COMPARATIVE EVALUATION OF GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND ECONOMICS OF PRODUCTION OF ANAK AND MARSHALL BROILER STRAINS IN A HUMID RAIN-FOREST ZONE OF NIGERIA

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ABSTRACT
This experiment was conducted at the poultry unit of the Teaching and Research farm, Michael Okpara University of Agriculture, Umudike to evaluate growth traits, carcass characteristics and economics of production of Anak and Marshal broiler strains. Ninety (90) broiler chicks comprising 45 birds each of Anak and Marshal strains were procured and used for the experiment. Each strain was allotted into five replicates of 9 birds per replicate in a Completely Randomized Design (CRD). Data were collected at both the starter phase (2-5 weeks) and finisher phase (6-10 weeks). The parameters measured were growth performance traits, linear body measurements, carcass traits and economics of production indices. The result showed significant ($P < 0.05$) strain effect on final body weight (1090.14 and 1279.54 g) for Anak and Marshal, respectively at the starter phase. The organ characteristics indicated significantly ($P < 0.05$) higher relative weights of liver and kidney (1.88 and 0.66 %) in the Marshal strain than (1.80 and 0.62 %) in the Anak strain. The revenue/bird and gross margin were higher ($P < 0.05$) in the Marshal than the Anak at the starter phase but higher in the Anak at the finisher phase. The respective values were 647.58, 705.30 and 518.06, 435.02; 501.06, 555.01 and 320.37, 212.31 at the starter and finisher phases. The result showed no significant ($P>0.05$) strain effect in growth performance parameters and linear body traits. The significant differences observed for a few parameters between the strains suggest evidence of slight genetic variation and this can be utilized for genetic improvement of the strains. The higher gross margin obtained for Anak compared to Marshal at the finisher phase suggests that it is more economical to raise Anak for sale at mature age while Marshal should go for brood and sale. Generally, the Marshal strain compared favourably with the Anak and has shown to be adaptable to our study environment.

INTRODUCTION
Poultry products such as meat and eggs are excellent sources of animal proteins necessary to meet the protein requirement of human populace. The Nigeria poultry industry has over the years witnessed the introduction of different broiler and layer strains as way of meeting the increasing demand for poultry products. The realization of the full growth potentials of these imported strains is largely expected to depend on their genotypic traits which have an effect on their production capacity (Essien and Adeyemi, 1999) as well as environmental conditions such as the nutritional and climatic variables. It then implies that the poultry producer needs to select stock which has the genetic potential for fast growth rate and early attainment of market weight under the existing climatic conditions of the given environment. Body weight and a number of conformation traits such as breast girth, shank length, back length, keel length etc have been applauded to be good indicators of body growth and market value in broilers. Fitzburgh (1976) noted that researchers and local farmers make use of body weight and body dimensions as selection parameters in order to improve the productivity of their breeds. Previous investigators had posited that differences in growth pattern are under genetic control, and that variations exist within species (Lilja *et al*., 1985; Carborg *et al*., 2003). Ajayi and Ejiofor (2009) found significant differences between strains and

sexes in body weight and body dimensions, as also reported elsewhere (Razuki, 2002; Olawumi *et al*., 2012b; Yahaya *et al*., 2012). Significant strain effects on live weight, weight gain and carcass traits (Ojedapo *et al*., 2008; Shim *et al*., 2012) as well as feed consumption, feed conversion and feed efficiency (Razuki and Al-Rawi, 2007; Olawumi and Dudusola, 2011) of broiler chickens have also been reported. Evaluation of these traits is therefore important as it does provide dependable information to serve as a guide to both researchers and farmers on choice broiler strain to procure for increased meat production and optimum profit.

Marshal broiler strain is a new broiler strain that was launched in India in 2009 and was specifically bred to provide excellent feed conversion in hot and tropical conditions of India and Asia at large. Trials conducted in India under normal management and environmental conditions showed that Marshal parent stock consumed an average of 389 g per broiler bird (0-8 weeks of age) and reached a body weight of 2.6 kg with a feed conversion ratio of 1.7 (New Indian Broiler Breed, 2009). Under the Nigerian condition, Udeh *et al.* (2011) compared the performance characteristics of four broiler strains - Anak, Arbor acre, Ross and Marshal from 2-8 weeks old and reported that Anak, Arbor acre and Ross strains were significantly ($P < 0.01$) lower compared to Marshal in all the traits measured (body weight, weight gain, total feed intake, feed conversion ratio, mortality and linear body measurements). Anak is a known broiler strain that has been found adaptable to the humid tropical environment of Nigeria. There is great scarcity of information in literature of this new strain "Marshall" in Nigeria. It is therefore necessary to assess the performance of this strain as well as its economics of production. This will help broiler farmers to establish its adaptive characteristics as well as its profitability in our environment. Such evaluation in relation to other strains will also give information on its genetic potential for growth and other performance traits. This will aid in breeding programmes designed for improvement purposes for the stock. The objective of this study was to compare the performance characteristics, linear body measurements, carcass characteristics and economics of production of Anak and Marshal broiler strains in a humid rain-forest zone of Nigeria.

MATERIALS AND METHODS

Experimental site

The research was conducted at the Poultry unit of the Teaching and Research farm of Michael Okpara University of Agriculture, Umudike, Abia State. Umudike lies on latitude $05^{0}29^{'}$ N and longitude $07^{0}33^{'}$ E with an elevation of 122 m above sea level and is located in the tropical rainforest zone of Nigeria. This zone is characterized by annual rainfall of about 2177 mm, monthly ambient temperature range of 22°C - 36°C and relative humidity of 50-95 % depending on the season and location.

Experimental birds and management

A total of ninety (90) broiler chicks comprising 45 each of Anak and Marshall strains were purchased from a reputable hatchery in Aba, Abia State. The chicks were brooded for two weeks and reared to ten weeks of age by conforming to standard management procedures. The chicks were offered clean water and fed *ad libitum* with a commercial feed starter diet from day old to 2 weeks of age. After brooding, each strain was randomly assigned to five replicates of 9 birds each. Then, compounded broiler starter (23.00 % CP, 2808 kcal/kgME) and finisher (20 % CP, 3000 kcal/kgME) diets were fed *ad libitum* and clean water also offered to birds at the two phases of production. Table 1 shows the composition of the experimental diets fed at the starter and finisher phases. Each strain of broiler was housed separately in a deep litter rearing pen. Proper sanitation and routine medication were maintained to forestall any outbreak of disease.

Data collection

Data were collected at both starter and finisher stages. The following parameters were measured on each strain:

Growth performance traits

The body weight of the birds was taken at the beginning of each phase and weekly thereafter

Daily feed intake: this was obtained by subtracting left over from quantity fed the previous day.

$$\text{Average feed intake (g/bird/day)} = \frac{\text{Quantity of feed consumed (g)} - \text{Leftover (g)}}{\text{Number of birds/ 28days}}$$

$$\text{Average daily weight gain (g/bird/day)} = \frac{\text{Final live weight (g)} - \text{Initial live weight (g)}}{\text{Number of birds/28 days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily weight gain (g)}}$$

$$\text{Mortality (\%)} = \frac{\text{Number of dead birds}}{\text{Initial stock}} \times \frac{100}{1}$$

Linear body traits

Fifteen birds each of Anak and Marshall broiler strains were randomly selected and measured fortnightly for linear body traits till the end of the experiment. The following body traits were measured using measuring tape:

Shank length: length of the tarso-metatarsus from the hock joint to the metatarsal pad.

Keel length: the length of the keel bone from the V-joint to the end of the sternum.

Body length: the distance between the base of the neck and pygostyle.

Breast width: region of the largest breast expansion when positioned ventrally.

Thigh length: length of the femur bone.

Carcass evaluation

After taking the final body weights at 10 weeks, the birds were starved of feed overnight and 20 birds (2 per replicate) each of the strain randomly selected for carcass evaluation. The selected birds were slaughtered by severing the jugular vein, scalded and plucked. The birds were de-feathered after immersing them in hot water, plucked and eviscerated. The dressed birds were weighed to obtain dressed weight before cutting into parts: thigh, drum stick, breast, wing and back cut and were weighed separately according to Scott *et al.* (1969). Dressed weight, slaughtered weight, cut parts and internal organs were expressed as percentage of live weight to obtain their relative weights.

Table 1: Composition of experimental diet fed to starter and finisher broiler chicks

Ingredients	**% Inclusion**	
	Starter	**Finisher**
Maize	47.00	60.30
Wheat offal	14.00	7.00
Palm kernel meal	4.00	3.00
Soybean meal	10.10	18.00
Groundnut cake	15.00	6.00
Fish meal	6.20	3.00
Bone meal	3.00	2.00
*Premix	0.25	0.25
Salt	0.25	0.25
Lysine	0.10	0.10
Methionine	0.10	0.10
Total %	100	100
Calculated Analysis		
Crude protein (%)	23.00	20
ME(kcal/kg)	2808	2997

* VITA D_{12} BCP Broiler Premix –each 2.5kg contains Vitamin A – 10,000,000 IU, Vitamin D_3- 2,000,00014; Vitamin E – 20,000 IU, Vitamin K- 2, 250mg, Thiamine B_1 -1750mg, Riboflavin, B_2 – 5,000mg Pyrodoxine B_6 – 2750mg, Niacin – 27,500mg, Vitamin B_{12} – 15mg, Pantothemic acid – 7,500mg, Folic acid – 7,500mg, Biotin – 50mg Choline Chloride -400g, Antioxidant – 125g, Manganese -80g, Zinc- 50g, Iron- 20g, Copper – 3g, Iodine 1.2g, Selenium – 200mg and Cobalt -200mg.

Economics of production indices

Cost analysis was carried out at the end of the finisher phase to determine and compare the profitability of the strains. The following parameters were measured:

Cost/kg feed = proportion of each ingredient in the diet × cost per kg of ingredients ÷ 100.

Feed cost/bird = feed consumed × cost/kg feed.

Feed cost/weight gain = cost/kg feed × feed conversion ratio.

Cost of production = cost/kg weight gain × mean weight gain.

Revenue = price of 1 kg meat × mean weight gain.

Gross margin = Revenue – cost of production.

Statistical analysis

Data collected were subjected to statistical analysis using SPSS (2008) software package. The independent student's t-test (Gusset, 1957) was used to compare means of the growth, carcass and cost variables between the two strains and statistical differences were established at the level $P \leq 0.05$.

RESULTS AND DISCUSSION

Growth traits

Table 2 shows the means ± SE of growth performance traits of Anak and Marshal broiler strains at the starter (2 – 6 weeks) and finisher (6 – 10 weeks) phases, respectively. Only final body weight was significantly ($P < 0.05$) different between the two strains at the starter phase. The Marshal strain had significantly ($P < 0.05$) higher value of 1279.54 g compared to the Anak strain which recorded a value of 1090.14 g. This significant difference in body weight is an indication that these strains have different genetic potential for body weight at this phase. Udeh *et al*. (2015) reported significant differences in body weight of Marshal, Arbor acre and Ross broiler chickens at weeks 1, 2, 3 and 4.

Table 2: Means±SE of growth performance traits of Anak and Marshal broiler strains at starter and finisher phases.

	Strain	
Parameter	**Anak**	**Marshal**
Starter phase		
Initial body weight (g)	280.67 ± 9.31	281.67 ± 9.45
Final body weight (g)	1090.14 ± 48.50[b]	1279.54 ± 88.39[a]
Daily feed intake (g/bird)	73.39 ± 3.09	75.98 ± 2.56
Daily weight gain (g)	28.87 ± 1.60	31.35 ± 1.70
Feed conversion ratio	2.58 ± 0.21	2.44 ± 0.10
Mortality rate (%)	1.00 ± 0.00	1.20 ± 0.20
Finisher phase		
Final body weight (g)	1738.53 ± 66.77	1703.31 ± 121.27
Daily feed intake (g/bird)	101.65 ± 7.60	111.39 ± 8.26
Daily weight gain (g)	23.62 ± 3.11	19.42 ± 2.80
Feed conversion ratio	4.62 ± 0.55	6.19 ± 0.85
Mortality rate (%)	1.20 ± 0.20	1.60 ± 0.24

[a-b]Means with different superscripts are significantly different ($P<0.05$), SE = standard error.

The authors noted that Marshal and Arbor acre were significantly ($P < 0.05$) superior to Ross at these starter ages. Olawumi *et al*. (2012a) also noted significant strain differences in Arbor acre, Hubbard and Marshal, in which Marshal recorded the least body weight at weeks 1 and 3. Body weight did not show any significant difference ($P > 0.05$) between the two strains at the finisher phase but had higher value for Anak compared to Marshal. This implies that the two strains are at par in terms of body weight. This result agreed with the report of Olawumi *et al*. (2012a) who found no significant effect on body weight at 5 and 7 weeks of age, but did not agree with those of Enaiat

et al. (2010) and Razuki *et al*. (2011) who obtained significant strain differences in live weight of broiler chicken slaughtered for carcass at 8-12 weeks. Amao *et al*. (2011) reported that Ross was superior to Marshal at 8 weeks of age. Daily Feed intake, daily weight gain, feed conversion ratio and mortality rate were not significantly different ($P > 0.05$) between the Anak and Marshal strains. This finding is in agreement with the report of Amao *et al.* (2011) that there were no significant differences ($P > 0.05$) in feed intake, weight gain and feed conversion ratio of Anak and Marshal strains. The mortality rate obtained in this study disagreed with earlier report of Udeh *et al.* (2011) that mortality rate was significantly higher in Anak than in Marshal strains. The observed differences between the present study and those of earlier authors might be as a result of differences in genetic constitution of birds and management practices.

Table 3 shows the means and standard errors of linear body measurements of Anak and Marshal broiler strains at both starter and finisher phases. No significant differences ($P > 0.05$) were observed for average weekly body weight and all the linear body parameters measured. The observed results suggest that environment and management influenced these growth traits more compared to genetic profile.

Table 3: Means±SE of linear body measurements in Anak and Marshal broiler strains at starter and finisher phases

Parameters	Strains	
	Anak	**Marshal**
Starter phase		
Average Body weight (g)	687.50 ± 19.06	708.15 ± 59.01
Body depth (cm)	19.12 ± 0.25	19.94 ± 0.31
Breast width (cm)	9.64 ± 0.13	9.98 ± 0.19
Keel length (cm)	6.93 ± 0.10	7.38 ± 0.20
Shank length (cm)	5.02 ± 0.14	5.02 ± 0.03
Thigh length (cm)	9.15 ± 0.10	9.57 ± 0.27
Finisher phase		
Average Body weight (g)	1552.50 ± 96.53	1625.00 ± 82.99
Body depth (cm)	27.25 ± 0.82	26.67 ± 0.56
Breast width (cm)	15.71 ± 0.82	16.29 ± 0.77
Keel length (cm)	9.60 ± 0.59	10.12 ± 0.22
Shank length (cm)	6.35 ± 0.32	6.13 ± 0.14
Thigh length (cm)	12.82 ± 0.52	12.98 ± 0.43

Carcass characteristics

Table 4 represents the carcass and organ characteristics of Anak and Marshal broiler strains. There were no significant differences ($P > 0.05$) between the two strains in their carcass characteristics except for liver (1.80 and 1.88) and kidney (0.62 and 0.66), respectively. Udeh *et al*. (2011) and Olawumi *et al.* (2012b) also found no significant effect of strain on carcass yield of broiler chickens. However, the carcass characteristics values obtained in this study are lower than the observed by Olawumi *et al*. (2012b) for male and female Marshal broiler strain after 56 days of rearing. Similarly, the relative organ parts were not significantly ($P > 0.05$) affected by strain in this study. Olawumi and Fagbuaro (2011) in their study on the productive performance of three broiler genotypes reared in the derived Savannah zone of Nigeria reported significant ($P < 0.05$) strain effect on carcass traits of broilers. The differences observed in the carcass and organ characteristics in this study compared with earlier reports elsewhere, show that, apart from genetic potentials, nutrition and environment are also major performance indices. Isidahomen *et al*. (2012) also reported significant effect of genotype on carcass characteristics of local chickens. The results obtained in this study suggest high genetic similarity between the two strains given the same production environment.

Table 4: Carcass and organ characteristics of Anak and Marshal Broiler strains at 10 weeks

Carcass traits	Anak	Marshal	SEM
Live weight (lwt) g	1860.00	1870.00	4.28
Dressed weight (g)	1158.14	1135.81	1.86
Dressing percent	62.27	60.74	0.84
Drum stick% lwt	11.60	10.95	0.74
Thigh % lwt	10.32	10.16	0.73
Breast % lwt	18.02	17.23	0.75
Back % lwt	13.92	14.25	0.73
Shank % lwt	4.70	4.64	0.73
Wing % lwt	8.41	8.15	0.73
Spleen % lwt	0.13	0.13	0.01
Liver % lwt	1.80^{b}	1.88^{a}	0.02
Kidney % lwt	0.62^{b}	0.66^{a}	0.01
Heart % lwt	0.46	0.44	0.01
Lungs % lwt	0.60	0.62	0.01
Gizzard % lwt	2.51	2.48	0.07
Intestine % lwt	5.01	5.02	0.00
% Organ	18.05	19.49	0.80

$^{a-b}$ Means with different superscripts within the same row are significantly different ($P < 0.05$); %lwt = percent live weight, SEM=Standard error of mean.

Economics of production

Table 5 shows the economic indices of Anak and Marshal broiler production at both the starter and finisher phases.

Table 5: Economic indices of Anak and Marshal broiler strains

Parameters	Strains	
	Anak	Marshal
Starter Phase		
Cost/Kg feed	70.22±0.00	70.22±0.00
Cost/Kg feed consumed	144.30±6.08	149.38±5.03
Cost/Kg weight gain	181.01±14.43	170.47±6.76
Cost of production	146.52±11.69	150.30±5.96
Revenue/bird	$647.58±0.00^{b}$	$705.30±0.00^{a}$
Gross margin	$501.06±11.69^{b}$	$555.01±5.96^{a}$
Finisher Phase		
Cost/Kg feed	66.15±0.00	66.15±0.00
Cost/Kg feed consumed	188.27±14.07	206.31±15.30
Cost/Kg weight gain	305.90±36.33	409.57±56.16
Cost of production	198.34±23.56	222.71±30.54
Revenue/bird	$518.71±0.00^{a}$	$435.02±0.00^{b}$
Gross margin	$320.37±23.56^{a}$	$212.3130.54^{b}$

$^{a-b}$Means with different superscripts are significantly different ($P<0.05$); SE- Standard error

Significant differences ($P<0.05$) were observed only in revenue/bird and gross margin between the two broiler strains, whereas no significant difference ($P>0.05$) was noted in the other cost- analysis parameters. The Marshal broiler strain performed better than the Anak broiler strain in revenue/bird (705.30 and 647.58) and gross margin (555.01 and 501.06) at the starter phase. According to Onu (2009), profit is a single index determining the economic value of keeping birds. This result therefore, shows that it is more economical to raise and sell the Marshal broilers than the Anak at the starter phase. At the finisher phase, however, Anak broilers generated more revenue/bird

(318.71 and 320.37) and gross margin (135.02 and 212.31) than their Marshal counterparts. Wekhe *et al.* (2012) reported a similar finding with gross margin (₦) value ranging from 269.18 to 764.34 in Anak broilers after 56 days. Adeoti and Olawumi (2013) obtained a gross margin of $1 (which is approximately ₦150.00) in Marshal broilers after 56 days of age. The gross margin obtained for Marshal broilers in this present research was higher than the value obtained by these researchers. Ijaiya *et al.* (2009) stated that diets are formulated to promote the desired intake of all nutrients and to improve the growth rate at reasonable cost. Although cost of production seemed the same, our result indicated that there will be more return on investment with Marshal broilers than the Anak strain whereas the reverse will be the case at the finisher phase.

CONCLUSION

Based on our results, the Marshal broiler strain compared favourably with Anak and can be reared conveniently in the humid tropic environment of Nigeria. However, the revenue/bird and gross margin indices indicated that the Marshal is better reared for brood and sale while the Anak is better reared to table weight for maximum economic returns. The significant strain effect observed on final body weight, liver, kidney, revenue per bird and gross margin suggests evidence of slight genetic variation between the two strains and can be utilized for selection of strains for improvement and for commercial purposes.

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