

Comparative analyses of growth response and genetic parameter estimates of some quantitative traits in three broiler strains in South-West, Nigeria

Sanda[1], A.J., Olowofeso[1], O., Adeleke[1], M.A., Oso[2], A.O., Durosaro[1] S.O. and Sanda[1], M.O.

[1]Department of Animal Breeding and Genetics, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria.

[2]Department of Animal Nutrition, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria

Email: sandamaradesa@yahoo.com

Abstract

A total of 150 pure strain broiler chicks comprising 50 each of Arbor Acre, Marshall and Ross were used for this experiment which lasted 10 weeks at the Poultry Breeding Unit of the Directorate of University Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State Nigeria. The experiment was carried out to make comparative analyses of growth response and genetic parameter estimates of some quantitative traits (Body weight and linear body measurement) in Arbor Acre, Marshall and Ross broiler chicken strains in South-West, Nigeria. Growth performance data was collected from week 3 to week 10 and analysed using the Generalized Linear Model. Marshall broiler chicken strain had the highest growth rate and better growth performance followed by Ross and Arbor Acre in terms of body weight and linear body dimensions. Marshall and Ross attained mean weight of 1964.50±43.10 g and 1913.02±41.05 g, respectively, which were superior ($p < 0.05$) to Arbor Acre 1831.63±36.28 g at 10 weeks of age. Marshall Broiler chicken strain also had the highest estimates of heritability for body weight 0.46±0.04, followed by Arbor Acre and Ross with estimates of heritability of 0.38±0.12 and 0.26±0.06, respectively. However considering the linear body measurements, none of the broiler chicken strains maintained high estimates of heritability from 3rd to 10th week.

Key words: Strains, Arbor Acre, Marshall, Ross and Heritability

Introduction

It is well known that the chicken industry is one of the most dynamic of world's agribusiness trade. Furthermore, poultry is generally acceptable to people all over the world and provides excellent source of protein especially for rural communities. There has been rapid increase in the number of farmers owning broiler parent and grandparent stocks leading to an increase in the population of meat type chicken in Nigeria (Adebambo *et al*., 2005). Arbor Acre, Marshall and Ross were among broiler chicken strains reared by farmers in southern Nigeria. Poultry breeders have tried to establish the relationship that exists between body weight and physical characteristics as this information reflect on the feed efficiency as well as performance of the broiler birds. Besides, this will help the breeders to organize the breeding program in order to achieve an optimum combination of body weight and good conformation for maximum economic returns (Okon *et al*., 1997).

Poultry breeders have now developed interest in the mature weight of broilers at tender age in order to make quick cash and prevent unnecessary waste of resources on

feed often being consumed by this class of birds (Olowofeso, 2009). The objectives of this research was to make comparative analyses of growth response and genetic parameter estimates of some quantitative traits in three broiler strains (Arbor Acre, Marshall and Ross) in South-West, Nigeria.

Materials and Methods

The experiment was carried out at the Poultry Breeding Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. This site is located on latitude 7°10'N and 3°2'E and the study reported herein lasted a period of ten weeks and the data was collected for seven weeks starting from the 3rd week.

A total of 150 pure strain broiler chicks comprising 50 each of Arbor Acre, Marshall and Ross were procured from reputable hatcheries in Abeokuta, Ogun State and Ibadan, Oyo State, respectively. Brooding was done for two weeks in which data was not collected and the birds were reared for a total period of 10 weeks with seven weeks of data collection; following standard routine and occasional management practices described by Oluyemi and Roberts (2000). Commercial feed and water were provided to bird's *ad libitum*; the experimental design was a randomised complete block design, with the three broiler chicken strains subjected to the same management system from day old to 10 weeks of age, though the broiler strains (Arbor Acre, Marshall and Ross) were separated into three different pens and replicated five times with 10 birds per replicate. The vaccination and medication programmes for the three broiler strains were also same throughout the experimental periods. The birds were fed *ad libitum* with broiler starter commercial feed containing 21% crude protein and 2840 kcal/kg metabolizable energy (ME) from day old to 5 weeks of age and broiler finisher commercial feed containing 19% crude protein and 2875 kcal/kg ME from 5 to 10 weeks of age. Clean drinking water was also provided *ad libitum* to all the birds. The average body weight of the chicks for the three strains was taken at day old and following brooding, individual's bird weight was taken on weekly basis starting from the 3rd week till the 10th week of age. Each bird was weighed with a sensitive scale to obtain the body weight, and the linear body measurements (breast girth, shank length, thigh length and wing span) were measured on weekly basis using a measuring tape as earlier described (Monsi, 1992; Udeh *et al.,* 2011). Feed intake was taken on daily basis. (Heritability and repeatability), regression and correlation analysis were carried out on the following growth parameters (body weight, breast girth, shank length, thigh length and wing span). The estimate of heritability was made possible through the pedigree data obtained from the three farms where the broiler strains were procured. Growth performance evaluation was carried out on body weight, breast girth, shank length, thigh length and wing span using sensitive scale and tape rule.

Statistical analysis

Data on growth performance were analysed using the Generalized Linear Model of SAS (2002). The model employed was

$$Y_{ijk} = \mu + T_i + B_j + (TB)_{ij} + e_{ijk}$$

where,

Y_{ijk} = Observation made on the individual belonging to the i^{th} strain of broilers.

μ = Overall estimate of the population mean.

T_i = Fixed effect of the i^{th} strain of broiler (i = 1, 2, 3)

B_j = Fixed effect of the j^{th} sex of broiler (j = 1, 2)

$(TB)_{ij}$ = Effect of the interaction between strains

and sex
e_{ijk} = Random error associated with each measurement.

Duncan's Multiple Range Test was used to separate the means to ascertain if there ware significant differences among strains.
For the estimate of heritability, sib analysis was used and the formula employed was

$$h^2 = \frac{4\sigma_S^2}{\sigma_S^2 + \sigma_W^2}$$

where,
h^2 is narrow sense heritability, σ_s^2 is the sire variance component and σ_w^2 is variance component within.
Standard error of h^2

$$S.E.\left(h^2{}_s\right) = 4\sqrt{\frac{2(1-t)^2\left[1+(K-1)t\right]^2}{K(K-1)(S-1)}}$$

where,
t is the intra-class correlation, k is the coefficient of variance component being estimated and S is the number of sires.

Repeatability (R) was estimated using the relation:

$$R = \frac{\sigma_b^2}{\sigma_b^2 + \sigma_w^2}$$

where,
σ_b^2 is variance component between and σ_w^2 is variance component within.

Results

Marshall and Ross attained average mean weight of 1964.50±43.10 and 1913.02±41.05, which were superior to Arbor Acre 1831.63±36.28 at 10 weeks of age. The males were significantly ($p<0.05$) superior to female in body weight from the 3rd week to 10th week, expressing the effect of sex on the body weight, while at 5th through 10th week for body weight, the strain did not have significant effect ($p>0.05$) except at the early stage of weeks 3 and 4, respectively. The heritability estimates for traits studied in this experiment ranged from very low to high. The heritability estimates for body weight (0.46±0.02) observed in Marshall at 8 weeks old was greater than the heritability estimates of (0.38±0.03) observed in Arbor Acre at 10 weeks and (0.26±0.06) observed in Ross strains at 8 weeks old. Therefore, detection of genetic variability on body weight seems to be more difficult in broiler chickens compared with a high genetic variability observed in their linear body dimensions at different ages. Thus, the use of body weight as a selection criterion seems to be more efficient than the use of linear body measurements. The repeatability estimates for body weight in the three broiler strains were high and ranged from 0.70 at week 4 to 0.88 at week 10. Arbor Acre had an estimate of 0.74 at week 4 and the highest of 0.86 was observed in week 8. In Marshal strain, repeatability estimates ranged from 0.72 at week 4 to 0.84 at week 10, while Ross that had the lowest repeatability estimate of 0.70 among the three strains at week 4, recorded the highest repeatability estimate of 0.88 at week 10.

Discussion

The average final body weight of 1813.92 g, 1904.24 g and 1876.17 g attained by Arbor Acre, Marshall and Ross respectively at 10 weeks of age were consistent with the report of Akanno *et al.* (2007) that broiler birds attained a market weight of 1300.00 to 2000.00 g at 8 to 10 weeks of age.

Table 1: Least squares means for body weight (g) as affected by strain and sex

	Age (Weeks)							
	3	4	5	6	7	8	9	10
Arbor Acre	540.41±10.90[a]	706.22±15.40[ab]	914.21±18.87	1080.04±22.02	1191.09±24.76	1492.23±29.60	1624.06±33.90	1831.63±36.28
Marshall	509.58±12.31[b]	742.32±17.40[a]	954.79±21.42	1098.93±25.11	1267.78±28.39	1561.74±33.65	1759.61±38.62	1964.50±43.10
Ross	455.13±12.20[c]	682.20±17.32[b]	930.67±21.21	1081.61±24.75	1225.97±27.83	1557.44±32.99	1729.02±37.66	1913.02±41.05
Sex								
Female	465.01±8.00[b]	656.45±11.36[b]	848.81±13.99[b]	982.05±16.41[b]	1104.41±18.56[b]	1273.75±22.15[b]	1397.11±24.77[b]	1565.43±27.26[b]
Male	538.40±11.05[a]	764.04±15.62[a]	1017.64±19.14[a]	1191.66±22.33[a]	1352.15±25.11[a]	1600.52±29.76[a]	1778.01±33.08[a]	1972.67±36.14[a]

[a, b, c,] : - means on the same column with different superscripts are significantly different (P< 0.05)

Table 2: Heritability estimates for body weight and linear body measurements of Arbor Acre, Marshall and Ross strain of broiler chickens

Strain	Weeks	Traits BW (g)	BG (cm)	SL (cm)	TL (cm)	WS (cm)
Arbor Acre	4	0.14±0.06	0.21±0.04	0.46±0.18	0.42±0.26	0.38±0.24
Marshall		0.20±0.06	0.14±0.08	0.26±0.14	0.34±0.10	0.56±0.22
Ross		0.04±0.02	0.28±0.12	0.56±0.22	0.66±0.16	0.34±0.12
Arbor Acre	6	0.24±0.08	0.06±0.10	0.70±0.18	0.60±0.36	0.62±0.32
Marshall		0.34±0.04	0.36±0.16	0.72±0.16	0.64±0.18	0.58±0.12
Ross		0.24±0.04	0.14±0.12	0.36±0.22	0.40±0.12	0.20±0.18
Arbor Acre	8	0.22±0.02	0.16±0.14	0.66±0.12	0.48±0.12	0.08±0.10
Marshall		0.46±0.04	0.10±0.08	0.16±0.14	0.22±0.16	0.22±0.08
Ross		0.26±0.06	0.16±0.06	0.46±0.14	0.14±0.14	0.24±0.10
Arbor Acre	10	0.38±0.12	0.16±0.10	0.17±0.12	0.44±0.12	0.20±0.06
Marshall		0.42±0.08	0.08±0.10	0.58±0.16	0.24±0.12	0.60±0.14
Ross		0.12±0.02	0.28±0.14	0.06±0.08	0.10±0.06	0.26±0.04

BW = Body Weight, BG = Breast Girth, SL = Shank Length, TL = Thigh Length and WS = Wing Span.

Heritability estimates for body weight and linear body measurements were similar to those found by Ledur *et al*. (1994) and Argenta˜o *et al*. (2002), respectively, and diverged from those found by Cahaner and Nitsan (1985); Le Bihan-Duval *et al.*

Table 3: Repeatability estimates for body weight and linear body measurements of Arbor Acre, Marshall and Ross strain of broiler chickens

Strain	Weeks	Traits BW(g)	BG (cm)	SL (cm)	TL (cm)	WS (cm)
Arbor Acre	4	0.74	0.20	0.39	0.46	0.53
Marshall		0.72	0.24	0.36	0.47	0.48
Ross		0.70	0.47	0.47	0.52	0.39
Arbor Acre	6	0.80	0.24	0.53	0.43	0.60
Marshall		0.79	0.44	0.50	0.62	0.86
Ross		0.83	0.36	0.51	0.59	0.42
Arbor Acre	8	0.86	0.50	0.57	0.63	0.57
Marshall		0.81	0.53	0.44	0.35	0.46
Ross		0.86	0.59	0.57	0.63	0.56
Arbor Acre	10	0.83	0.62	0.62	0.71	0.57
Marshall		0.84	0.59	0.53	0.38	0.52
Ross		0.88	0.52	0.64	0.62	0.50

BW = Body Weight, BG = Breast Girth, SL = Shank Length, TL = Thigh Length and WS = Wing Span

(1998); Mignon-Grasteau *et al.* (1999); and Rance *et al.* (2002), respectively. Higher repeatability estimates obtained for the broiler strains in this experiment is in line with the findings of Kabir *et al.* (2008) where high repeatability estimates (0.80, 0.84, 0.84 and 0.90 at week 4, 6, 8 and 10 respectively) were reported for growth traits in Anak 2000 broiler strain, indicating that the broiler strains used in this experiment have greater ability to repeat their present performance in the future. High repeatability estimates obtained also shows that fewer records are required to estimate the potential of these chickens across the strains and to realise a high expected response from selection. However, larger records will be required for those with lower repeatability, especially breast girth and shank length in the three broiler strains at week 4. The present result is consistent with the report of Falconer (1989), which stated that fewer records are required to realise a high expected response from selection in traits with high repeatability estimates, while those with low repeatability estimates will require larger number of records.

Conclusions

Marshall strain had the highest growth rate and better growth performance followed by Ross and Arbor Acre in terms of body weight and linear body dimensions. Marshall broiler strain also had the highest estimate of heritability for body weight followed by Arbor acre and Ross, but none of the chicken strains maintained a high heritability estimate from 4th to 10th week, considering the linear body measurements, while Ross broiler strain showed the highest repeatability estimates for body weight and shank length, Arbor Acre showed the highest estimates for breast girth and thigh length, and Marshall strain had the highest estimate for wing span, indicating more records would be required to realise expected response from selection. The cost-benefit analysis carried out on the three broiler strains showed that the choice of any of these strains for commercial broiler production in South-West, Nigeria will be a good source of income to poultry farmers, but based on this study, profit was be maximised in Arbor Acre.

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