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PERFORMANCE OF NIGERIAN INDIGENOUS CHICKEN GENOTYPES AND THEIR CROSSES WITH MARSHAL BREED

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ABSTRACT

Background: The population of indigenous chickens has a number of important survival genes to the detriment of productive genes, these can be improved through crossbreeding with improved exotic breeds.
Objectives: This study investigated the growth performance of Nigerian indigenous chicken genotypes and their crossbreds.
Methods: The genotypes are normal-feathered (Nm), frizzle-feathered (Fz) and naked neck (Na) chickens while the crossbreds with Marshal (M) breed were (MNm, MNa and MFz). Data were measured on body weight and growth parameters from day-old to 20 weeks. Data analyses were done using the General Linear Model of Statistical Analysis System.
Results: Results showed that genotype significantly ($p<0.001$) affected body weight and body parameters. At 20 weeks, body weight was 1,792.71±54.66 g, 1,746.15±68.51 g and 1,575.33±28.54 g for MNa, MFz and MNm chickens, respectively. Body weight of indigenous purebred Na, Nm and Fz were 1,726.09±70.42 g, 1,494.08±35.10 g and 1,300.00±78.41 g, respectively. Crossbreds had higher weights (1,641.15±30.66 g) compared with the indigenous purebreds (1,562.77±25.22 g), while Na birds had higher weights than others. Males consistently had higher weights (1,728.49±29.81 g) than their female counterparts (1,518.18±23.28 g). It was observed that, crossbreds generally performed better than indigenous purebreds in growth.
Conclusions: Nigerian indigenous chickens can be improved with Marshal Breed for meat production.

Keywords: Genotypes, Marshal Breed, Crossbreed, Indigenous Chicken, Pure breed

INTRODUCTION

Poultry products are among the most valuable sources of animal protein available for human consumption and they offer means of meeting the animal protein deficiencies gap in Nigeria and many African countries (Akinokun, 1990). In most of these countries, demand for eggs and poultry meat far outweighs supply, as evidenced by steep rises in the prices of these products (Akinokun, 1990). The poultry subsector is ranked best among the fastest growing livestock and animal industry in the world (Belova *et al*, 2012). Poultry birds have been widely reported to possess high degree of efficiency of feed utilisation with little or no socio-religious taboo in their consumption. Poultry meat and egg production accounts for more than 30% of all animal protein (Permin and Perdersen, 2000). Several surveys on local chicken population and production have been carried out and reported from many parts of the world, particularly in African countries. In Africa, rural poultry is believed to be a viable and a promising alternative source of income for rural households (Sonaiya, 1990). The chicken industry in Nigeria is dominated by two distinct categories of stock namely improved (exotic) and unimproved indigenous stock. The population of indigenous chickens has preponderance of survival genes to the detriment of productive genes. These may be partly due to the fact that the birds have not been subjected to adequate genetic selection for increased productivity (Ibe, 1998), but more to natural selection by the adverse environmental conditions.

A number of major genes or gene complexes have been identified in the genome of the native fowl of the tropics (Horst, 1988; Ibe, 1990). Prominent among these are the naked neck, frizzle and silky genes. These genes are propagated naturally in the Nigerian local chicken population, and superior to their normal-feathered counterparts with respect to growth performance.

Genotype and environmental interaction plays major role in the development of local chickens in Nigeria. One of the critical constraints militating against the growth and the development of the chicken industry in Africa is the lack of breeds of chickens that are adapted to traditional small-scale system of production which is prevalent in this region. Several researches have been conducted towards the effective genetic improvement of local chickens by many researchers across the different ecological zones of the country, such as the performance characterisation (Adebambo *et al.*, 1999), and the genetic differences in the performance (Ikeobi *et al.*, 1996). From 1976 to date, research on indigenous poultry had concentrated on the evaluation of the growth characteristics of the local chicken and an array of crossbreds between it and exotic chickens. The genetic bases of heterosis of these crosses were obtained (Ikeobi and Oladotun, 1998; Ikeobi *et al.*, 2001). Experimental results indicated that crossing the exotic cock with local hen would lead to rapid improvement of local chickens especially when the crossbred progeny are housed in laying cages (Omeje and Nwosu, 1982). Omeje and Nwosu (1982), also reported that a crossbreeding programme is a better and faster alternative to selective breeding among local breeds for the genetic improvement of the local chicken in Nigeria.

The current productivity levels of local chickens are low, considering their potentials because of poor management. Adaptability of exotic breeds under the climatic condition of Nigeria is also a major problem, as a result of genotype by environment interaction. Local chickens constitute about 80 – 90% of all birds found in Nigeria (Ikeobi *et al.*, 1996). The Nigerian indigenous chickens are a genomic bank that has not been adequately harnessed despite the tremendous potential for improving and increasing its production through breeding (Horst, 1988). The production of exotic poultry species is unaffordable to many Nigerians, owing to high foreign exchange implication of importing grand-parents (Ibe, 1990). Meanwhile, the indigenous chickens are characterised with low production despite the fact that they are better-adapted and cheaper to raise. It is therefore necessary that a balance between these extremes be attained through crossbreeding.

Materials and Methods

Experimental Site

The breeding unit of the poultry pen of the Teaching and research farm (TREFARD) of the Federal University of Agriculture, Abeokuta, Ogun State was used for this experiment.

Experimental birds

30 pullets from the breeding pen were inseminated to produce day-old chicks of different genotypes containing pure genotypes of normal-feathered chicks, naked neck chicks, and frizzle-feathered chicks. Semen from Marshal Cocks was used to inseminate pure genotypes of frizzle-feathered, normal-feathered and naked neck pullets to produce dihybrids (F1) with 50% Marshal blood and 50% local blood. Records of the sire and dam noted and written on the eggs before taken to the hatchery. After 19 days in the incubator, the eggs were individually placed in partitioned trays before taken to the hatcher, so that each chick can be identified with its sire and dam. All the chicks are from a single hatch. These chicks grew to become pullets and cockerels. These offspring of local chicken genotypes (normal-feathered (Nm), frizzle-feathered (Fz), naked neck (Na), and offspring of their crosses with Marshal (ie MNm, MFz and MNa) were examined for growth performance.

Data Collection

At day-old, the body weight and body parameters (body length, breast girth, wing length, wing span, thigh length, shank length and keel length) of the chicks were taken. This continued every four weeks till 20 weeks of age. The data were classified according to their genotype and age.

Statistical Analyses: Least square means, standard error, heritability, genetic and phenotypic correlation analyses were carried out using SAS (2002) software. Means were separated using Duncan's

Multiple Range Test (DMRT).

Results and discussion

The effects of genotype on growth traits is presented in Tables I - VIII. Genotype significantly affected body weight (P>0.01). Crossbreds generally had higher body weight than the purebreds with marshal x normal having the highest value. 37.77± 0.35g, 37.54±0.64g and 36.64±0.59g for marshal x normal, marshal x frizzle and marshal x naked neck respectively at day-old. The results of this study is higher than the findings of Atansuyi (*et al.* 2022), who reported that day old weights of indigenous chicken was between 25-32 g. At age of 4 weeks, marshal x naked neck which had the lowest value at day-old among crossbreds, had the highest value of body weight and at the end of the experiment (20 weeks). The results of body weight and linear body measurements as affected by genotype showed that the dihybrids had higher weights than the pure genotypes.

The means for breast girth, body length, wing length, wing span, thigh length and keel length as presented in Tables II - VIII showed that crossbreds generally had higher values than their purebred counterparts. This was expected because the Marshal exotic breed used for the experiment had been developed and selected for fast growth and high meat yield. According to Adebambo (2005), crossbreeding indigenous chicken with exotic improved body weight greatly. The performance of crossbreds over the pure indigenous genotype as shown in table IX, was consistent with the results obtained by Peters *et al.,* (2005), whose result showed heterosis in the growth performance of crossbreds used in the experiment. Among the indigenous, the naked neck had higher values for body weight compared with normal-feathered and frizzle-feathered. These results were in consonance with the report of Adeleke *et al*., (2011) who attributed the better performance of pure naked neck to the feather distribution gene (naked neck gene) that was reported to reduce feather mass by 20-40%.

This reduction in feather mass improves the heat dissipation through the naked neck area (Singh et al., 2001).

The results of the present study revealed significant genotype effect on body weight and other linear body measurements of birds. This is expected because of variations in the genetic constitutions of the birds is a major determinant of growth and physiological development. This is consistent with the reports of Adedeji et al. (2015). This current study on the growth performance traits of crossbred chickens produced from Marshal sires and Nigerian indigenous chicken dams affirmed that Naked neck chicken genotype had highest body weight and other body conformations than its counterpart crossbred chicken genotypes. This observation was in line with the earlier documentation of Amao (2020), Assefa and Mellese (2018) and Ojedapo et al. (2018). These authors from their various studies claimed that growth traits of chickens varied based on genetic components of the chickens, with naked neck genotype being the highest.

The increase in body weight and body linear measurements for all the genotype examined from day-old to 20 weeks can be explained from the fact that animal growth involved increase in size and functional capabilities of the various tissue and organs of the animal from conception to maturity. This observation is in agreement with Adedeji et al., (2008).

The effect of sex on body weight and linear body measurements was significant (P>0.05) on all body measurement examined as revealed in Table X. Males consistently had higher body weights, breast girth, body length, and wing length, wing span, thigh length, shank length and keel length from day-old to 20 weeks of age than their female counterparts. This could be attributed to the effect of testosterone, the male sex hormone. The observed difference in favour of males had also been reported by some authors (Peters *et al.*, 2005 and Adedeji *et al.,* 2008). They attributed it to the difference in hormonal profile, aggressiveness and dominance of the males when feeding especially when the sexes are reared together. Atansuyi et al., (2022) attributed this difference in sizes of males and females to a key evolutionary feature that was related to ecology, behaviour and life histories of organisms.

Conclusions

This research was aimed at improving the local Nigerian chicken genotypes (Normal feathered, Frizzled feathered and Naked neck) with Marshall exotic breed. From the results, the growth performance of hybrids were better than that of the pure genotypes while naked neck genotype performed better than the other two genotypes while Sex had effect on the body weight and body parameters of the genotypes studied. Therefore, Nigerian indigenous chickens can be improved with Marshal Breed for meat production.

Table I. Least Square Means for Body Weight ± standard errors (g) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	35.95±0.84[a]	188.08±5.81[c]	550.68±12.12[b]	781.32±16.99[b]	1248.03±27.83[b]	1494.08±35.10[c]
Na	29	36.63±0.78[a]	219.04±6.94[b]	626.88±17.23[a]	856.52±29.71[b]	1411.96±44.56[a]	1726.09±70.2[ab]
Fz	11	30.27±1.40[b]	157.82±8.90[d]	515.45±19.96[b]	695.45±34.68[c]	1111.36±52.59[c]	1300.00±78.41[d]
MNm	82	37.77±0.35[a]	219.58±3.69[b]	533.88±11.80[a]	839.47±16.30[b]	1229.29±22.00[bc]	1575.33±28.54[bc]
MNa	25	36.64±0.59[a]	272.56±8.42[a]	636.46±31.89[a]	947.92±45.86[a]	1417.71±51.06[a]	1792.71±54.66[a]
MFz	13	37.54±0.64[a]	260.00±14.80[a]	650.38±36.10[a]	971.15±37.54[a]	1442.31±63.51[a]	1746.15±68.51[a]

[abcd] Means with the same letter within the same column are not significantly different (P>0.05).

Table II. Least Square Means for Breast girth ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	6.51±0.07[b]	13.25±0.19[c]	21.21±0.32[b]	23.68±0.21[cd]	27.09±0.26[b]	29.26±0.28[bc]
Na	29	6.90±0.09 [a]	13.90±0.21[bc]	22.54±0.36[a]	25.04±0.41[ab]	28.35±0.44[ab]	30.60±0.56[ab]
Fz	11	6.27±0.10[bc]	12.36±0.32[d]	20.37±0.54[b]	22.78±0.34[d]	25.52±0.51[c]	26.65±1.08[c]
MNm	82	6.12±0.05[cd]	14.53±0.10[b]	20.69±0.17[b]	24.28±0.19[bc]	27.41±0.22[b]	30.10±0.26[abc]
MNa	25	6.42±0.08[b]	15.42±0.29[a]	21.29±0.41[b]	25.44±0.40[a]	29.56±0.48[a]	31.23±0.57[a]
MFz	13	5.88±0.15[d]	15.29±0.36[a]	21.42±0.51[b]	25.23±0.35[ab]	29.22±0.59[a]	30.58±0.67[ab]

[abcd] Means with the same letter within the same column are not significantly different (P>0.05)

Table III. Least Square Means for Body length ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	4.90±0.04[ab]	9.07±0.12[c]	13.55±0.19[b]	15.25±0.21[b]	18.09±0.18[ab]	18.63±0.25[ab]
Na	29	5.02±0.04 [a]	9.71±0.14[b]	14.78±0.33[a]	16.91±0.20[a]	18.74±0.29[a]	19.54±0.38[a]
Fz	11	4.73±0.08[b]	8.77±0.19[c]	13.16±0.26[b]	15.50±0.18[b]	17.55±0.53[b]	17.77±0.42[b]
MNm	82	4.90±0.05[ab]	9.64±0.08[b]	13.02±0.10[b]	15.65±0.12[b]	18.18±0.13[ab]	18.68±0.15[ab]
MNa	25	4.43±0.07[c]	10.08±0.17[ab]	13.48±0.21[b]	16.41±0.30[a]	18.63±0.20[a]	18.90±0.24[a]
MFz	13	4.64±0.18[bc]	10.23±0.35[a]	13.04±0.17[b]	16.62±0.29[a]	18.15±0.36[ab]	18.96±0.34[a]

[abc] Means with the same letter within the same column are not significantly different (P>0.05)

Table IV. Least Square Means for Wing length ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	4.46±0.05[ab]	11.66±0.18[bc]	16.94±0.33[b]	20.33±0.18[ab]	21.09±0.24[a]	21.68±0.27[a]
Na	29	4.10±0.05[c]	11.97±0.14[b]	18.23±0.32[a]	20.28±0.29[ab]	21.67±1.15[a]	21.15±0.29[a]
Fz	11	4.27±0.10[bc]	10.91±0.21[c]	16.77±0.67[b]	18.82±0.31[c]	19.18±0.41[b]	20.05±0.46[b]
MNm	82	4.65±0.06 [a]	13.08±0.17[a]	16.52±0.10[b]	19.54±0.13[bc]	21.16±0.13[a]	21.18±0.16[a]
MNa	25	4.50±0.06[ab]	13.52±0.31[a]	17.31±0.22[ab]	20.94±0.28[a]	21.54±0.34[a]	22.00±0.28[a]
MFz	13	4.5±80.15 [a]	13.81±0.50[a]	17.88±0.32[a]	20.28±0.35[ab]	21.54±0.30[a]	21.50±0.62[a]

[abc] Means with the same letter within the same column are not significantly different (P>0.05)

Table V. Least Square Means for Wing span ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	9.99 ± 0.12^{bc}	25.51 ± 0.34^{b}	36.07 ± 0.65^{b}	43.58 ± 0.35^{ab}	45.63 ± 0.46^{ab}	46.49 ± 0.35^{a}
Na	29	9.19 ± 0.10^{d}	25.77 ± 0.31^{b}	38.61 ± 0.65^{a}	43.36 ± 0.62^{ab}	44.80 ± 0.58^{b}	46.13 ± 0.63^{a}
Fz	11	9.82 ± 0.22^{c}	24.08 ± 0.46^{b}	35.55 ± 1.34^{c}	40.00 ± 0.80^{c}	41.41 ± 1.06^{c}	43.36 ± 1.03^{b}
MNm	82	10.78 ± 0.11^{a}	27.99 ± 0.35^{a}	35.03 ± 0.19^{bc}	42.20 ± 0.24^{b}	45.95 ± 0.26^{ab}	47.05 ± 0.33^{a}
MNa	25	10.46 ± 0.14^{ab}	28.80 ± 0.63^{a}	37.02 ± 0.46^{bc}	44.90 ± 0.62^{a}	47.15 ± 0.61^{a}	48.29 ± 0.62^{a}
MFz	13	10.69 ± 0.23^{a}	29.33 ± 1.00^{a}	38.15 ± 0.68^{a}	43.92 ± 0.67^{a}	46.37 ± 0.61^{ab}	46.87 ± 0.79^{a}

[abcd] Means with the same letter within the same column are not significantly different (P>0.05).

Table VI. Least Square Means for Shank length ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	4.17 ± 0.04^{a}	7.72 ± 0.13^{c}	11.12 ± 0.14^{b}	12.96 ± 0.15^{c}	14.41 ± 0.20^{b}	15.02 ± 0.22^{a}
Na	29	4.1 ± 70.05^{a}	7.91 ± 0.12^{bc}	11.70 ± 0.19^{b}	13.65 ± 0.22^{b}	14.62 ± 0.27^{b}	15.26 ± 0.31^{a}
Fz	11	4.10 ± 0.05^{a}	7.05 ± 0.18^{d}	11.05 ± 0.21^{a}	12.55 ± 0.25^{c}	13.59 ± 0.36^{c}	13.73 ± 0.37^{b}
MNm	82	5.1 ± 30.49^{a}	8.55 ± 0.14^{b}	10.79 ± 0.07^{b}	13.71 ± 0.09^{b}	15.11 ± 0.14^{ab}	15.24 ± 0.25^{a}
MNa	25	4.35 ± 0.05^{a}	9.32 ± 0.24^{a}	11.08 ± 0.17^{b}	14.37 ± 0.21^{a}	15.69 ± 0.29^{a}	15.89 ± 0.28^{a}
MFz	13	4.54 ± 0.12^{a}	9.23 ± 0.32^{a}	11.65 ± 0.27^{b}	14.31 ± 0.32^{a}	15.12 ± 0.44^{ab}	15.57 ± 0.42^{a}

[abcd] Means with the same letter within the same column are not significantly different (P>0.05).

Table VII. Least Square Means for Thigh length ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	5.08 ± 0.05^{bc}	9.70 ± 0.18^{abc}	13.41 ± 0.21^{a}	16.61 ± 0.17^{bc}	18.05 ± 0.27^{c}	19.57 ± 0.35^{a}
Na	29	4.92 ± 0.06^{c}	9.97 ± 0.17^{ab}	13.69 ± 0.64^{a}	17.32 ± 0.22^{a}	18.46 ± 0.27^{bc}	20.22 ± 0.39^{a}
Fz	11	5.00 ± 0.08^{c}	9.09 ± 0.35^{c}	13.23 ± 0.37^{ab}	16.14 ± 0.24^{c}	16.95 ± 0.36^{d}	18.22 ± 0.49^{b}
MNm	82	5.56 ± 0.06^{a}	9.56 ± 0.10^{abc}	12.55 ± 0.08^{b}	16.50 ± 0.11^{c}	19.24 ± 0.14^{ab}	19.86 ± 0.18^{a}
MNa	25	5.32 ± 0.07^{ab}	10.12 ± 0.22^{a}	13.40 ± 0.19^{a}	17.19 ± 0.21^{ab}	19.75 ± 0.32^{a}	20.15 ± 0.31^{a}
MFz	13	5.40 ± 0.15^{a}	9.37 ± 0.30^{bc}	13.54 ± 0.28^{a}	17.50 ± 0.30^{a}	19.42 ± 0.48^{a}	19.46 ± 0.50^{a}

[abcd] Means with the same letter within the same column are not significantly different (P>0.05).

Table VIII. Least Square Means for Keel length ± standard errors (cm) as affected by Genotype

Genotype	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Nm	56	0.88 ± 0.02^{a}	4.52 ± 0.06^{c}	7.03 ± 0.06^{c}	8.66 ± 0.08^{b}	10.06 ± 0.10^{a}	11.12 ± 0.12^{ab}
Na	29	0.93 ± 0.02^{a}	4.86 ± 0.08^{b}	7.51 ± 0.12^{ab}	9.36 ± 0.14^{a}	10.41 ± 0.16^{a}	10.90 ± 0.23^{ab}
Fz	11	0.88 ± 0.04^{a}	4.17 ± 0.11^{d}	7.00 ± 0.09^{ab}	8.15 ± 0.14^{c}	9.22 ± 0.18^{b}	9.92 ± 0.36^{c}
MNm	82	1.1 ± 10.12^{a}	4.78 ± 0.05^{bc}	7.17 ± 0.05^{bc}	9.18 ± 0.06^{a}	10.66 ± 0.19^{a}	10.66 ± 0.07^{b}
MNa	25	0.98 ± 0.02^{a}	5.35 ± 0.17^{a}	7.63 ± 0.13^{ab}	9.39 ± 0.15^{a}	10.67 ± 0.17^{a}	11.35 ± 0.16^{a}
MFz	13	0.92 ± 0.04^{a}	5.24 ± 0.19^{a}	7.69 ± 0.22^{a}	9.55 ± 0.16^{a}	10.68 ± 0.17^{a}	11.18 ± 0.21^{ab}

[abcd] Means with the same letter within the same column are not significantly different (P>0.05).

Table IX. Least Square Means ± standard errors of Body Parameters as affected by Crossbreeding

Parameter	Breed	N	Day old	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks
Body weight (g)	Purebred	96	35.57±0.51[b]	214.41±5.82[b]	577.29±8.63	801.17±12.88[b]	1292.55±21.08	1562.77±30.66[b]
	Hybrid	120	37.51±0.28[a]	235.67±4.08[a]	569.07±12.08	877.65±15.99[a]	1293.81±21.41	1641.15±25.23[a]
Breast girth (cm)	Purebred	96	6.57±0.05[b]	13.83±0.15[b]	21.62±0.20[b]	24.09±0.17[b]	27.35±0.20[b]	29.74±0.23[b]
	Hybrid	120	6.16±0.04[a]	14.81±0.11[a]	20.90±0.15[a]	24.64±0.16[a]	28.07±0.21[a]	30.39±0.23[a]
Body length (cm)	Purebred	96	4.92±0.02[b]	9.23±0.08[b]	13.95±0.14[b]	15.80±0.14	18.26±0.13	18.95±0.17
	Hybrid	120	4.77±0.05[a]	9.80±0.08[a]	13.12±0.09[a]	15.92±0.11	18.27±0.11	18.76±0.12
Wing length (cm)	Purebred	96	4.36±0.03[b]	11.94±0.11[b]	17.39±0.20[b]	20.24±0.13	21.05±0.31	21.51±0.17
	Hybrid	120	4.61±0.09[a]	13.26±0.14[a]	16.84±0.10[a]	19.92±0.12	21.29±0.12	21.39±0.13
Wing span (cm)	Purebred	96	9.77±0.07[b]	25.90±0.21[b]	36.95±0.41[b]	43.30±0.27	45.11±0.33[b]	46.56±0.58
	Hybrid	120	10.71±0.33[a]	28.32±0.29[a]	35.81±0.21[a]	42.97±0.25	46.25±0.23[a]	47.29±0.28
Shank length(cm)	Purebred	96	4.17±0.02	7.83±0.08	11.37±0.09[b]	13.25±0.10[b]	14.53±0.33[b]	15.11±0.15[b]
	Hybrid	120	4.91±0.04	8.79±0.11	10.95±0.07[a]	13.92±0.09[a]	15.24±0.13[a]	15.54±0.13[a]
Thigh length (cm)	Purebred	96	5.05±0.03[b]	9.88±0.11[b]	13.50±0.12[b]	16.86±0.11	18.22±0.13[b]	19.82±0.21
	Hybrid	120	5.49±0.04[a]	9.66±0.09[a]	12.84±0.09[a]	16.76±0.10	19.37±0.12[a]	19.88±0.15
Keel length (cm)	Purebred	96	0.89±0.01	4.78±0.06[b]	7.18±0.05	8.85±0.07[b]	10.1±20.07[b]	10.99±0.10
	Hybrid	120	1.06±0.08	4.96±0.06[a]	7.33±0.05	9.27±0.06[a]	10.66±0.14[a]	10.87±0.07

[ab] Means with different letters in the same column are significantly different (P>0.05)

Table X. Least Square Means for Body Parameters ± standard errors as affected by sex

Age (weeks)	N	Sex	Body weight (g)	Breast girth (cm)	Body length (cm)	Wing length (cm)	Wing span (cm)	Shank length (cm)	Thigh length (cm)	Keel length (cm)
0	90	Male	37.24±0.42	6.37±0.06	4.86±0.34	4.53±0.04	10.36±0.10	4.85±0.45	5.33±0.05	1.05±0.11
	126	Female	36.22±0.37	6.32±0.05	4.82±0.04	4.48±0.04	10.24±0.09	4.39±0.03	5.27±0.04	0.94±0.01
4	86	Male	239.53±5.34[a]	14.58±0.14	9.67±0.08	12.85±0.15	27.56±0.31	8.49±0.12	9.94±0.10 [a]	5.00±0.07 [a]
	124	Female	216.70±4.51[b]	14.22±0.13	9.47±0.08	12.53±0.14	27.00±0.27	8.26±0.11	9.63±0.09 [b]	4.79±0.05 [b]
8	86	Male	604.84±12.26[a]	21.67±0.19[a]	13.79±0.14[a]	17.45±0.17[a]	37.08±0.35[a]	11.38±0.08	13.34±0.12[a]	7.35±0.06
	122	Female	550.26±9.26[b]	20.93±0.16[b]	13.34±0.11[b]	16.83±0.14[b]	35.66±0.33[b]	11.15±0.19	12.98±0.10[b]	7.25±0.07
12	86	Male	895.93±16.02[a]	24.84±0.19[a]	16.11±0.14[a]	20.59±0.14[a]	44.10±0.28[a]	14.04±0.10[a]	17.22±0.10[a]	9.27±0.06 [a]
	121	Female	805.25±13.63[b]	24.08±0.15[b]	15.69±0.11[b]	19.69±0.09[b]	42.42±0.22[b]	13.31±0.09[b]	16.52±0.09[b]	8.94±0.06 [b]
16	86	Male	1368.31±24.10[a]	28.32±0.24[a]	18.57±0.12[a]	21.73±0.32[a]	46.70±0.29[a]	15.39±0.13[a]	19.37±0.17[a]	10.66±0.13[a]
	121	Female	1239.88±17.81[b]	27.33±0.18[b]	18.06±0.12[b]	20.79±0.12[b]	45.05±0.25[b]	14.58±0.12[b]	18.48±0.14[b]	10.25±0.11[b]
20	86	Male	1728.49±29.81[a]	30.79±0.24[a]	19.38±0.14[a]	22.15±0.15[a]	48.72±0.30[a]	15.94±0.22[a]	20.70±0.16[a]	11.24±0.08[a]
	121	Female	1518.18±23.28[b]	29.60±0.22[b]	18.46±0.13[b]	20.94±0.13[b]	45.71±0.44[b]	14.80±0.12[b]	19.25±0.16[b]	10.70±0.08[b]

[ab] Means with the same letter within the same column are not significantly different (P>0.05)

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