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Morphometric Characterization of Three Genotypes of Indigenous Chicken Populations in Kano State, Nigeria

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ABSTRACT

The study evaluated the morphometric measurements among three genotypes of indigenous chicken population in Kano state of Northern Nigeria. A total of 249 adult indigenous chickens comprising of 145 males and 105 females at the age of 6 months and above were sampled. The chickens were observed individually for phenotypic expression of feather distribution and structure. Three genotypes recognized are; normal feathered (*NF*), naked neck (*NN*) and frizzle feathered (*Ff*). The chickens were randomly collected from eight locations of the state. Body weight and seventeen (17) morphometric parameters were recorded. Data obtained were subjected to analysis of variance (ANOVA) using the generalized linear model by means of JMP software. The results showed that the average weight of indigenous chicken was 902.88 g. The mean body weights (BW) of male and female chickens were 949.67 g and 882.53 g respectively. The result revealed no significant (P>0.05) difference in BW among the genotypes, but naked neck chicken exhibited significantly (P>0.01) higher comb height (CH) and wattle length (WAL). Positive correlations were recorded between BW and morphometric parameters, with collinearity observed between CH and WAL (r = 0.88). Best regression model for prediction of BW was determined (R^2 = 0.798). It was concluded that naked neck chicken has the highest body weight and other morphometric parameters with economic importance. It is recommended that conservation and improvement strategies be adopted to curb further genetic dilution and erosion.

Keywords: Indigenous chicken, morphometric measurement, genotype, naked neck, frizzle feathered

INTRODUCTION

Chickens (*Gallus gallus domesticus)* are the most numerous and widely raised livestock species globally (FAO 2012). They are believed to have descended from wild Indian and Southeast Asian red jungle fowl thousands of years ago (Hillel *et al*. 2003). About 80% of chickens raised in Africa are indigenous, found in the rural and peri-urban areas in small numbers (Conan *et al*. 2012) under backyard systems. They are generally hardy, survive on little or no inputs and kept majorly by women and children (Gueye 2003). They express various genes: for meat and egg production, heat tolerance, feed efficiency, disease resistance, growth rate, colors, comb type, carcass composition, feather type and other morphological and genomic traits (Dennis *et al*; 2006). They are good mothers and have ability to lay, incubate and hatch their eggs efficiently, therefore are multipurpose.

Nigerian indigenous chickens are criticized for being small-bodied, slow-growth, poor feed converters and poor meat animals (Ajayi 2010) with a total egg production of 40 eggs/year (Ikeobi *et al*. 1996). The sexual maturity of the chickens under scavenging conditions ranges between 133-169 days (Gunn 2008). Factors such as insufficient feed supply, diseases problems and social behavior could be responsible for the variations in the timing of sexual maturity (Ibe 1989). The few eggs laid could be attributed to the extra burden of incubating and hatching, brooding and rearing of chicks (Pym *et al*. 2006). Poultry production is an important economic activity and it is the first source of high-quality protein to rural smallholder families in Africa (Tadelle and Ogle 2001). Chicken meat and egg are source of quality protein and contribute to satisfy nutritional needs of human (Apuno *et al*. 2011). Poultry production contributes significantly to Nigerian economy, providing up to 454 billion tons of meat and 3.8 million eggs per year, with an approximately population of 180 million birds. However, there is concern over the increasing loss of genetic diversity in livestock species, and more than half of common breeds especially poultry are now endangered or at risk of extinction (Dohner 2001; Hoffmann 2005). It has been observed that introducing exotic breeds into traditional and extensive production system can result in loss of genetic diversity in indigenous breeds, due to genome dilution as highlighted by Adeolu and Oleforuh-Okoleh (2014). However, the genetic resources inherent in indigenous chickens will provide basis for genetic improvement and diversification efforts aimed at developing breeds that are adapted to local conditions can be exploited (Sonaiya *et al*. 1999). The aim of the study was to evaluate the morphometric parameters among three indigenous chicken (frizzle feathered, naked neck and normal feathered) populations in Kano state.

MATERIALS AND METHODS

Study Location

Three indigenous chicken genotypes: *NF, Ff* and *NN* were randomly sampled in eight locations of Kano state; Minjibir, Kumbotso, Gezawa, Dawakin kudu, Wudil, Kura, Madobi and Tudun wada LGAs. Kano state is located between latitudes 10˚30'N and 12˚38'N and longitudes 7˚45'E and 9˚29'E as shown in figure 1. The state falls within tropical continental climate implying dry and wet season (Abaje *et al*. 2014). The average monthly minimum and maximum temperature is 18.6ºC and 34ºC, respectively. The total annual rainfall and average relative humidity are 884 mm and 45.4 % respectively (NiMet 2014). The rainfall amount makes the area to possess Sudan Savannah vegetation (Oyewole and Ojeleye 2015). Kano State has a total land area of 42,582.8 km^2, with an agricultural land of 754,200 ha and the forest and grazing land occupy 75,000 ha (African Institute for Applied Economics (AIAE) 2007). The state is located at an elevation of 481m above sea level. The population of the state was 13,076,892 in the year 2016 (NPC 2016). It is well known for its success in crop and animal production. Agricultural activities directly dependent on rain, and during the dry season on irrigation (Moses 2015).

Data Collection

The study was conducted on 249 adult indigenous chickens comprising of 145 males and 105 females between at the age of 6 months and above. The birds were individually observed to assess their phenotypic expression of feather distribution and structure. Frequencies of the genes obtained are 87, 82 and 80 for *NF*, *NN* and *Ff* respectively.

Parameters Measured

Body weight and seventeen (17) morphometric parameters were measured according to (FAO, 2012) guidelines. Body weight was measured using portable electronic weighing scale calibrated in grams (g), while the morphometric parameters were taken using measuring tape in centimeters (cm). The body morphometric measurements include: head length (HDL), comb length (CL), comb height (CH), wattle length (WAL), beak length (BKL), neck length (NL), body length (BL), shank length (SL), drumstick length (DL), drumstick circumference (DC), thigh circumference (TC), shank length (SL), body height (BH), chest circumference (CC) breast muscle (BM) and keel length (KL). Shank circumference (SC) was taken using a vernier callipers. All measurements were taken by the same person to avoid between-individual variations with the help of one assistance.

Study Design

Two hundred and forty-nine (249) birds were randomly selected from three groups (normal feather, naked neck and frizzle feathered) for the study. The study was laid in a Completely Randomized Design (CRD) to analyze the data, with genotype and sex as factors while morphometric measurements as variables.

Statistical Analysis

The data collected for body weight and morphometric were subjected to analysis of variance (ANOVA) using JMP software, version 13. Difference between means were compared by least-significant difference (LSD) on the basis of Tukey-Kramer Honestly Significant Difference (HSD) test for the three genetic groups of chicken and studentized t-test for two sex to determine the least-squares means and standard errors (SE) with mean separation at 5% and 1% levels of significance. Descriptive statistics and Principal component analysis (PCA) were used for possible data reduction. Simple linear regression was used for prediction of body weight. Pearson's coefficients of correlation (r) among body weight and the morphometric parameters were estimated. The appropriate statistical mode used was

$$Y_{ijk} = \mu + A_j + B_j + E_{ijk}$$

Y_{ijk} = observation of the kth chicken populations, of the jth genotype and ith sex

μ = overall mean of population

A_i = fixed effect of Jth genetic groups (*NN*, *NF* and *Ff*)

B_j = fixed effect of ith sex (male and female)

E_{ijk} is the random error.

RESULTSANDDISCUSSION

The descriptive statistics provided in table 1 summarize the values of body weight and morphometric parameters of Indigenous chicken in the studied Area. The result showed that the average weight of indigenous chicken in the studied area is 902.88g. The maximum and minimum value of 1400g and 410g of body weight were recorded and the coefficient of variation of 21.85% was recorded. The average body weight of 902.88g observed in this study was in agreement with earlier reports of (Oluyemi and Roberts 2000) indicating that indigenous chickens are relatively small in size. Momoh and Nwosu (2008) reported a range 680-1,500g for mature body weight of indigenous chicken in the derived savannah agro-ecological zone of Nigeria. Al-Yousef (2007) further mentioned that indigenous chickens are generally small in size. That smaller body weight of the chickens' exhibits smaller changes in body temperature when exposed to acute heat compared to larger body weight birds. This small body weight and size have adapted so well that they are not under thermal straps (Gowe and Fairfull 1995).

Results for shank length, chest circumference and keel length observed in the study were 7.36, 24.82 and 8.71cm respectively as shown in table 1. These values were found to be higher than those reported by Peters *et al*. (2010) but lower than those reported by Daikwo *et al*. (2011) in Nigerian indigenous chickens and in Vietnam indigenous chicken (Bett *et al.* 2014). The overall mean values for various morphometric parameters in the study are lower than those reported by Assefa and Melesse (2018) in Ethiopian indigenous chickens. These differences in morphometric measurements could be attributed to environmental factors, genetic makeup of the birds and feed availability in the ecological niches where the birds are reared (Egena *et al*. 2014).

Table 2 present the effects of genotype on body weight and morphometric parameters. The results revealed that there was no significant (P>0.01) difference observed between the genotypes in terms of body weight. However, the body weight was higher in naked neck (902.64g) than normal (902.20g) and frizzle feathered (875.93g) chicken. No significant (P>0.05) differences were observed in the beak length among the chicken populations. The body weight recorded for *NF*, *NN* and *Ff* chickens were lower than the report of Egena *et al*. (2014) in indigenous chickens. Al-Yousef (2007) mentioned that indigenous chickens are generally small in size. However, Patra *et al*. (2002) found that naked neck chickens tend to have heavier body weights compared to normal and frizzle feathered chickens. Additionally, Galal (2000) reported superiority of naked neck and frizzled over normal feathered chickens in body weight and various morphometric parameters, while Fayeye *et al*; (2006) found frizzle feathered chickens superior to naked neck birds in all the body parameters except for body length and body girth. This is also in line with the report of Ige *et al.* (2012) for Nigerian chicken populations. Rajkumar *et al.* (2011) reported that naked neck chickens had improved body weight over normal feathered chicken in hot climates. Olutunmogun (2015) mentioned that it is expected chickens with *Ff* and *NN* genes to have higher body weights due to the potential for faster growth associated with these genes. However, Yakubu *et al.* (2009) reported no genotype advantage of naked neck under diurnal cyclic temperature conditions.

The result for the effect of sex on body weight and morphometric parameters is shown in table 3 and significant differences were observed in all the morphometric parameters. Male chickens (949.67g) had significantly ($P<0.01$) higher body weight compared to females (882.53g). Wattle length was found higher in male ($P<0.01$) chicken. The male superiority found in these findings align with previous studies by Yakubu *et al*. (2009) Al-Yousef (2007), Hancock *et al*. (1994) and Fayeye *et al*. (2006) in Nigerian indigenous chicken populations, indicating sexual dimorphism in male chickens.

Pool Pearson correlation analysis for all the variables measured in the chicken population was presented in table 4. The result revealed positive and significant correlation between body weight and all the morphometric measurements, except for certain combinations such as CL and BKL, BKL and TL, BKL and TC, BKL and SL, BKL and BH. Collinearity was observed between CH and WAL with a correlation coefficient (r) of 0.88, indicating strong correlation between these parameters. Correlated value of 0.78 was observed between BW and KL, suggesting that improvement in keel length will lead to increase in body weight in indigenous chicken. Many researchers suggested that measuring of these morphometric parameters can predict the body weight (Tadele et al. 2018) due their positive correlation. The results are in accordance with the findings of Ikpeme *et al.* (2016), Faruque *et al.* (2010), Momoh and Kershima (2008). However, Result of Assefa and Melesse (2018) reported correlation value ($r = 0.64$) between BW and CC followed by correlation of 0.63 between BW and WL. Therefore, selecting indigenous chickens based on keel length and chest circumference will invariably improve body weight because of the high and significant relationship.

The result for the principal component analysis is presented in table 5. The table shows the eigen values and shares of total variance along with factor loading of pooled morphometric measurements of the local chickens. The result indicated that five principal components (PC) were extracted. First principal component (PC1) accounted for 36.78%. Furthermore, the result indicated that measurements that contributed significantly were body weight, breast muscle, wattle length, neck length, comb length and body length. Higher communalities observed in this study align with the results of Yakubu *et al.* (2009) and Egena *et al*., (2014). In similar analysis conducted by Ikpeme *et al*., (2016) on Nigerian indigenous chickens found two principal components accounted for 65% and 73.96% of the total variability.

The summary of prediction model for the body weight of chicken populations is presented in table 6. Parameters with higher eigen values were selected for the prediction model. The result showed that all parameters predicted were highly correlated and suited for prediction of body weight in indigenous chicken. The intercept and standardized beta values were represented in the table. Model 6 has highest coefficient of determination ($R^2 = 0.798$). Formulae for body weight prediction in different indigenous breeds were developed by several researchers (Bhakat*et al*; 2008). Henceforth, developing functional regression model to predict body weight using body morphometric parameters is very essential.

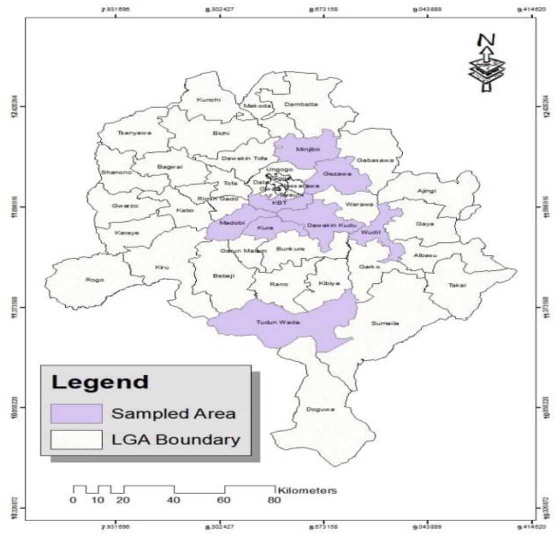

Figure 1: Map of study locations

Figure 4: Frizzle feathered

Figure 2: Naked neck

Figure 3: Normal feathered

Table 1: Descriptive Statistics for Body Weight and Morphometric Parameters of Indigenous Chicken Populations

Morphometric Parameters	Average	Range	Min. Value	Max. Value	Std. Dev	CV%
BW (g)	902.88	990	410	1400	197.24	21.85
HDL (cm)	5.03	3.50	2.50	6.00	0.57	11.33
CL (cm)	4.91	8.70	0.80	9.50	2.01	41.02
CH (cm)	2.66	6.20	0.30	6.50	1.24	46.62
WAL (cm)	2.73	5.40	0.60	6.00	1.25	45.79
BKL (cm)	3.00	1.60	2.00	3.60	0.29	10.62
NL (cm)	10.50	5.20	8.00	13.20	1.04	9.90
BL (cm)	19.91	10.00	15.00	25.00	1.75	8.79
HL (cm)	8.51	6.00	6.00	12.00	1.04	12.22
DL (cm)	11.98	8.00	8.00	16.00	1.37	11.44
DC (cm)	8.45	7.20	3.80	11.00	1.02	12.07
TC (cm)	9.56	7.50	6.00	13.50	1.36	14.23
SL (cm)	7.36	5.20	5.00	10.20	0.99	13.45
SC (cm)	3.56	4.60	0.20	4.80	0.46	12.92
BH (cm)	27.10	21.00	13.00	34.00	2.22	8.19
CC (cm)	24.82	16.00	16.00	32.00	2.70	10.88
BM (cm)	10.48	5.00	8.00	13.00	1.02	9.73
KL (cm)	8.71	3.80	6.80	10.60	0.60	6.89

BW = body weight, HDL = head length, CL = comb length, CH = comb height, WAL = wattle length, BKL = beak length, NL = neck length, BL = body length, DL = drumstick length, DC = drumstick circumference, TC = thigh circumference, SL= shank length, SC = shank circumference, BH = body height, BM = breast muscle, CC = chest circumference.

Table 2: Effects of Genotypes on Body Weight and Morphometric Parameters of Indigenous Chicken Populations

Morphometric Parameters	*NN*	*Na*	*Ff*	SE±	P-value
BW (g)	902.20	902.64	875.93	21.24	0.6090
HDL (cm)	4.88^{b}	5.20^{a}	5.03^{b}	0.074	0.0009*
CL (cm)	5.52^{a}	5.26^{a}	3.52^{b}	0.487	0.1959
CH (cm)	2.49^{ab}	2.86^{a}	2.02^{b}	0.159	0.0004*
WAL (cm)	2.55^{b}	3.06^{a}	3.06^{a}	0.168	<0.0001*
BKL (cm)	3.36	3.36	3.14	0.260	0.8010
NL (cm)	10.58	10.48	10.39	0.152	0.4729
BL (cm)	19.76	19.66	20.17	0.254	0.1301
HL (cm)	8.98^{a}	8.41^{b}	8.33^{b}	0.539	0.5711
DL (cm)	11.86	11.78	12.11	0.155	0.2765
DC (cm)	8.33	8.45	8.39	0.132	0.7394
TC (cm)	9.69	9.78	9.69	0.102	0.4302
SL (cm)	7.04^{b}	7.64^{a}	7.50^{a}	0.164	<0.0001*
SC (cm)	3.62^{a}	3.58^{ab}	3.43^{b}	0.062	0.0218*
BH (cm)	27.07	27.26	26.54	0.283	0.0869
CC (cm)	24.65^{b}	24.65^{b}	23.91^{b}	0.31	0.0002*
BM (cm)	10.46	10.65	10.35	0.150	0.1672
KL (cm)	8.72	8.74	8.58	0.065	0.1575

NN = Naked neck, *Na* = Normal feathered, *Ff* = Frizzle feathered

Table 3: Effects of Sex on Body weight and morphometric parameters of Indigenous chicken Populations

Morphometric Parameters	Sex		SE±	P-value
	♀	♂		
BW (g)	949.67^{a}	882.53^{b}	17.09	<0.0001*
HDL (cm)	5.18^{a}	5.18^{a}	0.065	<0.0001*
CL (cm)	5.37	4.67	0.387	0.2152
CH (cm)	2.85^{a}	2.85^{a}	0.265	<0.0001*
WAL (cm)	2.93^{a}	2.93^{a}	0.133	<0.0001*
BKL (cm)	2.99	3.58	0.206	0.0620
NL (cm)	10.75^{a}	10.21^{b}	0.139	<0.0001*
BL (cm)	20.27^{a}	19.46^{b}	0.315	0.0002*
HL (cm)	8.72	8.42	0.446	0.1464
DL (cm)	12.29^{a}	11.54^{b}	0.128	<0.0001*
DC (cm)	8.69^{a}	8.09^{b}	0.232	<0.0001*
TC (cm)	9.78	9.17	0.0818	0.3102
SL (cm)	7.65^{a}	7.13^{b}	0.154	<0.0001*
SC (cm)	3.65^{a}	3.43^{b}	0.0545	<0.0001*
BH (cm)	27.59^{a}	26.32^{b}	0.248	<0.0001*
CC (cm)	25.32^{a}	24.14^{b}	0.422	0.0005*
BM (cm)	10.65^{a}	10.32^{b}	0.137	0.0101*
KL (cm)	8.83^{a}	8.53^{b}	0.0528	<0.0001*

^{abc} means with different superscripts within the same row are significantly different,

♀ = male, ♂ = female SE= standard error, BW = body weight, HDL = head length, CL = comb length, CH = comb height, WAL = wattle length, BKL = beak length, NL = neck length, BL = body length, DL = drumstick length, DC = drumstick circumference, TC = thigh circumference, SL= shank length, SC = shank circumference, BH = body height, BM = breast muscle, CC = chest circumference

Table 4: Pool Pearson Correlation Analysis of the Measured Morphometric Parameters of Indigenous Chicken Populations

BW	-																	
HDL	0.31**	-																
CL	0.43**	0.31	-															
CH	0.44**	0.22**	0.76**	-														
WAL	0.52**	0.33**	0.75**	0.88**	-													
BKL	0.12**	0.18**	-2.0**	0.12	0.75**	-												
NL	0.53*	0.39**	0.47**	0.49**	0.51	0.27	-											
BL	0.68**	0.41**	0.41**	0.39**	0.49**	0.17**	0.47**	-										
HL	0.65*	0.19**	0.3**	0.42**	0.39**	0.10	0.36**	0.46**	-									
DL	0.43**	0.38**	0.20**	0.39**	0.4**	0.31**	0.44**	0.41**	0.26**	-								
DC	0.61**	0.22**	0.33**	0.40**	0.37**	0.16*	0.36**	0.45**	0.52**	0.38**	-							
TC	0.66**	0.31**	0.51**	0.46**	0.56**	-0.05	0.51**	0.43**	0.50**	0.43**	0.48**	-						
SL	0.26**	0.42**	0.18**	0.09	0.25**	-0.07	0.36**	0.46**	0.09	0.15*	0.06**	0.17**	-					
SC	0.59**	0.37**	0.34**	0.44**	0.48**	-.15*	0.52**	0.48**	0.50**	0.44**	0.39**	0.57**	0.23**	-				
BH	0.44**	0.37	0.40**	0.34**	0.43**	-0.01	0.43**	0.46**	0.22**	0.31**	0.21**	0.38**	0.34**	0.42**	-			
CC	0.62**	0.35**	0.38**	0.36**	0.42**	0.08	0.45**	0.42**	0.35**	0.29**	0.43**	0.49**	0.23**	0.42**	0.54**	-		
BM	0.56**	0.32**	0.47**	0.43**	0.42**	0.30	0.84**	0.49**	0.39**	0.37**	0.39**	0.51**	0.34**	0.48**	0.39**	0.53**	-	
KL	0.78**	0.29**	0.44**	0.37**	0.49**	0.02	0.41**	0.55**	0.56**	0.33**	0.45**	0.55**	0.28**	0.43**	0.46**	0.51**	0.43**	-

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

BW = Boy weight, HDL = Head length, CL = Comb length, circumference, CH = Comb height, WAL = Wattle length, BKL = Beak length, NL = Neck length, BL = Body length, HL = Hip length, DL = Drumstick length, DC = Drumstick circumference, TC = Thigh circumference, SL= Shank length, SC = Shank circumference, BH = Body height, BM = Breast muscle, CC = Chest circumference, KL = Keel length

Table 5: Eigen vectors, Eigen values and Accumulated Variation of the First Five Principal Components (PC) From the Correlated Matrix based On the Studied Indigenous Chicken

Morphometric Traits	PC1	PC2	PC2	PC4	PC5	Communalities
BW (g)	0.830	0.216	0.045	-0.305	-0.02	0.83
HDL (cm)	0.346	0.212	0.535	0.381	0.036	0.59
CL (cm)	0.726	-0.470	0.153	0.171	0.141	0.82
CH (cm)	0.704	-0.336	0.216	0.322	-0.02	0.76
WAL (cm)	0.747	-0.391	0.125	0.257	0.093	0.80
BKL (cm)	0.149	0.720	0.148	0.135	0.117	0.59
NL (cm)	0.735	-0.121	0.119	0.079	-0.36	0.70
BL (cm)	0.713	0.231	0.310	-0.123	0.092	0.68
HL (cm)	0.604	0.198	-0.150	-0.438	-0.175	0.65
DL (cm)	0.448	0.374	-0.171	0.521	-0.280	0.72
DC (cm)	0.531	0.275	-0.278	-0.12	-0.210	0.49
TC (cm)	0.728	-0.131	-0.126	-0.013	-0.15	0.58
SL (cm)	0.324	-0.004	0.784	0.069	-0.014	0.73
SC (cm)	0.666	0.137	-0.009	0.069	-0.062	0.47
BH (cm)	0.497	-0.001	0.210	0.103	0.591	0.65
CC (cm)	0.664	0.071	0.016	-0.217	0.315	0.59
BM (cm)	0.758	-0.008	0.072	-0.018	-0.274	0.66
KL (cm)	0.696	0.115	0.044	-0.338	0.146	0.64
Eigenvalue	7.357	1.851	1.621	1.228	1.060	
% Variance	36.78	9.256	8.104	6.138	5.300	

BW = body weight, HDL = head length, CL = comb length, CH = comb height, WAL = wattle length, BKL = beak length, NL = neck length, BL = body length, HL= hip length, DL = Drumstick length, DC = Drumstick circumference, TC = Thigh circumference, SL= Shank length, SC = Shank circumference, BH = Body height, BM = Breast muscle, CC = Chest circumference, KL = Keel length

Table 6: Stepwise Multiple Regression of the Prediction Model of Body Weight of Studied Chicken Populations

Model	Equation Predictor	Intercept α	Standardized β	Correlation	R^2	Adj R^2	SE
1	Keel length	-1208.23	0.736	0.736	0.542	0.540	133.72
2	Keel length	-1487.42	0.509	0.736	0.662	0.662	115.08
	Body length		0.415	0.694			
3	Keel length	-1402.39	0.356	0.736	0.736	0.733	101.99
	Body length		0.372	0.694			
	Thigh circumference		0.326	0.663			
4	Keel length	-1484.62	0.342	0.736	0.770	0.766	95.41
	Body length		0.297	0.694			
	Thigh circumference		0.281	0.663			
	Drumstick circumference		0.215	0.586			
5	Keel length	-1472.34	0.299	0.736	0.785	0.781	92.40
	Body length		0.279	0.694			
	Thigh circumference		0.257	0.663			
	Drumstick circumference		0.171	0.586			
	Hip length		0.158	0.635			
6	Keel length	-1490.66	0.258	0.736	0.798	0.793	89.79
	Body length		0.265	0.694			
	Thigh circumference		0.224	0.663			
	Drumstick circumference		0.146	0.586			
	Hip length		0.152	0.635			
	Chest circumference		0.146	0.640			

SE = standard error of estimate, R^2 = coefficient of determination

CONCLUSION

The findings of the study concluded that Naked neck chickens are superior to frizzle and normal feathered chickens in terms of body weight and morphometric traits, this is an indication for the breeders that the gene should be preserved from genetic dilution and erosion. The morphometric parameters accounted for PC1 could be used for selection in breeding program to improve the body weight of Nigerian indigenous chickens. This study revealed that body weight and most morphometric traits are genotype and sex dependent, and male was found to be heavier than females within and between genotype.

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