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Egg Hatchability and Early Growth Performance of Cross and Backcross Involving Nigeria Fulani Ecotype and Isa Brown Chickens

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Abstract

An experiment was carried out to study the egg hatchability and growth performance of crossbred chickens involving Fulani ecotype (E) and Isa brown (B) chickens and their backcross using artificial insemination method of mating. The F1 progeny, the crossbred (EB), was produced by crossing E (sire) with B (dam) while the first backcross (BEB) was achieved using the B (sire) and the EB (dam). The second backcross (EBB) was carried out by mating the EB (sire) and the B (dam). A total of 35 birds were used as foundation stock (five E males, five B males and 25 B female chickens) to produce 137 EB crossbred chickens and 187 backcross chickens (98 EEB chickens and 89 BEB chickens). Weekly body weight and daily feed intake were obtained on the progenies generated from the mating for a period of 20 weeks. Other parameters like weight gain, feed conversion ratio, percentage fertility, hatchability and percentage dead shell were calculated from the data. The results revealed that the growth performance was affected by genotype. The EB chickens obtained the highest body weight across the weeks (37.6 to 1169 g) and the backcross chickens had the highest fertility (76.2%) and hatchability (83.2%). Therefore, it could be concluded that crosses between the Fulani ecotype and Isa brown chickens had the best growth performance and improved fertility while the backcross sired by the F1 had better performance when hatchability is considered.

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Introduction

In Africa, agriculture and agro-industries account for more than 30% of national incomes on average, as well as for the bulk of export revenues [1]. While nearly three-quarters of the population depend on the livestock and crops to secure their livelihoods [2]. In Nigeria; however, the poultry industry, which consists of chickens, turkeys, ducks and pigeons is the largest industry amongst the agro-industries. The Nigerian poultry industry has been rapidly expanding in recent years and is, therefore, one of the most commercialized subsectors of Nigerian agriculture [3]. Poultry production has both social and cultural benefits and it plays a significant part in family nutrition in most developing countries. Poultry production is unique because it offers the highest turnover rate and the quickest return on investment outlay in livestock enterprises [4]. Of the 120 million poultry birds found in Nigeria, the native chicken constitutes about 80% of the population [5]. The Nigerian native chickens have been confirmed as a veritable tool for the genetic improvement and development of layer strain for the tropical environment because they possess some inherent advantages, including good fertility and hatchability, the better flavor of meat and egg, high degree of adaptability, high genetic variance in their performance, hardness, disease tolerance, ease of rearing, high genetic variance in their performance and ability to breed naturally [6, 7]. It has been reported by researchers that the main problem of indigenous chickens in the tropics is that they are poor producers of egg and meat [8]. On the other hand, exotic chickens, which have undergone genetic improvement for better performance in terms of faster growth, higher number of eggs and more meat than the unimproved indigenous chicken breeds rarely exhibit good repeatability in the tropics. The tropical climate is; however, a huge challenge to these exotic breeds to fully express their genetic potential because they are not adapted to the adverse tropical environmental condition like high temperature, disease occurrence and shortage of feed [9].

Fertility, hatchability, egg production and growth are economically important traits in local poultry production systems, and breeders usually aimed at conserving and increasing the productive genetic efficiency of native chickens through crossbreeding for higher economic gains [10]. High fertility and hatchability of breeder stock and survivability of the chicks are necessary to produce a large number of birds. This would augment the grossly inadequate protein supply of developing countries like Nigeria [11]. In order to exploit the improved traits in the exotic and the adaptability features in the indigenous chickens, crossing of the local stock with an exotic commercial breed could take advantage of artificial selection for productivity in the exotic birds and natural selection for hardiness in the indigenous birds [12]. Furthermore, backcrossing is a well-known and long-established breeding method where a trait of interest is introgressed from a donor parent into the genomics background of a recurrent parent. Because backcrossing can isolate a gene or chromosomal region in a different genetic background, it helps to discern the genetic architecture of qualitative traits [13]. Moreover, birds with better production performance can equal the combining ability of best performing exotic lines and indigenous chicken. Therefore, this study aimed at comparing the egg hatchability and early growth performance of the progenies resulting from crossbreeding of Nigeria Fulani ecotype and Isa brown chicken and their backcrosses.

Materials and Methods

Experimental site

The experiment was carried out in the poultry unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The site is located in the derived savannah zone of Nigeria on longitude $4^{0}15`$ East and latitude $8^{0}5`$ Northeast of the Greenwich meridian. The altitude is between 300 m and 600 m above sea level. The mean annual rainfall and temperature are 1247 mm and 27°C, respectively.

Mating procedure

The hens were artificially inseminated with semen obtained from the male chickens. The semen samples were collected through the massage technique by applying slight pressure at the back of the male chicken towards the tail. Feathers around the vent of the male chickens were shaved regularly for ease of semen collection and also to prevent contamination. The semen samples were used immediately after collection by applying 0.1 ml of the undiluted semen to the cloaca of each hen once a week. The Fulani ecotype was used as the parent sire breed to mate Isa brown female birds. The breeding model is written as Sire before Dam (*i.e.*, SD). Mating procedures are given below:

Fulani ecotype (E) sire × Isa brown (B) dam = E × B = F_1 (EB)

First backcross sire by Isa brown (B) × F1 dam (EB) = B × EB = BEB

Second backcross sire by F_1 dam (EB) × Isa brown dam (B) = EB × B = EBB

Experimental birds

A total of ten (10) sires and twenty-five (25) dams were used as foundation stock for the study. The foundation stock; however, included 5 Fulani ecotype (E) sire, 5 Isa brown (B) sire and twenty-five (25) Isa brown (B) dam. The foundation stock was fed breeder mash. The resulting F1 chickens and the backcross were fed *ad-libitum* with chick mash from day 1 to 4 weeks and growers mash from 4 weeks till the point of lay (18 weeks) and thereafter with layers mash for 4 weeks and then breeder mash for the rest of the experiment. The ingredient composition of the various diets is presented in Table 1.

Egg collection and incubation

The eggs were collected along the genotype line and stored in a cool room with an ambient temperature of 18-20°C before transferring to the hatchery for incubation. The incubator was set at the temperature between 27-39°C and relative humidity of 55-66% for the first eighteen days. The temperature was subsequently increased to 29°C and 35°C with the relative humidity of 70-75% for the last three days. Candling was carried out on the 3rd and 18th day of incubation for the identification of clear and fertile eggs. After hatching, the number of normal, weak, abnormal and dead chicks were recorded.

Management of chicks

All chicks resulting from each genotype were properly identified and wing tagged along sire lines and were placed separately in a brooding pen. Every hatch was brooded for a period of four weeks using a brooding guard within a pen house. Burning charcoal was provided to generate heat and maintain an ambient temperature of 27°C for the birds from a day old to 2 weeks of age. The birds were fed with commercial chicken mash *ad-libitum* till 4 weeks of age and water was given freely. Medication and vaccination were done as and when needed.

Data collection and statistical analysis

Bodyweight data and feed intake were obtained on the progenies generated from the mating for a period of 20 weeks. Weekly body weight was measured with the use of 0.01g sensitive scale while the average feed intake was calculated as the difference between left overfeed and feed given, divided by the total number of birds. The daily weight gain represented the difference between two consecutive measurements divided by the number of days. The feed conversion ratio (FCR) was calculated as the ratio of feed intake to weight gain within each measurement period. The progenies were allowed to lay two weeks before insemination and another one week to lay after insemination before the start of egg collection. The following data were recorded on hatchability: the number of egg set, which represents the number of eggs taken to the hatchery; percentage fertility, which was calculated as the percentage of eggs that were fertile out of all the egg set; hatchability was calculated

Table 1 Chemical composition of various diets used to feed mating chickens.

Ingredients	Chick mash	Grower mash	Layer mash	Breeder mash
Maize (%)	47.00	37.00	36.00	50.00
Maize bran (%)	5.00	12.00	17.20	15.00
Wheat offal (%)	17.25	23.00	20.00	8.00
GNC (%)	2.00	8.00	-	-
Soya bean (%)	22.00	6.00	14.00	16.50
Palm kernel cake (%)	-	9.75	-	-
Fish meal (72%)	3.50	1.00	1.00	1.50
Bone meal (%)	1.00	1.00	2.00	1.00
Oyster shell (%)	1.00	1.00	8.50	7.05
Methionine (%)	0.25	0.25	0.25	0.20
Lysine (%)	0.25	0.25	0.25	0.25
Premix (%)	0.50	0.50	0.50	0.25
Salt (%)	0.25	0.25	0.25	0.25
Crude protein (%)	20.50	15.00	16.80	17.50
Gross energy (kcal/kg)	2650	2500	2580	2700

as the percentage of egg hatched out of all the fertile egg set; the percent dead shell was calculated as unhatched eggs. The data were analyzed using ANOVA and the means were separated using Duncan multiple range test. The statistical analysis system (SAS), version 9.2, SAS Institute Inc. Cary, NC, USA was used for statistical analysis.

Results

The absolute values and the percentage of egg set, fertility and hatchability estimates in different chicken genotypes are presented in Table 2. Relative to the number of egg sets for all the genotypes, the highest percentage of the fertile egg was obtained in EB (75%) followed closely by EBB (74%) and BEB (73%). The percentage of hatchability was highest in EBB (81.5%) while the other two genotypes (EB and BEB) had similar values (75%). This close variation may be due to the number of egg sets. The highest percentage of the dead in the shell was recorded in EB (25%).

Table 2 Absolute values and percentage of egg set, fertility and hatchability estimates in different chicken genotypes.

Parameters	N	Genotype		
		EB	BEB	EBB
Egg set	400	128	126	146
Fertile egg	292	96 (75%)	92 (73%)	108 (74%)
Infertile egg	108	32 (25%)	34 (27%)	38 (26%)
Hatched egg	216	72 (75%)	69 (75%)	88 (81.5%)
Dead in shell	76	24 (25%)	23 (25%)	20 18.5%)

N = number of observations
EB = Fulani ecotype (E) × Isa brown (B); BEB = B × EB; EBB = EB × B

The mean body weight and feed efficiency at different ages of different chicken genotypes are presented in Table 3. The initial body weight of one-day-old chickens (37.6 g) was highest in the crossbred EB followed by BEB. The body weight at 4 weeks showed a similar trend observed for one day old EB having the highest value of 195 g followed by BEB (163.4 g) while EBB had the lowest body weight (157.7 g). Moreover, at 4 weeks, the feed intake (28.2 g) and body weight gain (6.27 g) were highest in BEB, while the feed conversion ratio was non-significantly different between EB and BEB and EBB showed the lowest feed conversion ratio. At 8 weeks, crossbreed EB (4.45) had the highest feed conversion ratio though with second best feed intake still ended up with the highest body weight of 511.7 g. BEB consumed more feed (40.3 g) but did not gain weight as much as the crossbred EB (511.7 g), which consumed lesser feed (35.4 g). At the twelfth week, EB and EBB consuming more feed (60.5 g and 61.6 g, respectively); however, EBB had the highest feed conversion ratio (18.30) and lowest body weight (643.4 g) despite having the highest feed intake. From the result of 16th week, the crossbred EB had a higher body weight (1169 g) and body weight gain (18.5 g) with the least feed conversion ratio (5.15). EBB had the highest feed intake of 99.3 g and the highest feed conversion ratio of 18.2 with the lowest body weight of 844.6 g. The backcross BEB overtook the crossbred EB at the 20 weeks in body weight (1480.5 g) and with a superior feed conversion ratio of 8.87.

Discussion

Three genotypes were considered for hatchability and growth performance. From the result of the present study, little variations were observed among the genotypes with respect to fertility, although the F1 crossbred EB had the highest fertility followed by the F1 sired backcross (EBB) and those sired by Isa brown (BEB). This may be due to variation in the genetic makeup of the different genotypes because all the genotypes were subjected to a similar management routine. Nwakpu et al. [6] in their study also observed significant differences in the fertility percentages among three genotypes of layer-type chickens. They observed that the black Olympia and Hubbard and Nick strains were higher in egg fertility than the investigated Nigerian local chicken. The backcross EBB sired by the F1 genotype had the highest hatchability percentage compared to the F1 crossbred and the Isa brown sired backcross BEB. This shows that the injection of genes from the Isa brown chickens on the backcross mating to the F1 genotype did not have any improvement on the hatchability of the genotype when compared to the impact of F1 genes backcrossed to Isa brown chickens where the hatchability was improved by 6.5% over other genotypes. This further shows that the addition of Fulani ecotype genes in a proportion of 25% may be good in the development of layer strain towards improving egg hatchability. However, the high hatchability reported in the present study along the inclusion of Fulani ecotype in the breeding of the backcross genotype was higher than 48% compared to the hatchability reported by Fayeye et al. [5] in their study with Fulani ecotype where they opined that it was not uncommon and may not be due to genetic factors.

Table 3 Mean and standard error of mean for body weight and feed efficiency at different ages for the different chicken genotypes.

Genotype	N	BW (g)	FI	BWG (g)	FCR
1 day old					
EB	72	37.56 ±1.69a	NA	NA	NA
BEB	69	34.92 ±0.54b	NA	NA	NA
EBB	88	33.17 ±0.05c	NA	NA	NA
4 weeks					
EB	71	195.00 ±8.75a	23.27 ±6.00b	5.27 ±0.02b	4.42 ±0.02a
BEB	67	163.44 ±4.62b	28.29 ±8.27a	6.27 ±0.03a	4.51 ±0.02a
EBB	87	157.71 ±6.20c	17.17 ±2.40c	4.70 ±0.02c	3.65 ±0.12b
8 weeks					
EB	71	511.67 ±27.61a	35.44 ±3.20c	7.90 ±0.02c	4.50 ±0.03a
BEB	66	443.64 ±12.44b	40.27 ±5.23a	11.62 ±0.03b	4.33 ±0.02a
EBB	87	421.62 ±22.69b	31.56 ±6.01b	15.90 ±0.04a	3.97 ±0.01b
12 weeks					
EB	71	830.00 ±35.98a	60.46 ±10.24b	22.10 ±2.51a	3.80 ±2.10b
BEB	64	795.56 ±23.06b	56.63 ±8.23c	12.30 ±6.04b	4.60 ±2.40b
EBB	85	643.38 ±53.45c	61.56 ±8.01a	3.47 ±2.40c	18.30 ±3.10a
16 weeks					
EB	67	1169.00 ±25.31a	95.24 ±2.43b	18.50 ±4.20a	5.15 ±0.02b
BEB	64	1124.11 ±35.03b	91.59 ±9.26c	12.44 ±4.28b	7.36 ±0.03b
EBB	84	844.60 ±66.13c	99.29 ±2.50a	2.60 ±0.02c	18.20 ±4.28a
20 weeks					
EB	65	1440.89 ±44.47b	118.18 ±8.11a	6.55 ±2.10c	18.04 ±2.75a
BEB	63	1480.45 ±48.07a	90.66 ±9.23b	10.22 ±2.40b	8.87 ±0.30b
EBB	84	1154.46 ±67.07c	64.81 ±6.42c	27.33 ±2.51a	2.37 ±0.02c

Values having different letters along column for a given trait differ significantly ($P<0.05$).
N = number of observations; BW = body weight; FI = feed Intake; BWG = body weight gain; FCR = feed conversion ratio; NA = not applicable
EB = Fulani ecotype (E) × Isa brown (B); BEB = B × EB; EBB = EB × B

The pattern of growth with respect to bodyweight recorded in the present study supported the fact that the initial weight of most livestock at birth is a determinant of the pattern of subsequent rate of growth. Meijerhof [14] stated that the weight of a day-old chicks can be used as an indicator of subsequent chick development. Furthermore, the superiority of the crossbred over the backcross chicken could be attributed to the additive and non-additive gene effects of crossbreeding. Johnson et al. [15] in their study reported that the crossing of different breeds allows the farmer to make use of additive and non-additive genetic differences among the breeds to increase production.

Conclusion

The study showed that there were notable differences among the genotypes with respect to fertility, hatchability and weight gain. The backcross to Isa brown chickens sired by F1 crossbred performed better in relation to fertility and weight gain while hatchability was an element of Fulani ecotype in the mating model as a sire breed. It could then be concluded that Fulani ecotype genes should be used as a sire breed for crosses involving Isa brown for better fertility, hatchability and growth.

Conflict of Interest

The author declares no conflict of interest in this study.

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