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Variations in growth performance traits and economic analysis of two Nigerian indigenous chicken strains and their crossbred

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Abstract

This study was undertaken to compare growth performance and economics of production of two Nigerian indigenous chicken strains and their crossbred. The parent lines of the Nigerian indigenous chicken population used consisted of two strains, the normal feather (NF) and the naked neck (NN), obtained from purebred strains of Nigerian indigenous chickens maintained at the Directorate of University farm, Federal University of Agriculture, Abeokuta, Nigeria. Three genetic groups comprising a combination of NF male X NN female (GG1), NN male X NN female (GG2) and NN male X NF female (GG3) were used for the study. The results revealed that though chicks from GG2 were heavier (P<0.05) than others at hatch, those from GG3 had higher specific growth rate (4.36 and 5.59% greater than values obtained for GG1 and GG2 respectively) which translated to heavier body weight (1116.55g) at 12 weeks of age. Quantity of feed consumed was similar (P>0.05) among the three groups. Birds from GG3 were however, able to utilize feed consumed by 11.21 and 12.93% more efficiently than GG1 and GG2 respectively. Feed cost per kg weight gain was least for GG3 (₦520) with gross margin of ₦132.35 and ₦133.43 above GG1 and GG2 respectively. GG3 had the best profitability index and return on investment. Crossbreeding naked neck and normal feather showed superiority in growth and economic returns and is therefore recommended in breeding/production programmes targeted at expanding Nigerian indigenous chicken production.

Keywords: Normal feather, naked neck, indigenous chicken, body weight, feed efficiency, economic returns

Introduction

With the present economic recession in Nigeria, attention has been shifted from the oil sector towards agriculture which was the mainstay of the nation decades ago. A sustainable boost in the gross domestic product can be achieved by investing more in animal agriculture particularly poultry production. The poultry value chain (poultry breeders/farmers, feed millers, poultry product marketers, consumers, etc.) makes poultry production one of the major means of livelihood being one of the most economic routes for producing high quality animal protein within the shortest possible time (Oluyemi and Roberts, 2007). Furthermore, poultry products also have better acceptability over other livestock species across all religion, culture and social status (Sanni and Ogundipe, 2005). Though there have been resurgence of interest and relatively high growth in the poultry industry in Nigeria, it is beguiled with intricate problems including inadequacies of production inputs, poor management practices, involvement of non-experts in the production processes, importation of parent stocks, and poor performance of these stocks due to genetic by environment interactions. The adoption of production strategies targeted at sustaining the industry in the long run is thus essential.

A crucial way to achieve this is the use of locally adapted chickens. Begil *et al.* (2010) noted that indigenous breeds are valuable genetic resources due to their adaptability to harsh conditions and their resistance against local diseases. In Nigeria, the normal feather chickens constitute a greater proportion of the chicken population reared by poultry farmers. However, certain major genes such as those responsible for plumage cover as exhibited in naked neck chickens have been found to be potentially useful in the tropical production environment (Singh *et al.*, 1998; Fahti *et al.*, 2013). Grepay (2010) acknowledged that the success or failure of any poultry breeding programme is more or less anchored on the genetic stock used. The use of this strain of chicken in large scale production could also serve as efficient means of diversifying Nigeria's chicken genetic production base. Studies on performance of the naked neck chickens indicate that their use in selective, pure breeding and crossbreeding programmes could be of immense advantage (Merat, 1986; Ibe *et al*. 1992; Adedokun and Sonaiya, 2002; Oleforuh-Okoleh, 2013; Fadare, 2014).

In livestock production, identification of the costs and returns in the production process should form part of the selection criterion (Zewdu, 2004). Raeesi *et al.* *(*2010) noted that profitability in commercial poultry production is measured by the ability of the birds to attain the highest body weight or peak egg production relative to a unit quantity of feed consumed. In poultry production, feed cost represents a major component of input/variable cost in the production cost (Adeoti and Olawumi, 2013). The major goal of any enterprise is profit maximization at minimum cost. This necessitates that the poultry farmer ought to make rational decisions based on economic analysis while the poultry breeder should imperatively aim at providing the farmer with stocks exhibiting great genetic potential for traits of interest such as efficient feed utilization with high economic returns. This study was, therefore, undertaken to assess growth performance and economic analysis of producing different strains of Nigerian indigenous chicken.

Materials and methods

Study area

This study was carried out within the months of January and March, 2017 at the Poultry Breeding Unit in the Teaching and Research farm of Department of Animal Science, Rivers State University (RSU), Nkpolu-Oroworukwo. The study area is located on longitude 6°98'E and latitude 4° 68'N in Port Harcourt Local Government Area of Rivers State, Nigeria. This area has a prevailing humid climate with mean annual rainfall of 2004.5mm. The mean monthly temperature and relative humidity ranges from 22.54 - 31.03°C and 69.08 -112.47% respectively (Uko and Tamunobereton- Ari, 2013).

Genetic stock and breeding management

63 normal feather (60 hens and 3 cocks) and 36 naked neck (30 hens and 6 cocks) used as parents for this study were selected at 36 weeks of age from a heterogeneous population of Nigerian indigenous chickens existing in the RSU farm. Selection of the parents was based on their body conformation, egg production performance (hens), and semen quality (cocks). Only birds that performed above the population average were selected. The origin of this population was described by Oleforuh-Okoleh *et al.* (2017).

The parents were bred using a mating ratio of 1:10 (male♂ :female♀) following the breeding layout shown in Table 1. Mating was by artificial insemination done twice a week for four weeks prior to collection of eggs for incubation. The parents were thus 40 weeks of age when egg collection for incubation started. Eggs were collected daily, sorted, pedigreed according to their sire and stored in paper egg crates for four days in an air conditioned room (18°C – 20°C) before incubation. There were three hatches (eggs set at four days intervals) with each hatch serving as a replicate. At hatch, 150 chicks were randomly selected and wing–tagged by sire pedigree. A total of 450 chicks with 150 chicks per genetic group (GG) were used for the study.

Table 1 Breeding layout

Genetic group	Parents (♂ x ♀)
GG1	3NF♂ X 30NF♀
GG2	3NN♂ X 30NN♀
GG3	3NN♂ X 30NF♀

NF - Normal Feather; NN - Naked Neck

The chicks were brooded from day old to 4 weeks and reared in replicate deep litter pens (three replicates/genetic group) till 12 weeks of age. Chick mash (20%CP and 3000kcal/kg metabolizable energy) was given from day old to 8 weeks of age and grower mash (17%CP and 2600kcal/kg metabolizable energy) was fed from 8 -12 weeks of age. Feed was formulated based on the recommendations of Oleforuh-Okoleh *et al.* (2016). Feed and clean water were served *ad libitum* throughout the study period. Vaccination was done against Newcastle disease (via intra ocular at day old and via drinking water every four weeks), gumboro, fowl typhoid and fowl pox. Necessary medications such as coccidiostats and multivitamins were administered. Sanitation and other management practices were strictly adhered to. The birds were generally managed within the standard ethical norms as prescribed by the Nigerian Institute of Animal Science.

Data collection

Growth performance traits

The chicks were weighed at hatch (BW1) and monthly thereafter till 12 weeks of age (BW12) using a sensitive weighing balance (0.01g). Data obtained were used to estimate body weight gain and specific growth rate (SGR), that is percent growth per day at a particular time as described in Gondwe and Wollny (2005). Weighed quantity of feed was given to the birds and feed intake recorded for each genetic group. The feed conversion ratio was expressed as the ratio of mean feed intake to mean body weight gain.

Economic analysis

Economic analysis was done by evaluating the following parameters: total feed consumed/bird/genetic group, total cost of feeding/bird, feed cost per kg body weight gain, total variable cost (the variable cost was obtained from costs of day-old chick, feed, labour, drugs and veterinary services), total revenue/bird (the birds were sold at ₦1000/kg live weight), gross margin/bird (total variable cost – total revenue), profitability index (PI = ratio of gross margin to total revenue), benefit cost ratio (BCR = total revenue to total cost of production), rate of return on investment (ROI = ratio of gross margin to total cost of production). The estimates were derived using the methods stipulated by Adeoti and Olawumi (2013).

Statistical analysis

Analysis of variance was carried out for all data collected using univariate analysis (genetic group as main effect) of General Linear Model in IBM SPSS (2013). Means separation was done using least-significant difference test and were considered significant at $p<0.05$.

Results and discussion

Growth performance traits

Growth performance traits of the three genetic groups are shown in Table 1. The result showed disparities ($p<0.05$) in BW1, BW12 and WBWG among the three genetic groups. Progenies of GG2 were 6.83% and 0.77% heavier than those from GG1 and GG3 respectively. Hatching weight of GG1 and GG3 were similar to 36.17±0.75g and 35.30±0.75g reported by Adedeji *et al.* (2004) for naked neck and normal feather Nigerian local chicken but differed from the findings of Momoh *et al.* (2010) and Ndofor-Foleng *et al.* (2015) who obtained mean hatch weight of 27.02g from Nigerian local chickens consisting of heavy and light ecotypes and their crossbred, and 30.11+0.12g from a normal feather female line of Nigerian local chicken respectively. Iraqi *et al.* (2002) observed heavier body weight at hatch in the purebreds of two local strains of Egyptian chickens.

Our results revealed that although hatch weight of GG3 was lower than that of GG2, progenies from GG3 had the highest weekly body weight gain (90.12g) which translated to a heavier body weight (1116.55g) at 12 weeks ($p<0.05$)**.** The heavier body weight in GG3 at 12 weeks of age can be attributed to the significant variation observed in their SGR which was 4.36 and 5.59% greater than values obtained for GG1 and GG2 respectively. Ibe (1993) noted that the rate of growth of an individual influences its body size, consequently it can be adduced that the disparities in the final body weight is closely associated with the higher specific growth rate observed in GG3. Cahaner *et al.* (1992) observed about 3% more weight in heterogeneous naked neck broilers than the normal feathers.

Table 2: Growth performance traits of the three genetic groups

	GENETIC GROUPS				
Trait	**GG1**	**GG2**	**GG3**	**SEM**	**P-value**
BW1(g)	35.39^{b}	37.18^{a}	35.12^{b}	0.45	0.000
BW12(g)	969.25^{b}	978.79^{b}	1116.55^{a}	56.96	0.024
WBWG(g)	77.82^{b}	78.47^{b}	90.12^{a}	4.76	0.023
SGR (%/day)	3.94^{b}	3.89^{b}	4.12^{a}	0.48	0.008
WFI(g)	359.49	366.66	366.23	33.26	0.942
FCR	4.55^{a}	4.62^{a}	4.04^{b}	0.22	0.027

^{ab}Row means followed by different superscripts are significantly different ($p<0.05$)
GG1 – Normal feather x Normal feather; GG2 – Naked neck x Naked neck;
GG3 – Naked neck x Normal feather; BW1 – Hatch weight; BW12 – Body weight at 12 weeks;
WBWG – weekly body weight gain; WFI – weekly feed intake; FCR – feed conversion ratio

Though the crossbreds had superior weights at 12 weeks of age, the similarity in body weight of the parental lines (GG1 and GG2) at this age affirmed the observations of Adeleke *et al*. (2011) and Oleforuh-Okoleh *et al.* (2017)., Positive and high hybrid vigor for body weight at varying ages has been reported in crosses involving local chickens (Sabra, 1990; Sabri *et al.*, 2000; Singh and Singh, 2005; Saadey *et al.*, 2008). Adebambo *et al.* (2010) reported a positive general combining ability for the normal Nigerian local chicken, an indication of good hybrid attribute. We, therefore, presume that the superiority of GG3 could possibly be associated with heterotic effect.

Feed intake was similar for all the genetic groups studied though genetic groups with the naked neck gene (GG2 and GG3) appeared to have consumed about 10g more feed (numerically) than GG1. Tomar *et al.* (2005) revealed that naked neck chicks consumed more feed than their normal feather counterpart. Quantity of feed consumed by birds has been related to their body weight, such that heavier birds tend to consume more feed than lighter birds (Nwachukwu *et al.* 2006). Our findings collaborates the reports of Adomako *et al.* (2014) and Rajkumar *et al.* (2011), on a non-significant variation in feed intake of naked neck and normal feather chickens. A highly significant variation in feed conversion ratio was observed with the crossbred (GG3) showing more efficient utilization of feed (11.21 and 12.93% more efficient than the purebred, GG1 and GG2 respectively). This could be due to the presence of the naked neck gene as attested by (Singh *et al.* 1998; Galal *et al.*, 2007; Gunn, 2008). Better feed efficiency in birds with the naked neck gene has been attributed to their ability to dissipate heat faster resulting in improved appetite and diversion of available proteins from feather production to development of other tissues, especially the muscle tissues (Merat, 1986). Although we had expected GG2 and GG3 to have more similarity, our findings were otherwise, as stated earlier such variation may be associated to heterosis and maternal effects.

Economic analysis

Usually, birds are sold at farm gates based on their live weight. An improvement in one unit (1g) of weight will, thus, lead to an increase in the profit coming from the extra weight. The economic analysis of the three genetic groups is presented in Table 3. Birds of GG3 had significantly heavier live body weight, total body weight gain and least feed cost/kg body weight gain than those of GG1 and GG2. Feed cost/bird was similar in the three genetic groups and ranged from ₦547.57 –562.02. Since feed cost was the major source of variation in the variable cost, more revenue was obtained from the sale of birds from GG3. Consequently, gross margin from GG3 was greater ($p<0.05$).

Table 3: Economic analysis of raising the three genetic groups

	BREEDING GROUPS				
TRAITS	**GG1**	**GG2**	**GG3**	**SEM**	**P-value**
Live body weight (g)	969.25^{b}	978.79^{b}	1116.55^{a}	56.96	0.024
Body weight gain (g)	933.86^{b}	941.61^{b}	1081.43^{a}	4.76	0.023
Total feed consumed (g)	4277.85	4399.95	4394.73	399.06	0.942
Feed cost (₦)/bird	547.55	563.19	562.53	0.22	0.820
Feed Cost/kg BWG/bird (₦)	580.00^{a}	590.00^{a}	520.00^{b}	29.17	0.027
Other variable cost/bird (₦)	253.33	253.33	253.33	0.14	1.000
Total variable cost/bird (₦)	800.89	816.52	815.85	51.08	0.942
Revenue/bird(₦)	969.25^{b}	978.79^{b}	1116.56^{a}	56.96	0.024
Gross margin (₦)	168.35^{b}	162.27^{b}	300.70^{a}	30.02	0.000
Benefit-cost ratio	1.21^{b}	1.22^{b}	1.37^{a}	0.04	0.001
Profitability index	0.18^{b}	0.17^{b}	0.27^{a}	0.02	0.001
Return On Investment %	21.42^{b}	21.85^{b}	36.57^{a}	4.17	0.001

^{ab}Means on the same row with different superscripts are significantly different ($p<0.05$)

GG1 – Normal feather x Normal feather; GG2 – Naked neck x Naked neck; GG3 – Naked neck x Normal feather

Benefit-cost analysis is a tool used in decision making on the best approach to achieving benefits at least cost, such that the farmer saves more in the course of production. Profitability ratios are thus applied to evaluate this. Table 3 reveals that a benefit-cost ratio (BCR) greater than 1 was obtained in all genetic group considered; indicating that investment in Nigerian indigenous chicken production will be profitable. However, production of GG3 with return on investment of 36.57% would be more profitable ($p<0.05$). Furthermore, profitability index (PI) did not vary between GG1 and GG2 while a significant difference existed between GG3 and both groups. Our result on the PI indicated that for every Naira obtained as revenue from the sale of GG3, about 0.27 kobo returned to the farmer. The PI obtained in this study was lower than those reported by Nworgu (2007) and Lawan *et al.* (2017). Such variations in economic returns have been ascribed to diverse causes ranging from the type of genetic stock used, production environment to prevailing market climate at the time of study (North and Bell, 1994). Tomar *et al.* (2005) suggested that it would be more economical to rear naked neck birds since feather formation is linked with protein requirement, and any reduction in the dietary protein would cumulate in reduced cost of production. Our findings on GG3 indicated that it was the best genetic group and uphold the fact that a good combining ability from best performing group/strain will result in reduced cost of production (Adebambo *et al.*, 2009).

Conclusion

This study revealed that the purebred naked neck (GG2) had superior hatch weight whereas the crossbred had better rate of growth as indicated by the results on body weight gain and specific growth rate at 12weeks of age. Feed cost represented the major source of variation in the cost of production and did not vary among the three genetic groups. GG3 had better feed utilization efficiency and superior live weight at market age which resulted in higher revenue, gross margin and return on investment. We, therefore recommend that crossbreeding the naked neck and normal feather, and inclusion of relative economic returns as part of the selection criterion, should be considered in breeding programmes/plans aimed at commercializing Nigerian indigenous chicken production.

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