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Strain x sex effect on production indices of broiler chickens reared in the humid tropics

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Target audience: Breeders, Farmers, Producers

Abstract

Production traits of broiler chickens could be strain and sex dependent. This study evaluated the effect of strain x sex on body weight, linear body, growth performance, carcass and economics of production indices. Hubbard, Marshall and Ross strains were used. Data were obtained on 150 broiler chicks consisting of 50 each of the strains. Body weight and linear body traits were measured from 2 to 8 weeks of age. Body weight, body length, keel length, shank length, wing length, breast width, tail length and drumstick differed significantly (p<0.05) among the strains and between the sexes within the strains at 2, 4, 6 and 8 weeks except for wing length at 8 weeks. Male Marshall and male Ross had superior (p<0.05) mean values for body weight and almost all the linear body traits. Males of Marshall and Ross also recorded significantly higher final weight (2077.29 g; 1907.14 g) and better FCR (2.33; 2.43), respectively. A similar trend was obtained for live weight (2050.00 g; 1956.25), defeathered weight (1812.50 g; 1741.25 g) and dressed weight (1543.75 g; 1425.00 g). However, females of Marshall and Ross significantly (p<0.05) had higher mean values for breast, drumstick and shank. Males of Marshall gave higher revenue (₦1633.82/bird) and gross margin (₦839.05/bird) Males of Marshall and Ross broilers could be raised for increased production. For maximum profit for stockholders, the Marshall strain is recommended.

Keywords: Strain, sex, humid tropic, broiler, linear body measurements

Description of Problem

Poultry industry constitutes a major part of the agricultural sector in developing countries, including Nigeria. For sustainable animal husbandry development, therefore, priority must be given to poultry because they are widely distributed across regions of the countries. In recent decades, Nigeria has had a remarkable growth in poultry industry majorly through introduction of different broiler strains, of which variations are expected in their performance due to genotype x environment interaction.

The concept of genotype x environment interaction has been noted to play a significant role in animal productivity, particularly with reference to poultry productivity (1). Distinctively, (2) and (3) considered specific strain as genotype, which is the sum total of all genetic materials transmitted or inherited from the parents to the progeny. While environmental differences include effects of nutrition, location, management, sex amongst others. Researchers have observed that genotype/strain and sex had significant influence on chicken performance, carcass and meat quality characteristics. Significant differences in body weight of Ross and Anak broilers at day old, 6 and 9 weeks of age was reported (4). The authors also reported significantly higher body girth, keel length and shank length for Anak at day old and 3 weeks than the Ross counterpart, but that the later showed superiority over the former at 6 and 9 weeks of age for body girth and shank length. Significantly higher live weight, dressed weight, heart and gizzard weights were observed in normal than in naked neck strains of scavenging Nigerian indigenous chickens (5).

(6) reported significantly higher body weight at weeks 2, 4, 6 and 8 for Anak and Shaver broiler males compared to their female counterparts. Linear body traits such as wing length (week 8), shank length (week 2, 4 and 6) and body length (week 2, 4, 6 and 8) were also found to be longer in males than in females of both Anak and Shavers (6). Arbor Acre males were noted to be most superior in body weight and weight gain compared to the males and females of Ross and Marshall broilers (7). Several studies have also acknowledged sex influence on carcass parameters of broilers. (8) and (9) found significant strain x sex interaction on live weight, weight gain and carcass traits of broiler chickens. Significant strain x sex interactions were observed in body weight, weight gain and feed intake of Arbor Acre, Ross and Marshall broilers (7). In another study, significant strain x sex interaction effects on all productive performance traits measured on Marshall, Arbor Acre and Hubbard broilers were reported (10).

The performances of modern broilers represent the increase in production achieved by selective breeding. For this reason, the breeder industry constantly strives to improve the genetic selection for efficiency in growth performance and carcass characteristics (11). This improvement effort warrant constant research on the effect that broiler strains selected for optimum growth and sex have on performance characteristics.

The objective of this study was to evaluate the influence of strain x sex interaction on body weight and linear body traits, growth performance, carcass and economics of production characteristics of three broiler chickens.

Materials and Methods

Research site

This research was conducted at the Poultry unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike located on latitude 05°29′N and longitude 07°33′E. Umudike is on an elevation of 122 m above sea level and located in tropical rain-forest zone of Nigeria, which is characterized by annual rainfall of about 2177 mm; monthly ambient temperature ranges of 22-33°C and relative humidity of 50-95 % depending on the season (12).

Experimental birds and their management

A total of 150 day-old broiler chicks, 50 each of Marshall, Hubbard and Ross were purchased from a reputable hatchery in Ibadan, Nigeria. After brooding, each of the strain was replicated into three with 15 birds per replicate. Two weeks to the arrival of the birds, the brooder house was washed, disinfected and allowed to dry. On arrival, anti-stress preparations were administered to enable the chicks recover from transportation stress. The birds were brooded for 2 weeks and were transferred to deep litter pens afterwards.

Antibiotics and anticoccidial drugs were administered at relevant periods. All routine vaccination and management procedures were strictly followed. Wood shavings were used as litter materials. The birds were fed formulated diet of 22.95 % CP and 2945 Kcal/kgME. Feed and water were given to the birds *ad libitum*. The experiment lasted for 8 weeks.

Collection of Data

Data were collected on growth performance traits, linear body traits, carcass evaluation (13) and economics of production parameters.

Growth performance traits

Initial weight: weight of the birds at the beginning of the experiment taken with the aid of a weighing scale in grams.

Final weight: weight of the birds at 8 weeks taken with the aid of a weighing scale in grams.

$$\text{Daily weight gain (g/bird/day)} = \frac{\text{Final weight} - \text{initial weight}}{\text{Number of birds/56 days}}$$

$$\text{Average daily feed intake (g/bird/day)} = \frac{\text{Quantity of feed given (g)} - \text{leftover}}{\text{Number of birds/56 days}}$$

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

Linear body parameters: Measurement of linear body traits were taken on all the birds in each replicate.

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

Keel length: measured as the length of the cartilaginous keel bone, from thev-joint to the end of the sternum.

Shank length: taken from the beginning of hock joint to the last ring before the tarsal or meta-tarsal digit.

Wing length: taken as the distance from the shoulder joint to the extremity of the terminalphalange.

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

Thigh length: taken from the beginning of the fibula to the hock joint.

Drumstick length: measured as the length of femur bone.

Carcass evaluation

At the end of the experiment, two birds (male and female) per replicate were randomly selected for carcass yield. The birds were deprived of feed over night to avoid gut fill, weighed and killed by slitting the jugular vein. The birds were defeathered after immersing them in hot water, plucked and eviscerated. The dressed birds were weighed to obtain dressed weight before cutting into parts – breast, shank, wing, thigh, drumstick, neck and back, which were weighed separately (13). Dressed weight, slaughtered weight, cut parts and internal organs were expressed as percent of live weight.

Economics of production

The parameters measured were:

Cost/kg feed = proportion of each ingredient in the diet x cost/kg of ingredient $\div 100$.

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

Feed cost/weight gain = cost/kg feed x FCR.

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

Gross margin = revenue – cost of production.

Experimental design and statistical analysis

The experiment was a completely randomized design (CRD) with a general linear model as given below:

$$Y_{ijk} = \mu + S_i + B_j + (SB)_{ij} + e_{ijk}$$

where

Y_{ijk} = individual observation on the j^{th} sex of the i^{th} strain
μ = population mean
S_i = effect of the i^{th} strain
B_j = effect of j^{th} sex
$(SB)_{ij}$ = strain x sex interaction effect
e_{ijk} = random error

Data generated were subjected to analysis of variance using (14) analytical package. Significant means were separated with Duncan's New Multiple Range Test (15).

Results and Discussion

Strain x sex interaction on body weight and linear body parameters of Hubbard, Marshal and Ross broilers

The least square means plus their standard errors of body weight and linear body measurements at 2 – 8 weeks of age of Hubbard, Marshall and Ross are presented in Table 1. Significant differences existed between males and females of the three strains in body weight and linear body traits in all the weeks studied, except for wing length at 8 weeks. For body weight at week 2, Marshall male was significantly superior to Marshall female and male and female of both Ross and Hubbard. However, in weeks 4,6 and 8 Marshall and Ross males ranked significantly superior to their female counterparts and male and female of Hubbard strain. A similar trend was observed for linear body traits. Male Marshall had significantly longer body length, keel length, shank length, thigh length, drumstick length and broader breast width compared to its female counterpart and both sexes of Ross and Hubbard strains at week 2. From weeks 4 – 8, Marshall and Ross males compared favorably and were statistically superior to their females and Hubbard males and females in almost all the linear traits. (16) noted that the effects of interaction of strain, age and sex for body weight and egg weight of Japanese quail were highly significant. Significant strain x sex interaction on body weight of three different commercial broilers (Arbor Acre, Marshall and Ross) from week 2 – 8 was reported (7). They noted that Arbor Acre males were superior in body weight at 8 weeks of age followed by Ross male, Marshall male, Ross female, Arbor Acre female and Marshall female. The result of present study also affirms the report of (17) and (8) that body weight of broilers is influenced by strain and sex interaction. However, it varied from the work of (18) that noted non-significant strain x sex interaction on body weight of broilers. (4) found significant strain x sex interaction effect for shank length at day – old and at 9 weeks, body girth and shank length at 3 weeks, body girth, shank length and keel length at 6 weeks with Anak and Ross broilers. The result of this study showed Marshall and Ross males had superior body weight and linear body traits compared to others.

Strain x sex interaction on growth performance characteristics of Hubbard, Marshall and Ross broilers

The least square means and their standard errors of the growth performance traits of male and female sexes of Hubbard, Marshall and Ross strains irrespective of age are shown in Table 2. The result showed significant differences among the males and females of the three strains for final weight (g) and FCR. Marshall male and Ross male were significantly heavier in weight and were better feed converters compared to Hubbard male and female, Marshall female and Ross female. This may be due to differences in feed metabolism especially at the on-set of fattening (19). (20) reported that feed conversion ratio differed according to strain x sex interaction. No significant difference was observed for daily weight gain (g/bird/day) and daily feed intake (g/bird/day) of both sexes of the three strains. Non significant strain x sex interaction was recorded for weight gain at 4 weeks as well as feed intake at 7 and 8 weeks for Arbor Acre, Marshall and Ross male and female broilers (7).

Strain x sex interaction on carcass and economics of production indices of Hubbard, Marshall and Ross broiler chickens

Table 3 indicated the least square means and standard errors of carcass characteristics of male and female sexes of Hubbard, Marshall and Ross broiler strains. Significant differences were observed for all the carcass traits studied except for dressed percent, thigh, neck and back. Marshall male and Ross male recorded superior and higher mean values for live weight, defeathered weight and dressed weight. Marshall and Ross females had significantly superior breast, drumstick and shank proportions. Hubbard males also compared favourably in shank proportion with female Marshall and Ross strains. These results indicated that the strains differ in their carcass proportions, and that the differences are strongly dependent to their sexes. This result agrees with (10) who observed significant breed x sex interaction effects on live weight, eviscerated weight, back muscle, thigh muscle, drumstick, wing, leg, head, neck and abdominal fat. (8) also reported highly significant strain x sex interaction effects on all carcass proportions broiler chicken breeds except for leg length. The authors noted that males and females of Marshall broilers recorded superior and higher mean values in almost all carcass traits than the sexes of Arbor Acre and Hubbard. The findings of this study contradicted that of (18) who reported non-significant strain x sex interactions on shank, thigh and drumstick weights. However, this trend was observed for thigh, neck and back weights in our study.

The result obtained in this study also showed significant strain x sex interaction on the economics of production of three broiler strains (Table 4). This implies that these economic indices are strain and sex dependent, i.e significant differences were observed among strains and between sexes within the strains. The male Marshall had significantly the least feed cost per weight gain and highest revenue and gross margin compared to its female counterpart and the male and females of Hubbard and Ross strains. The result therefore indicates that the male Marshall broiler is the most profitable when compared with its counterparts. (21) reported that the level of profitability and productivity of broilers depends among other factors on the strain. The result of this study has revealed that sex is a notable factor for broiler profitability.

Conclusions and Applications

1. It was concluded from this study that there were significant strain x sex interactions on almost all the traits considered.
2. Male Marshall followed by male Ross was the most superior in body weight, FCR, linear body and carcass traits.
3. Male Marshall revealed superiority in revenue and gross margin over sexes of the other strains, indicating that it is the most profitable to raise in our study area.

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Table 1: Means±SEM of strain x sex interaction on body weight and linear body traits of Hubbard,Marshall and Ross broiler strains

Week	Trait	Hubbard		Marshall		Ross		
		Male	Female	Male	Female	Male	Female	SEM
2	BW (g)	299.78^{cd}	289.77^{d}	452.08^{a}	340.00^{c}	385.00^{b}	286.46^{d}	8.33
	BL (cm)	19.93^{b}	20.25^{b}	21.83^{a}	20.61^{b}	21.59^{a}	20.30^{b}	0.12
	KL (cm)	6.65^{b}	6.55^{b}	7.41^{a}	6.60^{b}	7.14^{a}	6.58^{b}	0.06
	SL (cm)	4.07^{bc}	4.32^{ab}	4.50^{a}	4.18^{b}	4.23^{ab}	3.85^{c}	0.04
	WL (cm)	11.38^{b}	11.64^{ab}	12.24^{a}	11.65^{ab}	11.54^{b}	11.08^{b}	0.09
	BRW (cm)	5.50^{b}	5.11^{b}	5.93^{a}	5.08^{b}	5.36^{b}	4.61^{c}	0.07
	TL (cm)	4.82^{d}	5.15^{cd}	6.29^{a}	5.69^{b}	5.84^{b}	5.27^{c}	0.07
	DST (cm)	6.12^{b}	6.24^{b}	7.35^{a}	6.33^{b}	7.11^{a}	6.17^{b}	0.08
4	BW (g)	643.48^{b}	637.50^{b}	910.42^{a}	661.36^{b}	870.65^{a}	706.25^{b}	18.72
	BL (cm)	26.04^{b}	25.75^{b}	27.47^{a}	25.98^{b}	28.06^{a}	26.22^{b}	0.16
	KL (cm)	9.14^{b}	8.96^{b}	9.90^{a}	9.01^{b}	10.24^{a}	9.35^{b}	0.08
	SL (cm)	5.65^{a}	5.68^{a}	5.53^{ab}	5.23^{b}	5.64^{a}	5.24^{b}	0.05
	WL (cm)	13.99^{c}	14.55^{bc}	15.90^{a}	14.02^{c}	15.12^{b}	14.95^{b}	0.11
	BRW (cm)	6.95^{ab}	7.15^{ab}	7.22^{a}	5.67^{c}	6.67^{b}	5.51^{c}	0.09
	TL (cm)	7.47^{ab}	7.23^{b}	7.55^{ab}	6.76^{c}	7.87^{a}	7.19^{b}	0.06
	DST (cm)	8.96^{bc}	9.11^{bc}	9.57^{ab}	8.55^{c}	10.07^{a}	8.97^{bc}	0.10
6	BW (g)	973.75^{c}	1147.73^{bc}	1496.96^{a}	1157.50^{bc}	1581.82^{a}	1280.44^{b}	33.70
	BL (cm)	29.96^{b}	30.06^{b}	32.40^{a}	30.18^{b}	32.32^{a}	30.97^{ab}	0.25
	KL (cm)	10.86^{c}	11.00^{c}	12.62^{ab}	11.42^{c}	13.17^{a}	12.10^{b}	0.12
	SL (cm)	6.43^{b}	6.31^{bc}	6.92^{a}	6.07^{c}	7.01^{a}	6.51^{b}	0.05
	WL (cm)	17.23^{b}	17.67^{b}	19.02^{a}	18.08^{b}	19.45^{a}	17.88^{b}	0.14
	BRW (cm)	7.47^{bc}	7.07^{c}	8.04^{ab}	6.91^{c}	8.18^{a}	6.99^{c}	0.10
	TL (cm)	9.38^{d}	8.64^{d}	10.30^{ab}	9.35^{c}	10.91^{a}	9.83^{bc}	0.12
	DST (cm)	10.27^{d}	10.38^{d}	12.01^{ab}	11.14^{c}	12.71^{a}	11.61^{bc}	0.13
8	BW (g)	1401.25^{d}	1463.64^{d}	2077.27^{a}	1645.00^{cd}	1907.14^{ab}	1721.74^{bc}	41.12
	BL (cm)	33.78^{b}	34.71^{b}	36.92^{a}	34.35^{b}	36.92^{a}	34.78^{b}	0.25
	KL (cm)	13.24^{c}	13.46^{bc}	14.93^{a}	13.68^{bc}	15.17^{a}	14.55^{ab}	0.16
	SL (cm)	7.59^{cd}	7.74^{bc}	8.35^{a}	7.27^{d}	8.07^{ab}	7.52^{cd}	0.07
	WL (cm)	20.70	20.36	21.41	20.69	21.35	20.77	0.18
	BRW (cm)	9.28^{b}	9.38^{b}	10.26^{a}	8.24^{c}	10.36^{a}	8.59^{c}	0.11
	TL (cm)	11.25^{b}	11.11^{b}	12.34^{a}	11.07^{b}	12.25^{a}	11.41^{b}	0.10
	DST (cm)	11.89^{c}	12.91^{b}	14.85^{a}	13.04^{b}	14.63^{a}	13.54^{b}	0.16

^{abcd} Means with different superscripts across the rows differed significantly ($p<0.05$).

BW = body weight, BL = body length, KL = keel length, SL = shank length, WL = wing length, BRW = breast width, TL = tail length, DST = drumstick, SEM = standard error of mean.

Table 2: Means±SEM of strain x sex interaction on growth performance characteristics of Hubbard, Marshall and Ross broiler chickens

Hubbard			Marshall		Ross		
Trait	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**SEM**
Initial weight (g)	38.25	38.25	35.00	35.00	37.50	37.50	2.89
Final weight (g)	1401.25^{c}	1463.64^{c}	2077.27^{a}	1645.00^{b}	1907.14^{a}	1721.74^{b}	2.89
Daily weight gain (g/b/d)	24.34	25.45	36.47	28.75	33.39	30.08	0.00
Daily feed intake (g/b/d)	80.08	88.72	88.76	88.64	89.73	84.07	2.89
FCR	3.29^{b}	3.49^{b}	2.33^{a}	3.08^{b}	2.43^{a}	2.80^{b}	0.10

^{abc} Means with different superscripts across the rows are significantly different ($p<0.05$). SEM = standard error of mean, FCR = feed conversion ratio.

Table 3: Means±SEM of strain x sex interaction on carcass characteristics of Hubbard, Marshall and Ross broiler chickens

	Hubbard		Marshall		Ross		
Trait	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**SEM**
Live weight (g)	1500.00^{b}	1500.00^{b}	2050.00^{a}	1587.50^{b}	1956.25^{a}	1650.00^{b}	70.44
Defeathered weight (g)	13500.00^{b}	1400.00^{b}	1812.50^{a}	1475.00^{b}	1741.25^{a}	1493.75^{b}	62.69
Dressed weight (g)	956.25^{c}	1168.75^{b}	1543.75^{a}	1175.00^{b}	1425.00^{a}	1275.00^{b}	68.84
Dressed percent	63.56	77.81	74.90	74.29	71.36	76.95	2.48
Breast (%)	13.54^{b}	14.37^{b}	14.59^{b}	19.24^{a}	16.70^{ab}	20.18^{a}	0.83
Wing (%)	14.10^{a}	11.51^{ab}	10.86^{ab}	9.64^{b}	9.98^{b}	10.75^{ab}	0.44
Drumstick (%)	10.62^{b}	9.70^{b}	10.00^{b}	13.45^{a}	11.13^{ab}	12.19^{ab}	0.37
Shank (%)	5.75^{a}	4.96^{ab}	3.73^{b}	5.13^{a}	5.43^{a}	5.75^{a}	0.21
Thigh (%)	12.49	10.40	10.86	12.83	12.52	12.85	0.52
Neck (%)	6.53	8.09	5.82	5.76	6.82	7.35	0.31
Back (%)	15.69	13.74	15.01	14.45	15.87	15.19	0.49

^{abc} Means with different superscripts across the rows are significantly different ($p<0.05$). SEM = standard error of mean.

Table 4: Means±SEM of strain x sex interaction on economics of production of Hubbard, Marshall and Ross broiler chickens

	Hubbard		Marshall		Ross		
Parameter	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**SEM**
Cost/kg feed (₦)	110.00	110.00	110.00	110.00	110.00	110.00	0.20
Cost of feed consumed (₦)	493.29^{d}	546.52^{b}	546.76^{b}	546.02^{b}	562.74^{a}	517.87^{c}	5.18
Feed cost/weight gain (₦/bird)	361.90^{b}	383.90^{a}	267.30^{f}	338.80^{c}	295.90^{c}	308.00^{d}	9.64
Revenue (₦/bird)	1090.40^{f}	1140.31^{d}	1633.82^{a}	1288.00^{c}	1495.71^{b}	1347.39^{c}	45.93
Gross margin (₦/bird)	349.11^{f}	345.80^{f}	839.05^{a}	493.98^{d}	694.98^{b}	581.52^{c}	43.25

^{abcdef} Means with different superscripts across the rows are significantly different ($p<0.05$). SEM = standard error of mean.