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Comparative Evaluation of Two Nigerian Local Chicken Ecotypes and Their Crosses for Growth Traits

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Abstract: The Nigerian local chickens were grouped on the basis of body size and body weight into Heavy Ecotype (HE) and Light Ecotype (LE). Comparative evaluation of growth traits; Body Weight (BWT), Body Weight Gain (BWG) and Feed Conversion Ratio (FCR) at 4-weekly intervals (from 0-20 weeks) of HE, LE and their F_1 crosses; HE x LE - Main Cross (MCX) and LE x HE - Reciprocal Cross (RCX) were carried out. The total of 214, 142, 190 and 185 day-old chicks of HE, LE, MCX and RCX, respectively were used for the study. The chicks in all the genetic groups were raised on deep litter pens from 0-20 weeks using standard management procedures. Data were subjected to analysis of variance. Results showed that the HE differed ($p<0.05$) from the LE in BWT (0-20 weeks). Crossing the HE with LE appeared to have closed the gap between HE and LE in BWT as there were no significant differences ($p>0.05$) between the BWT of HE and the crossbred groups as from 8-20 weeks of age. The crossbred groups quickly overcame the initial set backs resulting from maternal/sire-dam interaction effects and grew significantly heavier than the straight bred heavy and light ecotypes during the period, 12-20 weeks of age. FCR showed highly significant ($p<0.001$) difference among the genetic groups which indicates differences in maintenance requirements. On the whole, results of FCR showed that the local chickens are less efficient in feed utilization.

Key words: Local chickens, heavy ecotype, light ecotype, main cross, reciprocal cross

INTRODUCTION

The local chickens constitute the majority of poultry types in Nigeria, being about 103 million (RIM, 1992) with more than 80% in the rural areas where they contribute substantially to annual meat and egg production. There are various ecotypes of the local chicken in the different agro ecological zones of the country, namely the mangrove swamp, tropical rainforest, derived savannah and dry savannah zones. They vary in shape, size and plumage colours (Oluyemi *et al*., 1982).

Conceptually, the different ecotypes can readily be grouped into two major categories on the basis of body size and body weight as 'light' ecotype and 'heavy' ecotype. The light ecotype refers to those types belonging to the swamp, rainforest and derived savannah agro-ecological zones whose mature body weights range between 0.68-1.50 kg. The heavy ecotype represents the types from the dry savannah (Guinea and Sahel savannah), montane regions and cattle kraals of the North, whose mature body weights range from 0.9-2.5 kg.

Most of the research findings on the local chickens of Nigeria (Hill, 1954; Hill and Modebe, 1961; Nwosu, 1979; Oluyemi, 1979; were obtained from research works on the chicken types described as light ecotype found in the Southern part of the country (South-west and South-east). The chicken type from the savannah, montane regions and cattle kraals of the North which appear heavier than those of the South and described as heavy ecotype have not been so much evaluated. They are likely to differ from the southern light ecotype in many production traits. Crosses between them may generate new genetic base (synthetic population) for selective breeding or progeny that can be further implicated in cross breeding with the exotic breeds for the purpose of breed development.

The objective of this study, therefore, was to evaluate the performance of the heavy and light chicken ecotype and their crosses for growth traits under on-station management conditions.

MATERIALS AND METHODS

This study was carried out at the local chicken unit of the poultry farm of the Department of Animal Science, University of Nigeria, Nsukka. Nsukka is located on latitude 05° 22' North and longitude 07° 24' East with annual rainfall ranging from 986-2098 mm (Inyang, 1978). The natural day length for Nsukka is 12-13 h and

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average annual maximum and minimum temperatures are 29.7°C and 21.0°C, respectively. The relative humility ranges from 34-78% (Monanu, 1975).

The study involved Heavy Chicken Ecotype (HE), Light Chicken Ecotype (LE) and their F_1 crosses. The HE birds were obtained from Obudu, a montane region of south eastern Nigeria and Guinea savannah agro-ecological zone of northern Nigeria while the LE birds were obtained from the swamp, rainforest and derived savannah of southern Nigeria. The two groups were being maintained on the farm as separate non-pedigreed, unselected and unimproved random mating populations.

Source of experimental chicks: The total of 214, 142, 190 and 185 day old chicks of straight bred heavy ecotype, light ecotype, main cross and reciprocal cross bred, respectively were used in the experiment. The birds were randomly mated in a cock to hen ratio of 1:10. Heavy cocks mated to light hens constitute the main cross while reciprocal crossbred were generated by mating light cocks to heavy hens. The mating arrangements are as set out below:

Breeding group	No. of male	No. of female	No. of pen	Genetic group
Heavy x Heavy	1	10	5	Heavy
Light x Light	1	10	5	Light
Heavy x Light	1	10	5	Main cross
Light x Heavy	1	10	5	Reciprocal cross

Hatching eggs were collected and hatched by a process of backward integration in local chicken Natural incubation using the basket system as described by Momoh *et al*. (2004). Natural incubation was used to hatch the eggs because of absence of a functional incubator. Three hatches were carried out each for all the genetic groups at two weekly intervals, between February and April, 2005.

Management of experimental birds: Each hatch in each genetic group was reared separately from day-old to 20 weeks on deep litter. The chicks were brooded for 8 weeks (0-8 weeks) on a formulated chick mash (20% crude protein and 2800 ME kcal/kg) and reared from 9-20 weeks on formulated grower's diet (16% crude protein and 2670 ME kcal/kg). During brooding and rearing periods all chicks were medicated similarly and regularly and subjected to the same standard managerial, hygienic and climatic conditions.

Parameters measured: Data on body weight, body weight gain and feed conversion ratio were measured. Body weight in each genetic group was taken at hatch i.e. 0 week, 4 weeks, 8 weeks, 12 weeks, 16 weeks and 20 weeks of age. Body weight gains were measured at 4 weekly intervals and expressed as daily weight gain at 0-4 weeks, 4-8 weeks, 8-12 weeks, 12-16 weeks and 16-20 weeks. Similarly, feed conversion ratio expressed as the ratio of mean feed intake to mean weight gain was measured at 4 weekly intervals.

Statistical analysis: Analysis of variance using the General Linear Model (GLM) procedure of SAS (1998) was carried out on the data. Body weight data were analyzed in two stages: 0-20 weeks and 12-20 weeks (to accommodate sex effect) similarly, data on body weight gain and feed conversion ratio were analysed in two stages, 0-12 weeks and 12-20 weeks. The following appropriate models were used:

Body weight:

$$Y_{ijk} = \mu + E_i + H_j + (EH)_{ij} + e_{ijk} \quad (0-20 \text{ weeks})$$

$$Y_{ijkl} = \mu + E_i + H_j + S_k + (ES)_{ik} + (HS)_{jk} + e_{ijkl} \quad (12-20 \text{ weeks})$$

Where:

Y_{ijk} = The body weight of the K^{th} individual bird in the j^{th} hatch of the i^{th} ecotype

Y_{ijkl} = The body weight of the l^{th} bird of the k^{th} sex in the j^{th} hatch belonging to the i^{th} ecotype or genetic group

μ = The population mean

E_i = Effect of the i^{th} ecotype (I = 1, …, 4),

H_j = Effect of the j^{th} hatch (J = 1, …, 3)

$(EH)_{ij}$ = Interaction of effects of ecotype/genetic group and hatch

$(ES)_{ik}$ = Interaction of effect of ecotype and sex

$(HS)_{jk}$ = Interaction effect of hatch and sex

e_{ijk} and e_{ijkl} = Residual errors

Assumption e_{ijk} and $e_{ijkl} \sim$ iind $(0, \sigma^2)$

Body weight gain and feed conversion ratio:

$$Y_{ij} = \mu + E_i + e_{ij} \quad (0\text{-}12 \text{ weeks})$$

$$Y_{ijk} = \mu + E_i + S_k + (ES)_{ik} + e_{ijk} \quad (12\text{-}20 \text{ weeks})$$

The Duncan Multiple range test (Duncan, 1955) was used to locate means that were significantly different.

RESULTS

Table 1 presents the body weight performance (sexes combined) of the heavy and light chicken ecotypes and their F_1 crossbred. Ecotype had a highly significant ($p<0.001$) effect on body weight at day old, 4, 12 and 16 weeks of age and also ($p<0.01$) at 8 and 20 weeks of age.

At day old the heavy ecotype had the highest mean body weight (30.2±0.06 g) followed by the reciprocal cross (28.6±0.07 g), main cross (25.1±0.04 g) and then the

Table 1: Least square means±SEM of body weight (g) in four genetic groups of local chickens reared intensively {sex combined}

	Genetic group			
Age (weeks)	Heavy ecotype	Light ecotype	Main crossbred	Reciprocal crossbred
0	30.2±0.06[a]	24.2±0.05[c]	25.1±0.04[c]	28.6±0.07[b]
	(214)	(142)	(190)	(185)
4	157±0.45[a]	139±2.24[c]	147±2.13[b]	148±2.03[b]
	(194)	(132)	(174)	(169)
8	350±3.01[a]	299±3.01[b]	335±2.81[a]	331±2.43[a]
	(181)	(125)	(170)	(164)
12	720±9.47[a]	560±4.31[b]	700±4.21[a]	693±3.51[a]
	(181)	(121)	(167)	(162)
16	840±9.35[a]	707±4.89[b]	819±486[a]	806±418[a]
	(176)	(114)	(163)	(162)
20	976±11.2[a]	831±5.52[b]	937±7.32[a]	934±4.54[a]
	(169)	(114)	(199)	(162)

abc = Means in the same row with different superscripts differed significantly ($p<0.05$). ( ) = Figures in parenthesis refer to number of observations

Table 2: Effect of ecotype x sex interaction on the least square means ± SEM of body weight (12-20 weeks) in four genetic groups of local chickens reared intensively

	Genetic group			
Age/sex	Heavy ecotype	Light ecotype	Main crossbred	Reciprocal crossbred
12 weeks				
Male	811±14.03[a]	595±5.18[b]	732±6.46[a]	725±5.77[a]
	(68)	(53)	(68)	(59)
Female	629±7.09[a]	526±3.37[b]	668±3.73[a]	661±2.32[a]
	(113)	(68)	(99)	(103)
16 weeks				
Male	935±12.69[a]	745±4.65[b]	860±6.80[a]	846±662[a]
	(66)	(52)	(67)	(59)
Female	746±6.57[a]	670±4.95[b]	777±4.08[a]	767±2.59[a]
	(110)	(62)	(96)	(103)
20 weeks				
Male	1072±19.14[a]	874±6.42[b]	973±15.28[a]	976±6.94[a]
	(66)	(52)	(67)	(59)
Female	880±7.17[a]	787±4.36[b]	901±4.43[a]	891±2.98[a]
	(103)	(62)	(67)	(103)

ab = Means within the same row with different superscripts are significantly different ($p<0.05$). ( ) = Figures in parenthesis refer to number of observations

light ecotype (24.3±0.05 g), which had the least mean body weight at this age. There was no significant difference ($p>0.05$) between the hatch (day old) weights of the main cross and the light ecotype. However, the heavy ecotype was significantly ($p<0.05$) higher than all the other groups while the reciprocal cross differed significantly ($p<0.05$) from the light ecotype and the main cross at hatch. The heavy ecotype maintained higher significant body weight up to 8 weeks of age over all the other genetic groups. At 4 weeks of age, there was no significant difference ($p>0.05$) between the body weight of the two cross bred groups, which were both significantly ($p<0.05$) higher than the light ecotype at this age. At 8 weeks of age the differences between the heavy ecotype and the two crossbred groups became insignificant ($p>0.05$). However, these three genetic groups showed significant differences in mean body weight from the light ecotype at this age. This trend was observed at all ages from 8 weeks until the 20th week of age.

Sexual dimorphism in the local bird was only noticeable as from the 10th to 12th weeks of age. Ecotype, sex and Ecotype x sex interaction were highly significant ($p<0.01$) at 12, 16 and 20 weeks of age. As expected, male chicks were significantly ($p<0.05$) heavier in body weights at 12, 16 and 20 weeks of age when compared to the females from the same ecotype or genetic group.

The least squares means of body weight of ecotype x sex interaction for 12, 16 and 20 weeks of age is presented in Table 2. Male growers from the heavy ecotype did not show significant difference ($p>0.05$) from the males of the two crossbred groups at 12, 16 and 20 weeks of age. However, the males of these three genetic groups differed ($p<0.05$) from the males of the light ecotype at this age. This trend was also observed for the pullets in the different genetic groups.

Table 3 shows the least squares means±SEM of body weight gain and feed conversion ratio. Between 0-4 weeks of age the heavy ecotype grew significantly ($p<0.05$) heavier than the light ecotype, main cross and

Table 3: Least square means±SEM of body weight gain (g) and Feed Conversion Ratio (FCR) of four groups of Nigerian local chickens reared Intensively

	Genetic group			
Age(wks)/Parameter	Heavy	Light	Main cross	Reciprocal cross
0-4 (No. of birds)	194	142	174	169
Total gain (g/bird)	127±1.38^{a}	119±1.67^{d}	119±1.51^{c}	123±1.48^{b}
Av. Daily gain (g)	4.54±0.05^{a}	4.24±0.04^{d}	4.25±0.05^{c}	4.38±0.05^{b}
Feed conversion ratio	4.13±0.06^{a}	4.12±0.066^{d}	4.04±0.06^{b}	4.45±0.06^{a}
4-8 (No. of birds)	181	132	170	164
Total gain (g/bird)	368±4.11^{a}	172±2.34^{b}	187±2.25^{a}	183±2.29^{a}
Av. Daily gain	6.65±0.08^{a}	6.15±0.07^{b}	6.69±0.08^{a}	6.53±0.08^{a}
Feed conversion ratio	4.28±0.06^{a}	4.18±0.06^{a}	3.24±0.06^{b}	3.94±0.06^{b}
8-12 (No of birds)	181	121	167	162
Total gain (g/bird)	368±4.11^{a}	351±4.31^{b}	367±4.32^{a}	361±4.41^{a}
Av. Daily gain	13.2±0.15^{a}	12.5±0.02^{b}	13.1±0.15^{a}	12.9±0.16^{a}
Feed conversion ratio	5.38±0.06^{a}	5.28±0.06^{a}	5.26±0.06^{b}	4.47±0.06^{c}
12-16				
Male (No. of birds)	66	52	67	59
Total gain (g/bird)	287±3.41^{b}	283±3.15^{b}	310±3.50^{a}	313±3.64^{a}
Av. Daily gain	10.3±0.12^{b}	10.1±0.13^{b}	11.1±0.13^{b}	11.2±0.13^{a}
Feed conversion ratio	5.46±0.07^{a}	5.36±0.07^{a}	5.21±0.08^{b}	5.06±0.08^{b}
Female (No. of birds)	110	62	96	103
Total gain (g/bird)	267±2.61^{a}	258±2.53^{a}	266±2.79^{a}	268±2.75^{a}
Av. Daily gain	9.83±0.11^{a}	9.23±0.10^{a}	6.69±0.10^{a}	9.57±0.10^{a}
Feed conversion ratio	5.91±0.06^{ab}	5.81±0.06^{a}	6.80±0.06^{a}	5.87±0.06^{b}
16-20				
Male (No. of birds)	66	52	67	59
Total gain (g/bird)	275±2.95^{b}	267±2.91^{b}	316±3.01^{a}	298±3.09^{a}
Av. Daily gain (g)	9.83±0.11^{b}	9.55±0.12^{b}	11.3±0.11^{a}	12.3±0.11^{a}
Feed conversion ratio	5.69±0.06^{a}	5.59±0.07^{a}	5.27±0.06^{b}	5.70±0.06^{a}
Female (No. of birds)	103	62	92	103
Total gain (g/bird)	267±2.27^{a}	262±2.30^{a}	266±2.39^{a}	272±2.33^{a}
Av. Daily gain (g)	9.52±0.08^{a}	9.35±0.09^{a}	9.52±0.08^{a}	9.71±0.08^{a}
Feed conversion ratio	5.87±0.05^{b}	5.80±0.06^{b}	6.23±0.05^{a}	6.23±0.06^{a}

abcd = Means in the same row with different superscripts differ significantly ($p<0.05$)

the reciprocal crossbred. Similarly, the reciprocal crossbred gained significantly ($p<0.05$) higher than the main cross, which also gained higher ($p<0.05$) than the light ecotype. The main crossbred equaled the reciprocal cross in body weight gain at 4-8 weeks and both the main cross and reciprocal crossbred equaled the heavy ecotype at this age but with the three groups surpassing ($p<0.05$) the light ecotype in body weight gain. This trend was maintained until the 12th weeks of age.

Ecotypes x sex interaction effects were also significant in body weight gain between 12-16 and 16-20 weeks of age. Between 12-16 and 16-20 weeks of age the males from the crossbred groups gained significantly higher ($p<0.01$) than the males from the heavy and light ecotypes. However, the females of different genetic groups did not show any significant difference ($p>0.05$) in body weight gain at 12-20 weeks of age.

Ecotype had highly significant ($p<0.001$) effect on feed conversion ratio. The highest feed requirement per unit of gain within the first four weeks of age (0-4) was 4.45±0.06 and was recorded for the reciprocal crossbred chicks which was significantly different ($p<0.05$) from the values of 4.13±0.06, 4.12±0.06 and 4.04±0.6 recorded for the heavy ecotype, light ecotype and the main crossbred chicks, respectively. After the first four weeks of growth, the clear consistent trend was that the heavy and the light ecotype significantly ($p<0.05$) required more feed intake per unit gain when compared with the two crossbred groups. There was no clear trend between the two crossbred groups at various ages.

DISCUSSION

The mean body weight of the light ecotype obtained in this study is similar to those reported for local chickens of the South-east region of Nigeria by Nwosu *et al.* (1984) and Adedokun and Sonayia (2001). The body weight performance of the heavy ecotype is slightly higher than the value reported by Adedokun and Sonayia (2001) for local chickens from the derived savannah agro-ecological zone. This may be probably due to the fact that the heavy ecotype chickens used in this study were from a different agro-ecological zone. Moreover, the present study separated the local chickens into light and heavy ecotypes on the basis of body size and body weight.

The crossing of heavy and light ecotypes generated crossbred groups whose mean body weight

performances were different from those of the parental performances. The significant inferior weight of the light ecotype and main cross chicks at hatch when compared with the heavy and the reciprocal cross might have been due mainly to maternal influence due to egg size. The heavy hens' eggs, from which the heavy and reciprocal cross chicks were hatched, were larger than those of the light ecotypes, from which the light ecotype and the main cross chicks were hatched. It has been reported (Omeje, 1983; Asuquo, 1990; Adedokun and Sonayia, 2001) that hatching weights as well as body weight at 4 weeks and 8 weeks are influenced by mature egg weight. This maternal effect started to wane from the 4th week and was completely over by the 8th week of age. The main crossbred overcame maternal handicap at the 8th week of age and maintained higher live weights than the reciprocal crossbred till the 20th week. This shows that the heavy cock was responsible for transmitting genes for higher body weight.

On ecotype x sex interaction, the males of the crossbred groups and the heavy ecotype were heavier than the males of the light ecotype. The presence of sexual dimorphism in the local chicken indicates potential for their development as sire and dam lines in breed development. Furthermore, these body weight differences at different ages and in different genetic groups could form basis for selection for higher body weights in the local chicken.

Body weight gain in the four genetic groups followed the same pattern as the body weight. On the whole, the result of monthly body weight gain and average daily weight gain in all the genetic groups showed a gradual increase from day old to 12 weeks of age. After the 12th week, the gain and rate of growth slowed down and declined, a trend that was maintained until 20 weeks of age. The 12th week could therefore, be regarded as the point of inflection for these genetic groups studied. Omeje (1983) and Asuquo (1984) had reported a similar observation that the point of inflection of growth in the local chicken of Nigeria is the 12th week of age while Nwosu (1979) and Nwosu *et al*. (1984) reported that the point of inflection of growth occurred at the 13th week of age in the local chicken. The weight gain at 12 weeks of age of the heavy ecotype and its cross reported in this study is in close agreement with the values of 371 g reported by Omeje and Nwosu (1984) for Nigerian local fowl from the South-east and those of Teketel (1986) for the Southern Ethiopian (351 g).

The significant differences in feed conversion ratio observed among the genetic groups may indicate differences in their maintenance requirements and genetic make-ups. Between 12-20 weeks of age, the female of each genetic group required more feed per unit weight gain than the males. This was probably due to the need for the females to direct their feed resources to development of secondary sexual characteristics and preparation for egg laying, which takes place at Point of Lay (POL) at about 20-21 weeks of age. On the whole, results of feed conversion ratio in the genetic groups showed that the local chickens are less efficient in feed utilization.

Conclusion: The heavy ecotype differed significantly ($p<0.05$) from the light ecotype in body weight (0-20 weeks of age). Crossing the heavy ecotype with the light ecotype appeared to have closed the gap between the heavy and light ecotypes in body weight as there were no significant differences ($p>0.05$) between the body weights of the heavy and the crossbred groups as from 8-20 weeks of age. The initial maternal handicap suffered by the crossbred groups was completely overcome by the 8th week of age and between 12-20 weeks of age, the crossbred had significantly ($p<0.05$) higher growth rate than the straight bred heavy and light ecotypes. This was also reflected in the more efficient utilization of feed by the crossbred groups within this period when compared with the heavy and light ecotypes.

From the performance of the heavy ecotypes in the growth traits studied, it can be concluded that the heavy chicken ecotype has potential to be developed as meat-type chicken. The crossbred can also be utilized in meat-type chicken development.

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