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Productive Potentials of Nigerian Indigenous Chickens Versus Rhode Island Red Chicken Reared Southern Guinea Savanna Environment of Nigeria

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Abstract

The study was conducted to assess the preliminary evaluation of productive potentials of Nigerian indigenous chicken breeds versus Rhode Island Red chicken reared Southern Guinea Savanna environment of Nigeria. A total of 937 day-old local chickens generated from a main cross of local chickens possessing some major genes; naked-neck (NN x NN), frizzle (FF x FF), normal feathered gene (NF x NF), Fulani ecotype (FE x FE) and exotic birds (RIR x RIR) were used to evaluate the productive potential of the pullets in a randomized complete block design. The genetic groups produced were homozygous naked neck, (NN), frizzled (FF), normal feathered (NF), fulani ecotype (FE) and Rhode Island Red (RIR) chickens. Significant ($p<0.05$) difference in body weight, daily feed intake, weight gain and feed conversion ratio were observed among genotypes and as expected, RIR crosses outstands bodyweight (1402 g), consuming more feed (98.33g), weight gain of 15.69 g with feed conversion ratio of 0.15 and average egg weight (54.02 g) than other genetic groups. Among the local birds, NN crosses were superior in growth performance and egg production parameters than other indigenous birds. NN crosses lay earlier (152 day) than other genetic groups and FE crosses had better fertility (86.65%) and hatchability (89.07%) traits compared with all their counterpart genotypes while body weight at first egg was highest and lowest for RIR crosses (1342.86 g) and NF crosses (1255.89 g) respectively. This result depicts that the Nigerian indigenous chickens especially naked neck genotype had a better productive performance among the Nigerian indigenous chicken which may be involved in breeding for developing native foundation stock with RIR exotic birds for production of egg type chicken in this southern guinea savanna region of Nigeria.

Keywords

Indigenous Chicken, Growth Performance, Egg Production, Reproductive Traits, Rhode Island Red Chicken

1. Introduction

According to "[1]" and "[2]", the Nigerian indigenous chicken are known for their hardiness, adaptability, survivability, produced valuable products (meat and egg) under variable environmental condition and are good scavengers with appreciable immunity to endemic diseases but the production potential of these chickens is however setback by poor genetic profile "[3], "[4]". The Nigerian local chicken which consists between 80 to 90 percent of the local population have small body size, poor growth, small egg size and poor reproductive performance "[5]". These characteristics makes them an undesirable stock in the economic stock market "[5]" and these local chickens constitute 80% of the 120 million poultry type raised in the rural areas in Nigeria "[6]".

The Nigerian indigenous chicken population contains genotypes that vary in productive potentials as well as those that exhibit major gene effects "[7], [8]" which also influence productivity "[9]". The genetic diversification could be

exploited to improve their productivity, It is a laudable proposition that more attention be given to the genetic importance and development of the local chicken, in order to improve on the present acute animal protein shortage in Nigeria "[10]". The Nigerian local chicken otherwise called the native or village chicken are widely distributed in the rural areas of the country where they are kept by the natives principally as a source of protein and income. These native chickens play major roles not only in rural economies but also contribute substantially to the gross national product "[11]". They have remained predominantly in villages because of their inherent advantages over their exotic breed contemporaries. This is often manifested in their ease of rearing, adaptability to prevailing conditions and better flavour of meat and eggs "[12]". However, Rhode Island Red is an exotic American breed characterized by high productivity and hardiness "[13]" and Rhode Island Red, which is successfully maintained under rural as well as farming conditions in different parts of the country and have potentials of a higher economic return as laying bird "[14]".

The study of productive performance and its related traits such as body weight, weight gain, feed intake, feed to gain ratio, age and body weight at first egg, hen - day and hen-house egg production attracted the attention of several researchers who affirmed that there were wide variations in these traits between different breeds and/or strains of chickens "[14]". According to "[15]" egg production is one of, if not the major performance variable of a laying bird and it is believed to be a complex qualitative trait which is influenced by several factors e.g. breed, nutrition, age, weight of birds, level of production, management practices and environ mental factors. There is dearth of information in literature regarding productive potential of Nigerian indigenous chickens and Rhode Island Red birds in the Southern Guinea Savanna zone of Nigeria. This study was therefore designed to gather preliminary information on productive potential of the Nigerian indigenous chickens and Rhode Island Red birds to serve as a platform for further genetic improvement between the Nigerian indigenous chickens and Rhode Island Red birds.

2. Materials and Methods

2.1. Experimental Site

The study was carried out at the Poultry Unit of Teaching and Research Farm, Emmanuel Alayande College of Education, Oyo, Oyo state, Nigeria and Oyo lies on the longitude $3^{0}5'$ east of the green witch meridian and latitudes $7^{0}5'$ North eastwards from Ibadan, the capital of Oyo State. The altitude is between 300 and 600 meter above sea level. The mean annual temperature and rainfall are 270C and 1,165mm respectively. The vegetation of the area is Southern guinea savanna zone of Nigeria "[16]".

2.2. Experimental Birds and Management

Total of forty (40) cocks and two hundred and forty (240) hens belonging to five different strains were used for the study. The strains used were the Fulani ecotype, Frizzled feather, Naked neck, Normal feather and Rhode Island Red birds of 8 cocks and 48 hens each of the chicken strains. The indigenous chickens used as parents stock were purchased from some villages around the study area while the Rhode Island Red chickens were procured from a reputable farm. All hens were purchased at age range of 16 - 18weeks, while the cocks were purchased at age range of 15 - 17weeks old. The birds were individually wing tagged for identification purpose. The cocks were trained for semen collection by applying slight pressure at the back towards the tail before sperm production. Feathers around the sire's vent were shaved at two weeks interval and semen collection started at 22 weeks of age.

2.3. Experimental Feeds and Feeding

The birds were fed *ad-libitum* with commercial breeder mash containing 17.5% crude protein and 2700 kcal/kg Metabolizable energy while the hens were also fed commercial layers mash containing 16% crude protein and 2800 kcal/kg Metabolizable energy. Clean water was also supplied *ad - libitum*. Medications and vaccinations were done as required by procedure described by "[17]".

2.4. Experimental Mating

Artificial Insemination (AI) was adopted in mating the hens. The massage technique was used to collect semen from the cocks of Fulani ecotype, Frizzled feather, Naked neck, Normal feather and Rhode Island Red birds. The semen collected was inseminated immediately into a doughnut shape in the left vent of the hens. This was done twice weekly in the evening. For each hen 0.1ml of undiluted semen was used for insemination each time.

The mating procedure is as follows:

Fulani Ecotype (Male) × Fulani Ecotype (Female): FE_m x FE_f

Frizzled feather (Male) × Frizzled feather (female): FF_m x FF_f

Naked neck (Male) × Naked neck (female): NN_m x NN_f

Normal feather (Male) × Normal feather (female): NF_m x NF_f

Rhode Island Red (Male) × Rhode Island Red (Female): RIR_m x RIR_f

2.5. Egg Collection and Incubation

Eggs from artificial inseminated hens were collected pedigreed along genotype lines and stored in a cool room at 18°C to 20°C for five days before the eggs were taken to the hatchery for incubation. The eggs were set in a cabinet type incubator at a commercial hatchery. The eggs were set along the genotype lines at a temperature between 27 – 39°C and a relative humidity of 55 – 56% for eighteen days, then the temperature was then increased to 29 – 40°C and a relative humidity of 70 – 75% from nineteenth day to hatching time. The eggs were also turned automatically through 90 ^{o} in the incubator.

2.6. Candling Process

Candling was carried out on the 18th day of incubation for the identification of fertile eggs, and clear eggs. The process was carried out in a dark room using a Candler fixed with a neon fluorescent tube. The eggs were placed on the Candler for easy penetration of light through the eggs and the eggs were viewed against the source of light. The fertile eggs were seen to be densely clouded and opaque with network of veins indicating development of embryo within the eggs while the unfertile eggs were translucent under the light. Number of infertile and embryonic mortality was recorded. After candling, the fertile eggs were transferred into the hatching tray according to the breeds into the hatchery unit and spent three days. After the chicks hatched, they were leaved in the hatchery until 90% were dried. On the 21st day, the numbers of hatched chicks including the normal, weak, abnormal chicks and dead chicks after hatch were recorded.

2.7. Housing and Management of Chicks

All chicks resulting from each genotype were properly identified by wing tagged with an industrial galvanized aluminum tags at the wing web at day old. All the birds were raised under the same intensive management system. The day old chicks were transferred to a separate and previously disinfected brooders pen. Every batch was brooded for four weeks period. The chicks were fed with a commercial chicks mash that supplied 22% crude protein and 2900 Kcal/kg Metabolizable Energy up to 6 weeks of age. Thereafter, they were fed with commercial grower's ration that supplied 16% crude protein and 2800 Kcal/kg Metabolizable Energy. Clean water was supplied *ad-libitum* while medication and vaccination were done as at when due and as described by "[17]".

2.8. Data Collection

(a). Data were obtained on the following parameters when the birds were twelve weeks into laying: average egg weight, number of egg set per genotype, number and percentage of fertile eggs, number and percentage of infertile eggs, number of eggs hatched, fertility percentage, hatchability percentage, hen-day egg production percentage and hen-housed production using the formula below:

$$\% \text{ fertility} = \frac{\text{Number of fertile eggs}}{\text{Number of eggs set}} \times 100$$

The eggs hatched and hatchability was calculated thus:

$$\% \text{ hatchability} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs}} \times 100$$

$$\text{HDEP}\% = \frac{\text{Number of eggs produced}}{\text{Number of hen alive}} \times 100$$

$$\text{HHEP } \% = \frac{\text{Number of eggs produced}}{\text{Number of hen housed}} \times 100$$

(b). Growth performance: body weights, feed intake, average daily gain and feed to gain ratio were monitored on each breed from day old to 20 weeks of age. These were obtained through the below procedures:

Body weight (g): This will be measured with the use of an electronic kitchen scale with maximum capacity of 20kg or 2000g

Feed Intake: The feed left over were subtracted from feed given and the value divided by total number of birds daily.

Feed intake (g) = Feed given to the birds – feed leftover

Total number of birds

Daily weight gain (g): This is the difference in body weight values between two consecutive measurements were divided by the number of days to obtain the daily body weight gain.

Daily weight gain (g) = Recent body weight - Previous body weight

Number of days

Feed conversion ratio: This was calculated as the ratio of daily weight gain to daily feed intake within each measurement period

FCR = Daily weight gain

Daily feed intake

(c). Reproductive traits: age at maturity and body weight at sexual maturity were obtained through the below procedure:

Egg weight: Eggs laid by each hen was weighed on daily basis. The average egg weight obtained from individual hens for each week of lay for each breed over the short-term period was used in the data analysis. All weights were obtained using an electronic weighing balance (Mettler P1020N) having a sensitivity of 0.01g

Body weight at sexual maturity: This was determined by weigh the pullets with the used of an electronic kitchen scale with maximum capacity of 20kg.

Age at sexual maturity: This was determined by counting days or weeks from hatch to the day the first egg is laid provided a second egg was laid within ten days following the first.

2.9. Data Analysis

All data was subjected to one-way analysis of variance in a completely randomized design using the procedure of general linear model of "[18]" and significant means were separated with the same procedure of "[18]". The below model was adopted:

$$Y_{ij} = \mu + \beta_i + e_{ij}$$

Where,

Y_{ij} = individual observation

μ = overall mean

β_i = fixed effect of i^{th} breed (1, 2, 3, 4, 5)

e_{ij}= experimental errors which is evenly distributed.

3. Results

The mean values and standard errors of body weights, feed

intake, average weight gain and feed to gain ratio of Nigerian indigenous chicken breeds and Rhode Island Red chicken are presented in Table 1. Chicken breeds significantly affected ($P < 0.05$) body weights, feed intake, average weight gain and feed to gain ratio. At the period of 20 weeks, RIR x RIR crosses had the highest bodyweight (1402 g), feed intake (98.33g), weight gain (15.69 g) and feed conversion ratio (0.15) compared with other crosses while among the Nigerian indigenous crosses, NN x NN crosses were superior with 1305 g, 88.19 g, 12.44g and 0.14 for bodyweight, feed intake, weight gain and feed conversion ratio, respectively. However, NF x NF crosses had the least value for bodyweight (1069 g) while FE x FE crosses had the lowest values for feed intake (71.94 g) and weight gain (10.35 g).

Table 1. *Mean values and standard errors of body weights, feed intake, average weight gain and feed to gain ratio of Nigerian indigenous chicken breeds and Rhode Island Red chicken.*

Breeds	BDW (g)	FI (g)	WG (g)	FCR
NN × NN	1305.18 ± 35.96^{b}	88.19 ± 7.73^{ab}	12.44 ± 1.27^{b}	0.14 ± 0.02^{ab}
FF×FF	1199.63 ± 48.03^{d}	74.98 ± 7.27^{bc}	11.58 ± 1.36^{bc}	0.15 ± 0.01^{a}
FE × FE	1250.40 ± 75.91^{c}	71.94 ± 6.02^{c}	10.35 ± 0.92^{c}	0.14 ± 0.02^{ab}
NF x NF	1069.69 ± 33.59^{e}	81.00 ± 7.80^{b}	10.97 ± 0.76^{c}	0.13 ± 0.02^{b}
RIR x RIR	1402.93 ± 107.90^{a}	98.33 ± 7.72^{a}	15.69 ± 1.72^{a}	0.15 ± 0.01^{a}

[abc]Mean along the same column with different superscripts are significantly ($P<0.05$) different
FE x FE = Fulani ecotype, FF x FF = Frizzled feather, NN x NN = Naked neck, NF x NF = Normal feather, RIR x RIR = Rhode Island Red, BDW (g) = Body weight, FI (g) = Feed intake, WG (g) = Average weight gain, FCR = feed to gain ratio.

Table 2 revealed the mean values and standard errors of average egg weights, hen - day egg production and hen - housed egg production percentages of Nigerian indigenous chicken breeds and Rhode Island Red chicken. Significant ($P<0.05$) differences observed indicated that RIR x RIR crosses had the highest egg weight (54.02 g), hen - day egg production (88.33%) and hen - housed egg production (86.44%) compared with other crosses while among the Nigerian indigenous chickens, NN x NN crosses were superior for egg weight (49.75 g), hen - day egg production (69.97%) and hen - housed egg production (64.34%) with the least values of 47.32 g, 65.78% and 63.45% obtained for egg weight, hen - day egg production and hen - housed egg production in NF x NF crosses.

Table 2. *Mean values and standard errors of average egg weights, hen - day egg production and hen - housed egg production percentages of Nigerian indigenous chicken breeds and Rhode Island Red chicken.*

Breeds	Average Egg Weight (g)	HDEP%	HHEP%
NN x NN	49.75 ± 0.76^{b}	69.97 ± 2.67^{b}	64.34 ± 2.33^{b}
FF x FF	48.68 ± 0.43^{b}	60.18 ± 1.89^{d}	58.56 ± 1.72^{d}
NF x NF	47.32 ± 0.43^{c}	55.78 ± 1.72^{e}	53.45 ± 1.78^{e}
FE x FE	46.89 ± 0.13^{c}	62.74 ± 1.12^{c}	60.23 ± 1.56^{c}
RIR x RIR	54.02 ± 0.66^{a}	88.33 ± 3.46^{a}	86.44 ± 3.88^{a}

[abc]Mean along the same column with different superscripts are significantly ($P<0.05$) different
FE x FE = Fulani ecotype, FF x FF = Frizzled feather, NN x NN = Naked neck, NF x NF = Normal feather, RIR x RIR = Rhode Island Red, HDEP% = hen - day egg production, HHEP% = hen - housed egg production

The means values of age and body weight at sexual maturity, fertility and hatchability percentages are presented in Table 3. The results revealed that the age at sexual maturity (day) were earlier for NN x NN (152 days), followed FF x FF (154 days), NF x NF (156 days), FE x FE (157 days) while late days was obtained for RIR x RIR crosses (162 days). However, the body weight at sexual maturity were higher as expected for RIR crosses (1342 g) than other Nigerian indigenous chicken while among the local birds, FE x FE crosses had the highest value of 1270 g better than 1260, 1255 and 1256 g obtained for NN x NN, NF x NF and FF x FF crosses respectively. Fertility and hatchability percentages were better for FE crosses (86.65% vs 89.07%) and NF crosses (79.65% vs 85.07%) than NN x NN, FF x FF and RIR x RIR crosses.

Table 3. *Mean values and standard errors of age and body weight at sexual maturity, fertility and hatchability percentages of Nigerian indigenous chicken breeds and Rhode Island Red chicken.*

Breed	Age at sexual maturity (day)	Body weight at sexual maturity (g)	Fertility%	Hatchability%
FE×FE	157.09 ± 4.57^{b}	1270.89 ± 16.89^{b}	86.65 ± 0.47^{a}	89.07 ± 8.90^{a}
FF× FF	154.89 ± 4.67^{bc}	1250.89 ± 16.89^{c}	76.05 ± 3.40^{c}	82.45 ± 4.10^{b}
NN×NN	152.23 ± 5.34^{c}	1260.20 ± 25.07^{bc}	76.89 ± 2.47^{c}	81.45 ± 3.90^{b}
NF x NF	156.78 ± 9.22^{bc}	1255.89 ± 16.89^{c}	79.65 ± 0.47^{b}	85.07 ± 8.90^{ab}
RIR × RIR	162.89 ± 8.56^{a}	1342.86 ± 21.45^{a}	75.10 ± 9.80^{c}	71.89 ± 5.56^{c}

[abc]Mean along the same column with different superscripts are significantly ($P<0.05$) different
FE x FE = Fulani ecotype, FF x FF = Frizzled feather, NN x NN = Naked neck, NF x NF = Normal feather, RIR x RIR = Rhode Island Red

4. Discussion

The results of the present study revealed that RIR x RIR crosses were favoured in terms of body weights, feed intake, average weight gain and feed to gain ratio were expected due to genetic potential of RIR chickens over the local birds and such results had been documented by "[19]" that Rhode Island Red breed consumed more feed and gained maximum weight than those of Fayoumi and crossbred chickens at all ages of growing phase, which could be explained by the variation of genotype. Similarly, "[20]" reported growth performance of RIR from day-old to 20 wks of age. They found that day old weight, final body weight, body weight gain and mortality rate in RIR were 35.2 g, 1394 g, 1359 g and 18.3%, respectively. Also, "[21]"concluded that, RIR purebred had the highest body weight, average daily gain and relative growth rate at all ages considered while compared with Fayoumi purebred and RIR x Fayoumi crossbred.

Among the Nigerian indigenous chicken, NN x NN crosses were superior in growth performance traits than FF x FF, FE x FE and NF x NF crosses. Thus, this observation was in line with the findings of "[22]" that naked-neck and frizzled birds have been found to be thermally stress tolerant compared with their normally feathered counterparts. The naked-neck and frizzle genes have been found to be associated with heat tolerance, and therefore in areas with high ambient temperature, birds with these genes are superior to their normally feathered counterparts for feed efficiency "[23]" while according to "[24]" birds with the naked-neck and frizzle genes have better adult bodyweights than their normally feathered counterparts. However, this current result disagreed with the findings of "[25]"who reported non-significant difference in growth performance between the naked neck and normal feathered chicken in Botswana. Meanwhile, the mean body weight values obtained for the Nigerian indigenous chickens in this study fall within the range of values reported for the Nigerian local chicken in previous study by "[24], [26]". This observation shows that the indigenous chicken is a small sized poultry. Reduction in body size is very important from the point of view of lower maintenance, requirement and greater efficiency of thermoregulation and has informed the use of the sex-linked dwarf genes (dw) which causes 20-30% reduction in size in poultry improvement programme "[27]".

The superiority of RIR chicken on average egg weights, hen - day egg production and hen - housed egg production percentages over the Nigerian indigenous chicken breeds suggests that they have better egg production than the others. This result agreed with the findings of "[28]" for RIR over Fayoumi and where RIR birds took the lead for HHEP% and HDEP% and "[29]" for Isa Brown over Bovan Brown and Potchefstroom Koekoek chickens under village production system in Ada'a and Lume districts of East Shewa, Ethiopia while "[30]" also affirmed that Fayoumi crosses were better than RIR crosses in terms of egg production traits. However, among the Nigerian indigenous chicken, the egg weight, hen day and hen house percentage productions values observed were in accordance with ranged of values earlier documented by "[31]"for local chicken of Nigeria. The outstanding ability of naked neck for egg weights, hen - day egg production and hen - housed egg production percentages over other local birds in this present study accord with the works of "[32]" on egg laying characteristics of naked neck, normal feathered and frizzled feather of Nigerian local chickens and they affirmed the superiority for naked neck chicken over others indigenous birds.

Age at sexual maturity in poultry is usually influenced by the rate of growth. Thus between and within genotypes, fast growing birds attain sexual maturity earlier than slow growing ones. This explains why efforts are made to avoid characterized by exceptionally early maturity growth of pullets and the small sized eggs that results and tend to persist "[33]". The trend obtained for age at sexual maturity that favoured local birds against RIR crosses agreed with the documentations of "[30], [33]" for Ethiopian naked-neck chickens kept under intensive management conditions while the inability of RIR crosses to matched the local birds for age at first egg had been earlier reported by "[34]" that differences in attaining sexual maturity might be due to the genetic differences of the strains involved and this depends on the physiological age of the animal and if this process is delayed due to various factors such as poor nutrition, disease, etc., it will be reflected in the later start of egg laying period.

The mean body weight at first egg reported in this study for Nigerian indigenous chicken confirm earlier results of "[24], [35], [36], [37]" that Nigerian local chickens are relatively small in body size compared to exotic chickens with an average weight of 1300.00 g "[38]". The body weight at first egg for RIR crosses in the present study was similar to the values documented by "[39]" for RIR crosses over Nole KabbaWoreda chickens in Ethiopia and "[40]" for RIR crosses over Fayoumi crosses under Bangladesh condition. Moreover, the present trend of results on fertility and hatchability percentages were similar to the findings of "[7]" and "[30]" who reported almost the same values of these traits for Nigerian adapted chickens in Nigeria and Fayoumi and Sonali chickens in Bangladesh respectively. Also, the current results are in agreement with "[41]" in Nigeria and "[40]" in Sudan. The authors reported variability in fertility and hatchability percentages in Nigerian local chickens and local chickens of the Sudan respectively. Meanwhile, a previous study by "[43]" in Nigeria and "[42]" in Bangladesh contracted this current finding because these authors reported that fertility and hatchability traits of naked neck and normal feathered chickens were not differed.

5. Conclusion

This result depicts that the Nigerian indigenous chickens especially naked neck genotype had a better productive performance among the Nigerian indigenous chicken which

may be utilized in breeding for developing native foundation stock and be improve with RIR exotic birds for production of egg type chicken in this southern guinea savanna region of Nigeria.

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