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Growth Performance of Crossbred and Purebred Chickens Resulting from Different Sire Strain in a Humid Tropical Environment

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Abstract: A total of 357 progenies (both sexes) produced by 23 sires belonging to 4 sire strains; 3 Nigerian indigenous (Naked-Neck, Frizzle and Normal) and an exotic purebred (White Leghorn) chickens were evaluated for growth traits at day-old, 4, 8, 16 and 20 weeks of age. The growth traits measured were body weight (BDW), body length (BDL), Breast Girth (BG) and Keel Length (KL). Sire genotypes significantly ($p<0.05$) affected BDW, BDL, BG and KL at all ages except at first week of age for breast girth ($p>0.05$). Significant differences were also recorded for sex for each of the growth traits at different ages ($p<0.05$). Progenies of Naked Neck sire were generally superior in BDW followed by Frizzle, Normal and White Leghorn progenies. Male progenies were significantly ($p<0.05$) heavier and possess higher linear body measurements than their female counterpart in all age except KL at day-old and 20 week of age. The significance ($p<0.05$) of sire x sex interactions on growth traits varied with age. This study revealed the existence of genetic variations and potential for improvement amongst the Nigerian local chickens.

Key words: Sire strain, growth performance, purebred, crossbred, sex, age, chickens

INTRODUCTION

The Nigerian local chickens constitute between 80 to 90% of the local population of chickens in Nigeria. Over 98% of these chickens are traditionally managed in the villages[1]. Three major genes have been identified in the Nigerian local chicken, Frizzle, Naked necked and sex-linked dwarfism. These birds are characterized by poor growth, small body size and small egg size that are not desirable in a competitive economic situation[2,3]. Several attempts made in the past by the government to improve the productivity of the indigenous chicken because of its potential as a source of meat to reduce animal protein deficiency failed because there was no proper articulation and involvement of animal breeders[4,5] coupled with the problem of Genotype X Environment interaction[6]. It is imperative that improvement of the body and egg size of these birds be done to meet the protein needs of Nigerian populace and[7,8,9] advocated the use of selection within the population or crossbreeding in order to create heterogeneous population followed by intense selection. Various authors[10,2,11] had reported positive and significant heterosis in body weight and other body dimensions of local chicken when crossed with exotics. This study therefore seeks to determine the growth performance of crossbred and purebred chickens in a humid environment.

MATERIALS AND METHODS

Experimental study area: The study was carried out at the Poultry Breeding Unit of the Department of Animal Breeding and Genetics University of Agriculture, Abeokuta, Ogun state, Nigeria ($7^0 10^1$ N and $3^0 2^1$E). The area lies in the Southwestern part of Nigeria and has a prevailing tropical climate with a mean annual rainfall of about 1037mm. The mean ambient temperature ranges from 28°C in December to 36°C in February with a yearly average of 34°C. Relative humidity ranges from 60% in January to 94% in August with a yearly average of about 82%. The vegetation represents an interphase between the tropical rainforest and the derived Savannah.

Experimental birds and managemnet: The experimental birds consisted of twenty- three (23) sires belonging to four different sire strains and seventy-five (75) purebred White Leghorn dams. The four sire strains are three indigenous (Naked Neck, Normal feather and Frizzle

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feather) and exotic (White Leghorn) chickens. Sires and dams were caged individually in an open-sided house providing a cage space of 0.4 m^2. The birds were individually wing-tagged for identification purposes. The birds were exposed to natural day light of 12 h per day and mating was done by artificial insemination. Semen was collected from each sire using the massage technique[12]. 357 progenies were generated from the following crosses; Naked Neck×White Leghorn; Frizzle×White Leghorn; Normal×White Leghorn and White Leghorn×White Leghorn. Eggs from artificially inseminated hens were collected, pedigreed along sire lines and sent to the hatchery for incubation. After hatching, all chicks resulting from each mating were properly identified and wing tagged (pedigreed along each sire) and immediately vaccinated against Newcastle disease. The chicks were transferred to separate and previously disinfected brooder pen and were brooded for four weeks.

Experimental feeds and feeding: The chicks were fed *ad libitum* with a commercial chick starter diet that supplied 22-25% crude protein and 11.1KJ g metabolizable energy from 0 to 8 weeks of age. Thereafter, they were fed with commercial grower's ration that supplied 16% crude protein and 10.48 KJ/g metabolizable energy. Clean water was a supplied *ad-libitum*. Medications and vaccinations were done as at when due.

Data collection and duration: The project last for a period of twelve months. The progenies were studied for growth parameters. Progenies belonging to each cross were individually weighed using a sensitive balance of 0.05 gramme sensitivity while tailor's tape rule was used to measure other body dimensions. Each measurement was taken on weekly basis till the birds were 20 weeks. The parameters measured include;

Body Weight (BW): This was taken as the absolute weight of the bird and it is measured with the use of a sensitive balance (0.05g sensitivity) having capacity of three decimal digits;

Body Length (BDL): It was measured as the distance between the base of the neck and the cloaca; Breast girth (BG): This was taken as the circumference of the breast around the deepest region of the breast;

Keel Length (KL): This was taken as the length region of the sternum.

Data analysis: The data was analyzed using Mixed Model least squares[13] after the original data has been corrected for hatch effect. The model was fitted for the effects of sire, sex and sire X sex interaction.

Model 1

$Y_{ijkl} = \mu + S_i + X_J + A_k + (SX)_{ij} + e_{ijkl}$

Where;

Y_{ijk} = Single body measurements;
μ = Overall mean;
S_i = Effect of the i^{th} sire (i = 1, 2, 3, 4);
X_j = Effect of the j^{th} sex (j=1, 2);
A_k = Effect of the k^{th} age (k= 0, 4, 8, 12, 16, 20)
$(SX)_{ij}$ = Effect of sire x sex interaction
e_{ijk} = Random residual error normally distributed with zero mean

RESULTS

The least square means of body weight, body length, breast girth and keel lengths of progenies belonging to different sire strains at different ages are presented in Table 1. Sire strain had significant ($p<0.05$) effect on body weight, body length, breast girth and keel lengths (sexes combined) at all ages except at day-old for breast girth.

Individuals with Naked-Neck were significantly ($p<0.05$) superior in body weight at day old and 20 weeks of age than other sire progenies. However, at 4th to 16th week, Frizzles were significantly ($p<0.05$) heavier in body weight. (Table 1).

Naked-Neck birds were generally the highest in body length when compared with other genotypes at all ages however; Frizzle progenies were superior in body length both at 4 and 20-week of age while Normal feather individuals were the lowest generally. In the study of breast girth, there was no significant ($p>0.05$) difference in the breast girth among all progeny genotypes at day-old, however, from the 4th to 20th week of age, individuals with Naked Neck were significantly ($p<0.05$) superior in breast girth. Similarly, Naked-Neck progenies were generally superior in keel length followed by those of Frizzle, Normal and White Leghorn birds (Table 1).

Mean of body weight, body length, breast girth and keel lengths of the sexes within genotypes at different age are presented in Table 2. The sex of progenies had significant effect ($p<0.05$) on all the traits measured. Males were heavier than their female counterpart in each of the growth traits at all ages. Body length and breast girth's values followed similar trends with male progenies dominating in each of the week of growth. However, female progenies of Normal and Naked-Neck were had more keel length at day-old with 0.58% and 0.90% variations, respectively.

Table 1: Least square means of growth traits of four genotypes from day-old to 20 weeks

Parameters	Genotype	Day-old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
BDW(gm)	NN × WL	36.17±0.75^{a}	142.90±8.46^{d}	348.61±4.21^{d}	595.61±5.99^{b}	842.58±11.01^{b}	1052.25±15.83^{a}
	FR × WL	35.10±0.75^{b}	169.03±8.42^{a}	366.46±4.11^{a}	625.52±5.93^{a}	855.57±11.00^{a}	1030.43±15.86^{b}
	NM × WL	35.30±0.75^{b}	150.24±8.30^{c}	351.31±4.45^{b}	576.68±6.41^{d}	783.59±11.34^{d}	942.92±17.21^{d}
	WL × WL	30.18±0.90^{c}	152.35±12.89^{b}	351.22±6.65^{c}	585.19±9.72^{c}	797.19±17.49^{c}	966.42±25.41^{c}
BDL (cm)	NN × WL	5.55±0.07^{a}	9.03±0.09^{a}	11.90±0.22^{a}	15.13±0.14^{a}	18.28±0.14^{a}	21.85±0.11^{a}
	FR × WL	5.47±0.07^{b}	8.80±0.09^{b}	11.77±0.22^{c}	14.86±0.14^{b}	18.01±0.14^{b}	21.70±0.11^{b}
	NM × WL	5.50±0.07^{b}	8.77±0.09^{c}	11.89±0.23^{b}	14.83±0.15^{c}	17.72±0.15^{c}	21.26±0.23^{c}
	WL × WL	5.03±0.07^{c}	8.61±0.13^{d}	11.56±0.35^{d}	15.14±0.23^{a}	18.06±0.23^{b}	21.42±0.18^{c}
BG(cm)	NN × WL	5.00±0.34^{ns}	7.78±0.07^{a}	10.62±0.09^{a}	13.73±0.09^{a}	16.86±0.09^{a}	20.21±0.09^{a}
	FR × WL	4.95±0.34^{ns}	7.65±0.07^{b}	10.55±0.09^{c}	13.63±0.09^{b}	16.75±0.09^{b}	20.07±0.09^{c}
	NM × WL	4.95±0.34^{ns}	7.64±0.07^{c}	10.61±0.09^{b}	13.54±0.10^{c}	16.49±0.09^{c}	19.71±0.10^{c}
	WL × WL	5.60±0.41^{ns}	7.62±0.11^{d}	10.61±0.14^{b}	13.50±0.15^{c}	16.50±0.14^{c}	20.13±0.14^{b}
KL (cm)	NN × WL	1.73±0.06^{a}	3.74±0.04^{a}	5.52±0.04^{a}	7.51±0.05^{a}	9.48±0.07^{a}	11.55±0.08^{a}
	FR × WL	1.71±0.06^{a}	3.62±0.04^{b}	5.34±0.04^{ab}	7.32±0.05^{b}	9.26±0.07^{b}	11.34±0.07^{b}
	NM × WL	1.67±0.06^{b}	3.58±0.04^{bc}	5.29±0.04^{b}	7.23±0.05^{c}	9.18±0.08^{b}	11.10±0.08^{bc}
	WL × WL	1.32±0.07^{c}	3.28±0.06^{d}	4.97±0.07^{c}	7.07±0.08^{d}	9.26±0.12^{b}	11.02±0.10^{c}
No		357	356	356	356	355	353

NN = Naked Neck; FR= Frizzle; NM= Normal; WL= White Leghorn, BDW= body weight, BDL= body length, BG= breast girth, KL= keel lenght, a,b,c,d= means in the same column within each growth trait and age with different superscripts are significantly different (p<0.05)

Table 2: Least square means of some growth traits by sexes of four genotypes from day-old to 20 weeksgenotype

			Genotype			
Parameters	Age (wks)	Sex	NN × WL	FR × WL	NM × WL	WL × WL
BDW (gm)	day-old	M	37.25±0.91^{a}	36.02±0.93^{a}	36.25±0.93^{a}	31.41±1.14^{a}
		F	35.07±1.18^{b}	34.19±1.18^{b}	3436±1.17^{b}	28.94±1.39^{b}
	8 weeks	M	391.37±5.86^{a}	403.22±5.81^{a}	394.00±0.30^{a}	402.97±9.41^{a}
		F	649.44±8.31^{b}	329.69±5.81^{b}	308.62±6.29^{b}	299.47±9.39^{b}
	16 weeks	M	904.29±15.32^{a}	906.42±15.54^{a}	828.64±15.83^{a}	867.35±25.27^{a}
		F	780.88±15.81^{b}	804.73±15.58^{b}	738.54±16.22^{b}	727.02±24.40^{b}
	20 weeks	M	1110.53±22.09^{a}	1080.55±22.08^{a}	994.71±24.01^{a}	1025.67±36.62^{a}
		F	993.96±22.68^{b}	980.31±22.76^{b}	891.13±24.66^{b}	907.18±35.22^{b}
BDL (cm)	day-old	M	5.60±0.08^{a}	5.51±0.09^{a}	5.53±0.09^{a}	5.09±0.11^{a}
		F	5.49±0.11^{b}	5.42±0.11^{b}	5.47±0.11^{b}	4.96±0.13^{b}
	8 weeks	M	12.04±0.31^{a}	11.94±0.30^{a}	12.18±0.33^{a}	11.71±0.49^{a}
		F	11.76±0.32^{b}	11.60±0.30^{b}	11.60±0.33^{b}	11.41±0.48^{b}
	16 weeks	M	18.67±0.20^{a}	18.49±0.20^{a}	17.89±0.21^{a}	18.51±0.33^{a}
		F	17.89±0.21^{b}	17.70±0.20^{b}	17.57±0.21^{b}	17.61±0.31^{b}
	20 weeks	M	22.31±0.15^{a}	22.14±0.15^{a}	21.63±0.73^{a}	21.76±0.25^{a}
		F	21.38±0.16^{b}	21.27±0.16^{b}	20.89±0.17^{b}	21.08±0.24^{b}
BG (cm)	day-old	M	5.03±0.41^{a}	4.98±0.42^{b}	4.98±0.42^{a}	6.59±0.62^{a}
		F	4.96±0.53^{b}	4.92±0.53^{b}	4.92±0.53^{b}	5.49±0.44^{b}
	8 weeks	M	10.73±0.12^{a}	10.77±0.12^{a}	10.99±0.13^{a}	10.92±0.20^{a}
		F	10.51±0.13^{b}	10.33±0.12^{b}	10.23±0.13^{b}	10.30±0.20^{b}
	16 weeks	M	17.20±0.12^{a}	17.07±0.12^{a}	16.88±0.13^{a}	16.59±0.20^{a}
		F	16.5±30.13^{b}	16.44±0.12^{b}	16.10±0.13^{b}	16.41±0.1^{b}
	20 weeks	M	20.60±0.12^{a}	20.43±0.12^{a}	19.97±0.14^{a}	19.33±0.20^{a}
		F	19.82±0.13^{b}	19.17±0.13^{b}	19.44±0.21^{b}	19.20±0.20^{b}
KL (cm)	day-old	M	1.72±0.07^{ns}	1.72±0.08^{ns}	1.66±0.08^{ns}	1.33±0.09^{ns}
		F	1.74±0.10^{ns}	1.68±0.10^{ns}	1.69±0.10^{ns}	1.31±0.11^{ns}
	8 weeks	M	5.79±0.06^{a}	5.55±0.06^{a}	5.53±0.06^{a}	5.14±0.94^{a}
		F	5.26±0.06^{b}	5.13±0.06^{b}	5.05±0.06^{b}	4.80±0.09^{b}
	16 weeks	M	9.82±0.10^{a}	9.67±0.11^{a}	9.55±0.11^{a}	9.84±0.17^{a}
		F	9.14±0.11^{b}	8.85±0.11^{b}	8.81±0.11^{b}	8.69±0.16^{b}
	20 weeks	M	11.92±0.10^{a}	11.66±0.10^{a}	11.44±0.11^{a}	11.38±0.17^{a}
		F	11.17±0.10^{b}	11.02±0.10^{b}	10.77±0.11^{b}	10.66±0.16^{b}

NN = Naked Neck; FR = Frizzle; NM = Normal; WL = White Leghorn, a,b, = means in the same column cell within each genotype with different, superscripts are significantly different (p<0.05). M: Male; F: Female Adedeji, T.A., Dept. of Animal Production and Health, LAUTECH, Ogbomoso, Nigeria

The significant (p<0.05) interaction of sire and sex varied with growth parameters and age of the birds.

DISCUSSION

The significant variations in the body weight and linear body measurements of the resulting progenies arising from the effects of sire genotype are consistent with the report of and[14,15] in which breed differences had significant effect on growth performance of chickens and[16,17] also reported significant difference in the growth performance of different strains of birds. In this study, crossbred chickens were superior in all growth traits to their pure bred White Leghorn counterpart. This is in line with the report of[18] that cross between Creole and RIR were superior to Creole purebred birds. The superior performance of Naked-Neck followed by Frizzle crossbreds in terms of body weight at all ages could be

attributed to their feather structure, which enhances heat dissipation[19,20]. Chickens suffer under high ambient temperature because of their feather coverage and this hinders internal heat dissipation, leading to elevated body temperature[21] and consequently a reduction in feed intake thus ultimately resulting in decrease in growth and meat yield in broilers. In addition[22], attributed the superiority of Naked Necks to reduced feathering with its consequent saving in protein, which could have been used in feather growth. Body weights obtained in this study were lower than what was reported in a crossbreeding experiment involving two local strains of chickens in Egypt[23] and higher than the findings of[24] with Nigeria local chickens.

The variations in the body length of the resulting progenies of the sire strains as obtained in this study are consistent with the report of[25]. The superiority of Naked Neck individuals over others in terms of body length, breast girth and keel length could be due to positive correlations that exist between body weight and other linear body measurements [26]. noted that body weight is a measure of the overall body growth while body growth is the sum total of body components. The significant effect of naked-neck genes on breast meat yield[20] was attributed to lower subcutaneous fat deposition and to increase blood flow in the breast area, which becomes a cooling site because of the marked reduction in its feather coverage. Values reported for breast girth in this study fall within the values reported by[27]. General increase in all body measurement of individuals in each genotype as age increases agrees with the reports of and [1,28] that age is a major determinant of growth and physiological development.

The significant effect of sex on growth traits studied at different ages is in agreement with the findings of [10,29,30,31]. These authors reported the presence of sexual dimorphism in favour of males in the growth performance of strains of bird studied[10,25] attributed it to differences in hormonal profile, aggressiveness and dominance of males when feeding especially when the sexes are reared together. Body weights reported in this study at day-old in both males and females progenies of all genotypes were lower than what was reported by[32] and higher than what[24] reported on Nigeria indigenous chickens. The differences might be as a result of broiler chickens studied by the former and pure local chickens by the latter. The overall dominance of male progenies of Naked Neck followed by Frizzle in all growth traits is an indication that these genes did not improve growth of pullets as they did in cockerels[24] though beneficial to pullets in preventing precocious growth.

The significant effect of interaction of sire and sex on some growth parameters indicated that growth performances of male and female progenies in each sire strain were favoured differently and this can be ascribed to the genetic make-up of the progenies which confers better social dominance on the male progenies than the females.

CONCLUSION

In conclusion, the progenies resulting from the crossbreeding of Naked-neck and White Leghorn and Frizzle with White Leghorn performed better in all the growth traits, therefore, the resulting crossbreds could be improved and adapted to produce better meat than the pure indigenous birds. Therefore, development of the broiler lines within the local stock could be exploited. However, the advantage of the body size of female progenies could be investigated in egg production since various researches have shown that light strain birds are good layers.

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