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EFFECT OF GENOTYPE, SEX AND AGE AND ITS ASSOCIATION BETWEEN BODY WEIGHTS AND BODY MEASUREMENTS IN INDIGENOUS CHICKEN POPULATION

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ABSTRACT

A study was carried out to determine the effect of genotype, sex and age and its association between body weights and body measurements in indigenous chicken population. The parent stocks were sourced from the local markets within Dutsin-Ma and its environs. Each parental genetic group was separated into breeding groups of 1:10 cock to hen, respectively on a deep litter. Performance data of body weight (BW), chest girth (CG), body length (BL), shank length (SL), shank circumference (SL), wing length (WL) and keel length (KL), respectively of 120 progenies generated at 4, 8, 12, 16 and 20 weeks of age were analyzed using Statistical Analysis System (SAS, Version, 9.1). Generally, body increased with age. The overall mean obtained were 659.64 g, 20.93 cm, 22.12 cm, 8.00 cm, 11.93 cm, and 8.24 cm for body weight, chest girth, body length, shank length, wing length and keel length, respectively. The effect of genotype on body weight and body measurements were significant ($P<0.05$). The naked neck chickens had higher values for all the morphological traits, followed by normal and frizzle feathered birds, respectively. Males had significantly ($P<0.05$) higher body weights and body measurements than females. The phenotypic correlations among growth traits were positive moderate, high and significant ($P<0.05$). The estimates ranged from 0.49 to 0.73 between body weight and body measurements. Highest estimates were observed between body weight and chest girth (r_p=0.73) in naked neck chicken. Correlations between sexes were generally high and positive and ranged from 0.61 to 0.77 and 0.56 to 0.70 in males and females, respectively. The highest (r_p=0.77) positive coefficient was recorded between body weight and wing length in males and between body weight and body length (r_p=0.71) in the females. This implies that selection for improvement in the linear body traits could lead to improvement in body weight of these chickens.

Keywords: Genotype, Body weight, Indigenous chicken, Correlation, Sexual dimorphism

INTRODUCTION

Nigeria has estimated 175 million highly heterogeneous chicken population of which indigenous chickens' accounts for more than 60% (Fayeye, 2011). These chickens are largely distributed in rural areas (Ajayi, 2010). The importance of these chickens includes general hardiness, ability to adapt to harsh environments, capable to thrive on little inputs in terms of feed, shelter and medication (Ajayi, 2010). Indigenous chickens, particularly at family level, plays an important role in supplying high quality protein and provision of additional income (Gueye, 2003). They are categorized into varieties such as the normal feathered, frizzled feathered and naked neck (Udoh *et al*., 2012).

The Normal feathered chicken is by far the most common indigenous strain of fowl in Nigeria (Ajayi, 2010). They have straight feather covering the entire skin and are classified into different ecotypes by size and location (Olawunmi *et al*., 2008). A typical normal feathered chicken has a broad breast which is slightly round, its wing could be fairly long or big, fitted close to the body (Crawford, 1990). It has strong scale shank and has four toes, it has a stately vivid posture and are mostly of black, brown and pied colourations. The naked neck gene (Na) is an autosomal, incompletely dominant gene. It causes bare skin on the neck which becomes reddish toward sexual maturity.

The Naked neck birds (Na) allele is associated with increased tolerance for heat, which is probably due to the 30% reduction in overall plumage for heterozygotes and 40% for homozygotes. Generally, the Na gene had a favourable effect on the growth performance of chicken reared under high temperatures (Cahaner *et al*., 1993). Naked neck chickens were reported to have good fertility and hatchability (Fathi *et al*., 2013). The frizzled chicken (F) has an autosomal, incompletely dominant gene. Frizzling appearance can be identified in chicks three to four days after hatching (Galal and Fathi, 2001). The shafts of the contour feathers are curved instead of being straight. The F gene may reduce the heat insulation of feathers by curling and reducing their size. (Fathi *et al*., 2013).

Body weight is used to assess growth in farm animals, in addition, many studies have shown that other growth traits relating to body measurements such as chest girth, shank length and body length, can serve as good indicators of growth (Ige, 2013; Yunusa and Adeoti, 2014). The correlations existing among body weight and body morphometric traits provides important information on the performance, productivity and carcass characteristics of farm animals. According to Onasanya *et al*. (2018) sex is an excellent source of variation for live body weight and other traits of economic importance indigenous chickens. However, there is limited information on the effect of genotype and sex and its association on body weight and body measurements of Nigerian local chicken population. Therefore, this study was designed to determine the effect of genotype and sex and its association with morphological traits of indigenous chicken.

MATERIALS AND METHODS

Experimental Site

The study was conducted at Professor Lawal Abdu Saulawa Livestock Teaching and Research Farm., Poultry Production Unit, Department of Animal Science, Federal University Dutsin-Ma, Katsina State. Dutsin-Ma is located between latitudes 12^0 27' and 22' N, longitudes 7^0 30' and 83' E at an altitude of 605 m above sea level (Bernice *et al*., 2018). It falls within the wet and dry Sudano-Sahelian Savannah belt of Nigeria (Tukur and Kan 2013), and it is characterized by fluctuating climatic and seasonal variations. Furthermore, the area has a short period (4-5 months) of rainfall, usually between June to October having an average rainfall of 700 mm/annum with a long dry season of about 7-8 month. The mean annual temperatures range from 29 to 31 ºC, the high temperature normally occur Apri/May and the lowest in December through February (Abaje *et al.*, 2014). Relative humidity is 64% in August which usually lowers to about 13% in February and March.

Experimental Birds and Management

The parent stocks were sourced from the local markets within Dutsin-Ma and its environs. Each
parental genetic group was separated into breeding groups of 1:10 cock to hen respectively on deep litter. Laying boxes were provided for each pen for natural incubation. Feed and water were provided *ad libitum*. Eggs laid from each mating group of sire were identified. Chicks hatched from each mating group were properly identified (wing tagged) and brooded artificially. The resulting F1 chicks were raised on deep litter using commercial feed to meet their requirement at different stages of their growth. All routine husbandry management practices were adhered strictly and maintained through-out the study period. The birds were vaccinated against the major poultry diseases prevalent in the area.

Data Collection

Body weight (BW) and body measurements such as body length (BL), Chest girth (CG), shank length (SL), Wing length (WL) and Keel length (KL) were measured for each bird from 4 to 20 weeks of age. The body weight of each chicken was recorded individually using a weighing balance and linear body measurements were carried out using a simple tape rule calibrated in centimeters as described by (Adeleke *et al*., 2011).

Chest girth: This was measured as the circumference of the breast region, through the anterior border of the breast bone crest and the central thoracic vertebra.
Body Length: This was obtained through measuring the distance from the base of the neck, through the body trunk to the tip of the pygostyle.
Shank Length: Shank length was taken as the distance between the hock joint and the tarsometatarsus.
Wing Length: This was measured as the distance between the tip of the phalanges and the coracoid-humerus.
Keel Length: This was measured as the length of the sternum.

Statistical Analysis

Growth traits of progenies were analysed using General Linear Model procedure and their means were separated using Duncan's Multiple Range Test with the aid of Statistical Analysis System (SAS, Version 9.1), the model adopted is presented below:

$Y_{ijk} = \mu + G_i + X_j + A_k + e_{ijk}$
Where;
Y_{ijk} = K^{th} individual observation,
μ= overall mean in the population,
G_i = effect of the i^{th} Genotype (Naked neck, Frizzle and Normal Feather)
X_j = effect of J^{th} Sex (1, 2)
A_k = effect of k^{th} age (4, 8, 12, 16 and 20)
e_{ijkl} = residual random error

Pearson's correlation coefficients were estimated between body weight and body linear traits using SAS (Version 9.1). The correlation equation used in this study is expressed as follows;

$$r = \frac{\sum X_i Y_i}{\sqrt{\Sigma X^2 i \ \Sigma Y^2 i}}$$

Where:

r = Pearson's product moment correlation coefficient

X_i = the first random variable of the i^{th} linear body measurement of body weight
Y_i = the second random variable of the i^{th} linear body measurement or body weight

RESULTS AND DISCUSSION

The means of body weights and body measurements of indigenous chickens as affected by different factors are shown in Table 1. The mean values obtained in this study were 659.64 g, 20.93 cm, 22.12 cm, 8.00 cm, 11.93 cm, and 8.24 cm for body weight, chest girth, body length, shank length, wing length and keel length, respectively. The values are close to those reported by Lamido *et al*. (2023) and Adeleke *et al*. (2011) for indigenous chicken population. The effect of genotype on body weight and body measurements were significant (P<0.05). The naked neck chickens had higher values for all the morphological traits, followed by normal and frizzle feathered birds, respectively. This may be due to the fact that the naked neck chickens were larger in size and had heavier muscles as well as longer body parts than the other genotypes. Similar observation was made by Abduraheem *et al*. (2020) on the three strain of local chickens. Therefore, naked neck chickens could be a genotype to be used to improve other indigenous broiler chickens. The effect of sex on growth traits was also significant (P<0.05). Generally, sexual dimorphism was observed among the three genotype due to differential growth rates of the males and females. The sexual dimorphism is explained by the differences in level of male sex hormones which is responsible for greater muscles development in males than in females (Adeleke *et al*., 2011). The aggressiveness of males over the females especially when reared together put the females at a disadvantage for feed and water (Fadare, 2014). Sexual differences in growth traits of local chickens were also observed by Aliyu (2012), Faith *et al*. (2018), Abdulraheem *et al*. (2020) and Lamido *et al*. (2023). The effects of age on body weight and morphometric traits were significantly (P<0.05) different among the genotype and generally increased with age. The results were in line with the results of Lamido *et al*. (2023) who observed progressive increase in growth traits of indigenous normal feathered at different ages. Similarly, Olereforuh-Okoleh *et al*. (2017) worked on a population of normal feathered and naked neck genotypes and observed a more rapid weight gain between 4, 8 and 12 weeks of age.

Variables	Body weight (g)	Chest girth (cm)	Body length (cm)	Shank length (cm)	Wing length (cm)	Keel length (cm)
Overall	**659.64±21.93**	**20.93±0.34**	**22.12±0.34**	**8.00±0.12**	**11.93±0.22**	**8.24±0.19**
Genotype	*	*	*	*	*	*
Frizzle feather	594.47±33.26^{c}	19.29±0.59^{c}	20.82±0.55^{c}	7.77±0.23^{c}	11.23±0.42^{b}	7.97±0.32^{c}
Naked Neck	714.12±41.28^{a}	22.26±0.57^{a}	23.67±0.59^{a}	8.21±0.19^{a}	12.32±0.37^{a}	8.50±0.32^{a}
Normal Feather	670.32±38.19^{b}	21.23±0.59^{b}	21.86±0.61^{b}	8.03±0.21^{b}	12.22±0.38^{a}	8.25±0.32^{b}
Sex by Genotype						
Frizzle Feather	*	*	*	Ns	*	*
Cock	599.24±41.13^{a}	19.58±0.73^{a}	21.00±0.66^{a}	7.83±0.26	11.39±0.53^{a}	8.04±0.41^{a}
Hen	584.92±57.60^{b}	18.71±1.01^{b}	20.47±1.00^{b}	7.65±0.39	10.92±0.68^{b}	7.84±0.50^{b}
Naked Neck	*	*	*	Ns	ns	Ns
Cock	721.00±51.00^{a}	22.49±0.70^{a}	23.94±0.72^{a}	8.26±0.23	12.39±0.46	8.55±0.41
Hen	700.36±71.59^{b}	21.79±1.00^{b}	23.12±1.03^{b}	8.11±0.33	12.18±0.61	8.39±0.55
Normal Feather	*	*	*	*	*	*
Cock	679.20±47.65^{a}	21.50±0.73^{a}	22.07±0.76^{a}	8.13±0.26^{a}	12.37±0.47^{a}	8.45±0.39^{a}
Hen	652.56±64.79^{b}	20.70±1.00^{b}	21.43±1.06^{b}	7.85±0.36^{b}	11.93±0.64^{b}	7.84±0.57^{b}
Age by Genotype						
Frizzle Feather	*	*	*	*	*	*
4	183.13±0.74^{e}	12.79±0.17^{e}	14.65±0.16^{e}	4.65±0.11^{e}	6.45±0.07^{e}	3.79±0.13^{e}
8	386.33±2.49^{d}	16.07±0.20^{d}	17.45±0.19^{d}	7.29±0.15^{d}	8.42±0.12^{d}	6.46±0.08^{d}
12	620.87±4.71^{c}	17.41±0.15^{c}	20.05±0.30^{c}	7.87±0.13^{c}	11.20±0.14^{c}	8.10±0.12^{c}
16	793.93±7.35^{b}	23.97±0.27^{b}	24.52±0.21^{b}	9.33±0.06^{b}	13.85±0.17^{b}	10.09±0.10^{b}
20	988.07±2.75^{a}	26.22±0.18^{a}	27.45±0.19^{a}	9.71±0.05^{a}	16.25±0.17^{a}	11.41±0.20^{a}
Naked Neck	*	*	*	*	*	*
4	211.27±3.31^{e}	15.05±0.11^{e}	16.40±0.10^{e}	5.59±0.05^{e}	8.35±0.04^{e}	4.29±0.06^{e}
8	442.80±1.54^{d}	19.14±0.20^{d}	19.86±0.32^{d}	7.33±0.06^{d}	9.49±0.05^{d}	6.85±0.05^{d}
12	761.67±13.18^{c}	22.15±0.21^{c}	24.45±0.14^{c}	8.44±0.07^{c}	12.63±0.14^{c}	8.57±0.07^{c}
16	946.13±1.93^{b}	26.22±0.11^{b}	27.35±0.15^{b}	9.74±0.07^{b}	14.15±0.10^{b}	10.51±0.07^{b}
20	1208.73±6.04^{a}	28.72±0.16^{a}	30.27±0.21^{a}	9.95±0.09^{a}	17.01±0.10^{a}	12.28±0.06^{a}
Normal Feather	*	*	*	*	*	*
4	198.07±0.84^{e}	13.23±0.11^{e}	14.62±0.11^{e}	5.17±0.07^{e}	7.95±0.07^{e}	4.04±0.16^{e}
8	437.47±2.61^{d}	18.71±0.20^{d}	17.48±0.12^{d}	6.97±0.04^{d}	9.60±0.06^{d}	6.65±0.06^{d}
12	701.53±7.18^{c}	21.88±0.24^{c}	22.23±0.17^{c}	8.60±0.05^{c}	12.53±0.16^{c}	8.55±0.06^{c}
16	884.27±11.54^{b}	24.64±0.17^{b}	26.33±0.16^{b}	9.29±0.07^{b}	14.05±0.09^{b}	10.15±0.07^{b}
20	1130.27±10.03^{a}	27.71±0.26^{a}	28.61±0.25^{a}	10.14±0.10^{a}	16.98±0.14^{a}	11.85±0.23^{a}

Table 1: Means and Standard Error of Means of Body Weight and Morphometric Measurements of three Strain of Indigenous Chickens

^{a,b,c,d,e} Means within the same columns with different superscript are significantly different at * P<0.05 and ns non-significant P>0.05.

The phenotypic correlation coefficients (r_p) for body weight and body measurements of the three strains namely; frizzled feathered, naked neck and normal feathered chickens as shown in Table 2. The correlation coefficients were high, positive and significant. Generally, there were moderate (0.49) and high (0.73) correlations (r_p) between body weights and linear body traits. Similar trend was reported by Abduraheem *et al*. (2020) who reported moderate to high correlations between body weight and body measurements in the three strains of local chickens. Also, Oleforuh-Okoleh *et al*. (2017) observed positive moderate to high estimates between body weight and linear traits ranged 0.20 to 0.82 for indigenous normal feathered chickens.

Table 2: **Phenotypic correlations between morphological traits in three strain of indigenous chicken population**

Traits/Strains	Chest Girth	Body Length	Shank Length	Wing Length	Keel Length
Body Weight					
Frizzle Feather	0.70*	0.66*	0.54*	0.70*	0.63*
Naked Neck	0.72*	0.69*	0.60*	0.70*	0.66*
Normal Feather	0.73*	0.68*	0.71*	0.69*	0.68*
Chest Girth					
Frizzle Feather		0.61*	0.48**	0.62*	0.57*
Naked Neck		0.69*	0.58*	0.61*	0.63*
Normal Feather		0.67*	0.73*	0.63*	0.67*
Body Length					
Frizzle Feather			0.49**	0.66*	0.58*
Naked Neck			0.57*	0.65*	0.68*
Normal Feather			0.70*	0.66*	0.66*
Shank Length					
Frizzle Feather				0.54*	0.49**
Naked Neck				0.52*	0.57*
Normal Feather				0.65*	0.64*
Wing Length					
Frizzle Feather					0.66*
Naked Neck					0.65*
Normal Feather					0.66*

Significant at * $P<0.05$ and ** $P<0.001$

Highest phenotypic correlation estimates were observed between body weight and chest girth (r_p= 0.73), in normal and naked neck birds, followed by shank length (r_p= 0.71) in normal feathered and wing length (r_p= 0.70) in the three strains, respectively. In related study, Oleforuh-Okoleh *et al*. (2017) reported highest phenotypic correlation between body weight and shank length (r_p= 0.91), and between body weight and body length (r_p= 0.94) in normal and frizzled feathered chickens, respectively. Highest correlations between body weight and chest girth (r_p= 0.74), shank length (r_p= 0.61) were observed in Ethiopian native chickens by Bekele *et al*. (2021) which also agree with the findings of this study.

In a related study, Egena *et al*. (2014) recorded a high phenotypic correlation (r_p= 0.71) between body weight and body length in a population of indigenous chickens. Yakubu and Salako (2009) also reported significant and strong correlation between body weight and body length (r_p= 0.85) and shank length (r_p= 0.79) in Arbor broiler chickens. Similar observations were also made by Alabi *et al*. (2012) and Oleforuh-Okoleh *et al*. (2017) for indigenous chickens. Haunshi *et al*. (2012) also observed that strong and positive phenotypic correlations between body weight and shank length of indigenous chickens maintained on free range or semi intensive system of rearing. In related studies, Oyegunle (2013) and Durusaro *et al*. (2016) reported moderate to high phenotypic correlation between different body measurements of indigenous turkey at different ages. This implies that selection for any of these linear body traits will cause direct improvement in body weights of indigenous chicken populations.

Table 3: Phenotypic Correlations Between Morphological Traits (Cocks, above) and (Hens, below) of Indigenous Chicken Population

Traits	Body Weight	Chest Girth	Body Length	Shank Length	Wing Length	Keel Length
Body Weight		0.68	0.74	0.73	0.77	0.72
Chest Girth	0.68		0.67	0.60	0.60	0.61
Body Length	0.71	0.64		0.66	0.65	0.65
Shank Length	0.61	0.59	0.58		0.66	0.70
Wing Length	0.70	0.58	0.61	0.56		0.65
Keel Length	0.69	0.58	0.62	0.56	0.67	

Significant at P<0.05

Correlation estimates between body weight and body measurements for the sexes of indigenous chicken population ranged from moderate to high (Table 3). The values were generally high and positive and ranged from 0.61 to 0.77 and 0.56 to 0.70 in cock and hen, respectively. The highest (0.77) positive coefficient was recorded between body weight and wing length in males and between body weight and body length (0.71) in the females. Body weight had strong and positive correlations with all the morphological traits which is an indication that selection for improvement in the traits could lead to improvement in body weight of the chickens. Generally, coefficients of correlation between morphometric traits in cocks were higher than that of hens.

CONCLUSION

This study concluded that naked neck genotype is superior to normal and frizzled indigenous chickens in terms of body weights and body measurements. Sexual dimorphism was also observed where males had higher values than their female counterpart. Growth traits increased with age. Phenotypic correlations between body weight and body measurements in three genotype were generally positive, significant and were varied from moderate to high. This implies that selection for improvement in the linear body traits could lead to improvement in body weight of the chickens.

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