	16756.32 ± 0.00^b	18278.40 ± 0.00^a
Total weight gain (g)	871.69 ± 0.00^c	1176.09 ± 0.00^b	1403.50 ± 0.00^a
Body weight at first egg(g)	795.23 ± 17.90^c	1168.17 ± 24.73^b	1369.30 ± 56.61^a
Weight of first egg (g)	25.54 ± 0.72^c	29.74 ± 0.65^b	39.40 ± 0.65^a

^{abc}Means along the same row with different superscripts are significantly ($p < 0.05$) different. F_1 = First filial generation, F_2 = Second filial generation.

Table 5. Body linear measurements of indigenous chicken and their F_1 crosses

Parameters	Indigenous F	Indigenous M	F_1 F	F_1 M
Average body weight (g)	886.88 ± 31.38^c	1165.50 ± 46.7^b	1175.12 ± 30.95^b	1437.42 ± 32.20^a
Keel length (cm)	13.50 ± 0.42^b	14.75 ± 0.48^a	14.04 ± 0.17^{ab}	15.44 ± 0.31^a
Comb length (cm)	2.59 ± 0.92^b	8.83 ± 0.28^{ab}	3.45 ± 0.19^b	8.97 ± 0.32^a
Back length (cm)	20.25 ± 0.25^b	20.75 ± 0.48^b	21.26 ± 0.24^{ab}	22.43 ± 0.26^a
Shank length (cm)	7.81 ± 0.13^b	9.00 ± 0.00^a	6.61 ± 0.14^c	8.08 ± 0.29^{ab}
Drumstick (cm)	11.88 ± 0.35^c	14.38 ± 0.24^b	12.87 ± 0.17^b	15.02 ± 0.20^a
Neck length (cm)	10.81 ± 0.13^c	12.50 ± 0.29^b	11.94 ± 0.39^b	13.05 ± 0.60^a
Beak length (cm)	2.93 ± 0.06^b	3.03 ± 0.03^b	3.21 ± 0.05^{ab}	3.40 ± 0.07^a
Chest girth (cm)	2.86 ± 0.07^{ab}	2.93 ± 0.08^a	2.21 ± 0.09^c	2.37 ± 0.12^{ab}

^{abc}Means along the same row with different superscripts are significantly ($p < 0.05$) different. F_1 = First filial generation, M – Male, F – female.

The average body weight, keel length, comb length, back length, drumstick, neck length and beak length values were significantly ($p < 0.05$) higher for F_1 male chickens than the indigenous females, indigenous males and F_1 female chickens. However, the shank length and chest girth were significantly ($p < 0.05$) higher in indigenous male chicken.

Table 6 shows the linear body measurement characteristics of the indigenous chicken and their F_2 crosses. Significantly higher values were obtained for body weight, keel length, comb length, back length, shank length, drumstick, neck length, beak length and chest girth in the F_2 male birds as compared to their counterparts – indigenous female, indigenous male and F_1 female chickens.

Table 6. Body linear measurements of indigenous chicken and their F_2 crosses

Parameters	Indigenous F	Indigenous M	F_2 F	F_2 M
Average body weight (g)	886.88 ± 31.38^c	1165.50 ± 46.72^b	1244.12 ± 22.32^b	1674.22 ± 64.89^a
Keel length (cm)	13.50 ± 0.42^b	14.75 ± 0.48^a	14.75 ± 0.49^a	16.03 ± 0.31^a
Comb length (cm)	2.59 ± 0.92^b	8.83 ± 0.28^{ab}	3.47 ± 0.24^b	9.26 ± 0.58^a
Back length (cm)	20.25 ± 0.25^b	20.75 ± 0.48^b	20.64 ± 0.39^b	23.06 ± 0.45^a
Shank length (cm)	7.81 ± 0.13^b	9.00 ± 0.00^a	7.27 ± 0.20^b	9.00 ± 0.18^a
Drumstick (cm)	11.88 ± 0.35^c	14.38 ± 0.24^b	13.71 ± 0.21^b	15.78 ± 0.25^a
Neck length (cm)	10.81 ± 0.13^c	12.50 ± 0.29^b	13.42 ± 0.24^{ab}	14.75 ± 0.28^a
Beak length (cm)	2.93 ± 0.06^b	3.03 ± 0.03^b	3.22 ± 0.05^{ab}	3.67 ± 0.08^a
Chest girth (cm)	2.86 ± 0.07^{ab}	2.93 ± 0.08^a	2.52 ± 0.10^b	2.92 ± 0.08^a

^{abc}Means along the same row with different superscripts are significantly ($p < 0.05$) different. F_2 = First filial generation, M – Male, F – female.

Table 7 shows some selected external egg parameters of indigenous chicken and their F_1 and F_2 crosses. The F_2 eggs had the higher values of egg weight, egg length, egg breadth and shell weight than the indigenous and F_1 eggs while shell thickness was highest in indigenous chicken eggs.

The albumen height, albumen weight, yolk length and yolk weight were higher in F_2 bird eggs than in F_1 birds, while eggs from F_1 cross had higher yolk index and yolk height than F_2 bird eggs.

DISCUSSION

The growth performance traits in this study that indicated that F_2 chickens had the highest initial

Table 7. Selected external egg quality parameters of indigenous chicken and their F_1 and F_2 crosses

Parameters	Indigenous eggs	F_1 eggs	F_2 eggs
Egg weight (g)	29.4 ± 10.29^c	35.71 ± 0.44^b	43.09 ± 0.61^a
Egg length (cm)	4.47 ± 0.03^c	4.84 ± 0.03^b	5.06 ± 0.03^a
Egg breadth (cm)	3.30 ± 0.02^c	3.66 ± 0.02^b	3.96 ± 0.02^a
Shell weight(g)	4.02 ± 0.08^c	4.74 ± 0.06^b	5.27 ± 0.12^a
Shell thickness(mm)	0.24 ± 0.01^a	0.19 ± 0.00^c	0.22 ± 0.01^b
Egg colour	White	Brown	Tinted brown

^{abc}Means along the same row with different superscripts are significantly ($p < 0.05$) different. F_1 = First filial generation, F_2 = Second filial generation.

Table 8. Selected internal quality traits of indigenous, F_1 and F_2 bird eggs

Parameters	Indigenous eggs	F_1 eggs	F_2 eggs
Albumen height (mm)	6.41 ± 0.18^b	6.53 ± 0.11^b	6.96 ± 0.12^a
Albumen weight(g)	16.30 ± 0.29^c	20.75 ± 0.33^b	26.82 ± 0.51^a
Yolk length(cm)	3.43 ± 0.04^b	3.51 ± 0.03^b	3.73 ± 0.05^a
Yolk index(mm)	0.41 ± 0.01^c	0.39 ± 0.01^a	0.34 ± 0.02^b
Yolk height(cm)	1.39 ± 0.03^a	1.37 ± 0.02^a	1.26 ± 0.07^b
Yolk weight (g)	9.23 ± 0.09^c	10.21 ± 0.15^b	11.09 ± 0.22^a

^{abc}Means along the same row with different superscripts are significantly ($p < 0.05$) different. F_1 = First filial generation, F_2 = Second filial generation.

weight at hatching, body weight at 24 weeks, total feed intake and total weight gain that is in line with some previous works (Amao *et al.,* 2020a; Oleforuh-Okoleh *et al.,* 2017; Rotimi *et al.,* 2016; Adedeji *et al.*, 2015a). These authors affirmed that genetic constituents influenced the growth performance characteristics of chickens. This could be due to the heterosis effect, leading to improved performance traits in the F_2 progenies. The results of this study are also in accordance with the findings of Sagarika *et al.* (2017), who affirmed that backcrossed birds (F_2) had higher beak length, breast girth and feed conversion ratio compared to F_1 birds. These significant effects among the chicken crosses showed that the indices measured were highly influenced by genetics.

Males were superior in body weight than the females. This result agreed with the findings of Okoro and Ogundu (2006) and Adedeji *et al.* (2008), who reported the presence of sexual dimorphism in favour of male birds. This may have resulted from differences in hormonal profile and presence of the androgen hormone in males compared to the females. Also, this could be due to aggressiveness and dominance of males when feeding, especially when both sexes are reared together.

The higher egg weight and egg length measured in the F_2 crosses showed the impact of improved genetics on the egg quality. This higher egg quality could be due to higher body weight of F_2 progenies compared to the indigenous and F_1 progenies, since increased body weight may connote higher qualitative egg characteristics like the egg weight (Anyaegbu *et al.*, 2016; Chineke, 2001). The result of our study is also similar with the study of Nwachukwu and Ogbu (2015), who reported that reciprocal backcrossed eggs were better in respect of shell weight, yolk weight, yolk index, albumen weight and haugh units than their F_1 bird eggs.

However, shell thickness being higher in eggs from Yoruba indigenous birds could be due to genetic or environmental influence affecting the amount of egg shell deposited during egg formation, since factors like nutrition and environment can affect shell thickness (Oluyemi and Robert 1979). However, good egg shell thickness is desirable as it is a cogent biochemical trait especially in commercial egg production. The egg shell colour range, observed in this study, was similar to the report of Oluyemi and Roberts (2001) that F_1 bird eggs appear tinted brown in colour, while the indigenous eggs are often white in colour and F_2 eggs brown in colour. The variation in the egg shell colour may be attributed to differences in their genetic make-up since the bird's shell colour is a breed characteristic.

CONCLUSION

The results from this study indicate that F_1 and F_2 crosses are better in the growth parameters, egg quality and in most of the body linear parameters evaluated, while F_1 birds were superior to the indigenous birds in most of the indices assessed. However, F_2 progenies were more improved than the F_1 progenies. This suggests that growth performance, egg quality and productivity of indigenous Yoruba ecotype chicken can be positively influenced through selective crossbreeding with improved strains of chicken like Lohmann.

AUTHOR CONTRIBUTIONS

Conceptualization: Ojebiyi, Olusegun Ojeniyi
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All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on request from the corresponding author.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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