PREDICTION OF BODY WEIGHT AND CARCASS YIELD FROM MORPHOMETRIC TRAITS OF THREE STRAINS OF BROILER CHICKEN

EBONG, Uko Nehemiah, SAM, Idorenyin Meme and ESSIEN, Comfort Abel
Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria.

Corresponding Author: Sam, I. M. Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria. **Email:** sidorenyin@yahoo.com **Phone:** + 234 802 900 4857

Received *August 28, 2023;* ***Revised*** *September 07, 2023;* ***Accepted*** *September 10, 2023*

ABSTRACT

A study was conducted to establish the correlation between morphometric traits and carcass yield as well as predict carcass yield from morphometric traits in three strains of broiler chicken. The morphometric traits studied were Wing length (WL), Keel length (KL), Thigh length (TL), Body girth (BG) and Body height (BH), while the carcass yield were dressed weight (DRSWT), thigh weight (TWT) and breast weight (BRSWT). A total of 144 birds were divided into three treatment groups according to strains and each group was randomly replicated four times with 12 birds per replicate. The data obtained were subjected to correlation analysis, linear and multiple regression analyses were also used to predict body weight and carcass yield from morphometric traits. The results showed that the correlation between body weight, morphometric traits and carcass traits were significantly positive (p<0.001) with correlation coefficient ranging from 0.068 – 0.993, 0.216 – 0.882 and 0.027 – 0.990 in Arbor Acres, Ross 308 and Cobb 500 respectively. The correlation between breast weight and all morphometric traits were positive and significantly high (p<0.001) in all the three strains of broiler studied. suggesting dependency among these traits. Simple linear regression equation predicted carcass yield from morphometric traits in all the three strains, as R^2 value computed using each morphometric trait in the three strains were above 50%. However, inclusion of more than one trait in the regression model increased the accuracy of prediction. It could be recommended that more than one trait should be included in the regression model for greater accuracy.

Keywords: Broiler chicken, Strains, Prediction, Carcass, Morphometric

INTRODUCTION

The cost of animal protein in Nigeria is very high, thus translating to high cost of animal protein. Most Nigerians thus cannot meet the recommended daily dietary animal protein intake. FAO (2011) recommended 70 – 100 g of animal protein intake for growing and developing individuals per day. It has been reported that Nigerians consume only 6 – 8 g of animal protein per day (Iyangbe and Orewa, 2009; De Vries-Ten Have *et al.*, 2020). There has been a call for substantial increase in the intake of protein of animal origin in developing countries like Nigeria. This can be achieved through the production of broiler strains that have fast growth and attain market weight timely (Nosike *et al.*, 2017). Morphometric traits also called linear body measurements or conformation traits are important parameters in predicting body weight and this has been observed by commercial breeders and producers. A number of conformation traits are known to be good indicators of good growth and market value of broiler (Ibe, 1989; Sam *et al.*, 2019). Measurement of morphometric traits such as shank length, keel length, wing span, breast width, body length and body height had been reported to indicate long bones in animals (Amao *et al.*, 2012; Nosike *et al.*, 2017). Combination of body weight and conformation traits in management of poultry birds usually results in maximum economic returns (Adeniji and Ayorinde, 1990).

It has been reported that the association and relationship between morphometric traits and body weight is very important in predicting other characteristics such as carcass and body weight traits (Nosike *et al.*, 2017). The use of this technique will facilitate the evaluation of these traits by simple protocols involving the use of measuring tapes and rulers. These parameters; body weight and carcass traits can be estimated without necessarily slaughtering the birds.

The knowledge of interrelationships among body measurements can be applied in breed selection, breeding, conservation and management of livestock species (Birteeb *et al.*, 2014; Durosaro *et al.*, 2019). Body weight and body conformations are important traits for measuring growth in the domestic chickens. The mechanism involved in the control of growth and formation of muscles in chicken are too complex to be explained only under univariate analysis because all related traits are biologically correlated due to pleiotropic effect of gene and linkage of loci (Rosario *et al.*, 2008). Linear body measurements have been used to predict live weights in poultry (Okon *et al.*, 1997; Sadick *et al.*, 2020). Prediction of body weight and carcass traits from morphometric traits in broilers is very important, however, much more information is needed on the use of morphometric traits to predict carcass yield in broiler chicken. Therefore, the objective of this study was to establish the relationship between body weight, morphometric traits and carcass yield as well as predict body weight and carcass traits from morphometric traits in three strains of broiler chicken.

MATERIALS AND METHODS

Location of the Experiment: This study was carried out at the Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University Obio Akpa. Obio Akpa is located between latitudes 4º30ºN and 5º00N and longitudes 70º30ºE and 80º00E. The area is characterized with an annual rainfall ranging from 3500 – 5000 mm and average monthly temperature of 25 ± 5^{0}C, and relative humidity between 60 – 90 %. It is in the tropical rainforest zone of Nigeria. The people in the study areas depend on livestock and crop production (AKSG, 2022).

Experimental Birds and Management: A total of 144 unsexed day-old broiler chicks comprising 48 each of Arbor Acres, Cobb 500 and Ross 308 commercial strains were purchased from Zactech, Goldsmind and Agrited hatcheries respectively in Oyo State, Nigeria. The birds were allocated into three treatments (according to strain) groups with four replications (12 chicks per replicate) in a completely randomized design (CRD). Each strain was identified by wing tag and assigned to pen in a brooder house. Chicks were brooded for two weeks using 200 watts electric bulb and charcoal stoves as source of heat. After brooding birds were transferred to the rearing house for another six weeks. All necessary routine management practices and the recommended vaccination schedule were strictly observed throughout the period of the study (Aviagen, 2018). All chicks were fed *ad-libitum* with a commercial broiler starter diet (Top Feeds Super Starter, Premiere Feed Mills Company Limited, Nigeria) containing 24% crude protein and 3000 kcal/kg metabolizable energy up to four weeks of age. Thereafter, the birds were given broiler finisher ration (Top Feeds Broiler Finisher, Premiere Feed Mills Company Limited, Nigeria) containing 21% crude protein and 2800 kcal/kg metabolizable energy up to eight weeks. Fresh drinking water was given *ad-libitum* to the birds throughout the experimental period.

Data Collection: At the end of eight weeks data were collected on body weight, morphometric and carcass traits. Live body weight was taken using Camry Mechanical Table Scale (20 kg maximum weight). The linear body measurements were taken in cm using tailor's tape as described by Sam *et al.* (2019) as follows:

Breast girth: This was taken as the circumference of the breast around the deepest region of the breast using measuring tape in cm.

Keel length: This was taken as the length of the sternum.

Shank length: This was measured as the length of the tarsus-metatarsus from the hock joint to the metatarsal pads.

Thigh length: This was measured as the distance between hock joint and pelvic joint.

Wing length: This was measured between the tip of the phalanges and coracoids – humorous joint.

Body length: This was measured as the distance between the base of the neck to the tip of the tail.

Carcass traits: Cut-up parts and organ weight were determined as describe by Sam *et al.* (2010). Two birds from each replicate that is eight birds per treatment and 24 birds all together (birds closest in mean weight per replicate) were selected. The selected birds were fasted overnight and weighed to obtained the live weight thereafter bleed by severing the jugular vein. They were then dipped in hot water and defeathered. The head, neck and shank were removed to have the dressed weight. Dressed weight was taken as live weight minus (weight of the head + shank + feather + visceral content). After taking the dressed weight, the carcasses were cut into parts and weighed using Digital Electronic Laboratory Scale (SF-400C – 500g x 0.01 g) and were expressed in grammes. Breast weight was measured as the weight of the breast, while thigh weight was taken as measured as weight of the thigh.

Statistical Analysis: The degree of correlations between body weight, morphometric traits and carcass yield were obtained using Pearson correlation analysis of SPSS (2011) Version 20. Data of morphometric traits at 8 weeks were regressed against body weight and carcass yield using simple and multiple regression procedure. The linear model used is as follows: Y= a + bx, where y = the dependent variable (carcass yield), a = the intercept of the regression curve on y-axis, b = regression coefficient and x = independent variable (morphometric traits). The multiple regression model used is as follows: $Y= a + bx_1 + bx_2 + bx_3 + bx_4 + bx_5$, where Y = dependent variable (body weight and carcass yield): x_1, x_2, x_3, x_4 and x_5 are wing length (WL), keel length (KL), thigh length (TL), body girth (BG) and body girth (BH): a = the intercept of the regression curve on y-axis; b_1, b_2, b_3, b_4 and b_5 are the regression coefficients associated with the independent variables. The relationship between carcass traits and each of the morphometric traits were also evaluated.

RESULTS AND DISCUSSION

Descriptive Statistics of Body weight, Morphometric Traits and Carcass Yield of Arbor Acres, Ross 308 and Cobb 500: The means, standard deviation and coefficient of variation of body weight, morphometric and carcass yield traits of Arbor Acres, Ross 308 and Cobb 500 strains of broiler chicken are shown in Table 1. The average body weights were 3.01 ± 0.2, 3.02 ± 0.3, 3.42 ± 0.47 kg for Arbor Acres, Ross 308 and Cobb 500 respectively. These values were higher than the values reported by Udeh and Ogbu (2011), who reported body weight of 1.88, 1.81 and 1.65 kg for Arbor Acres, Ross 308 and Marshal Strains respectively. It was also different from the reports of Akanno *et al.* (2007) who reported that broiler birds attains 1300 – 2000 g of body weight between 8 – 10 weeks of age as well as 1951.25 g reported for Arbor Acres at 10 weeks by Sam *et al.* (2010). Sam *et al.* (2019) had earlier reported body weight of 3.00 kg in Arbor

Acres strain of chicken at 8 weeks which was similar to the present report. The differences observed in the different reports on body weight could be due to differences in nutrition, management as well as location of study.

The results also showed low to moderate variability in terms of coefficient of variation (CV) ranging between 0.15 – 23.20%, 7.77 – 27.35% and 1.10 – 49.87% in Arbor Acres, Ross 308 and Cobb 500 respectively. In Arbor Acres strain the lowest CV was obtained for thigh weight, while the highest was obtained in wing weight. In Ross 308, the lowest CV was seen in dressed weight, while the highest was obtained for neck weight. However, in Cobb 500, the lowest CV was obtained in Drumstick while the highest was seen in dressed weight. The implication of the values is that traits with low CV had better accuracy of test compared to traits with high CV as reported by Acourene *et al.* (2001).

Correlation between Body weight, Morphometric Traits and Carcass yield in Arbor Acres, Ross 308 and Cobb 500 broiler strain: The results of correlation coefficient between body weight, morphometric traits and carcass traits of Arbor Acres, Ross 308 and Cobb 500 broiler strain at 8 weeks of age are presented in Table 2. In Arbor Acres strain, the correlation coefficient among body weight, morphometric traits and carcass traits in Arbor Acres ranged from 0.068 – 0.993. There were significant positive ($p<0.001$) correlations among the traits measured. Breast weight had a positive relationship with BWT (0.704), WL (0.635). KL (0.639), TL (0.475) and BG (0.400). Thigh weight also had very high and significant positive ($p<0.001$) correlation with WL (0.766) and TL (0.804). It was observed that the highest correlation coefficient was obtained between BWT and KL (0.993).

In Ross 308, the correlation between body weight, morphometric traits and carcass traits were positive and significant. The correlation coefficient ranged from 0.216 (correlation between BWT and BH) to 0.882 (correlation between TWT and BH). Breast and thigh weights were significantly ($p<0.001$) correlated with all the morphometric traits measured. Body girth had positive and significant ($p<0.05$) correlation with the entire carcass yield measured. Dressed weight also had positive and significant correlation with the entire carcass yield measured. Dressed weight also had positive and significant correlations ($p<0.05$) with all the morphometric traits measured.

When Cobb 500 was considered, it was observed that dressed weight, thigh weight and breast weight were all positively and significantly ($p<0.01$) correlated with all the morphometric traits studied. The correlation coefficient in Cobb 500 ranged from 0.027 (correlation between BH and TL) to 0.990 (correlation between BWT and KL).

The medium to high correlation coefficient between body weight, morphometric traits and carcass traits indicates high correlation between these traits, suggesting that any of these traits could be used to predict the other trait (Adeleke *et al.*, 2004). The medium to high correlation obtained in this study were in agreement with the reports of Adebambo *et al.* (2005). These results also indicated pleiotropic effects, which suggest that the traits were controlled by the same set of genes (Adeleke *et al.*, 2004).

The indication of these results is that the improvement in body weight and morphometric traits will lead to corresponding improvement in carcass yield of these broiler strains. The result of these positive correlation coefficient between body weight and morphometric traits agrees with the findings of Udeh and Ogbu (2011), Udeh *et al.* (2011), Sam *et al.* (2019) who reported positive and high significant ($p<0.01$) among traits within each strain. These results were also in agreement with the report of Ige *et al.* (2016) who observed that body weight was positively and significantly correlated with all body measurements in both male and female Arbor Acres and Hubbard strains.

The positive and significant correlation among carcass traits observed in the three strains of broilers indicates high predictability among the traits. Similar observation was reported by Ajayi *et al.* (2008).

Table 1: Descriptive statistics of body weight, morphometric and carcass traits of Arbor Acres, Ross 308 and Cobb 500 strains of broiler chicken

Traits	Arbor Acres		Ross 308		Cobb 500	
	Mean ± SE	CV	Mean ± SE	CV	Mean ± SE	CV
Body weight	3.01 ± 0.27	8.97	3.02 ± 0.31	10.26	3.42 ± 0.47	13.73
Wing Length	20.17 ± 2.55	12.64	19.53 ± 1.84	9.42	20.27 ± 1.52	7.50
Keel Length	15.5 ± 2.15	13.87	16.34 ± 2.04	12.48	17.45 ± 2.21	12.66
Thigh Length	19.03 ± 2.07	10.88	19.44 ± 2.08	10.70	19.27 ± 2.34	12.14
Shank Length	8.61 ± 1.14	13.24	8.77 ± 1.03	11.74	8.71 ± 0.75	8.61
Body Girth	37.80 ± 4.12	10.90	37.92 ± 3.17	8.35	38.81 ± 2.70	6.96
Body Height	34.23 ± 2.50	7.30	34.92 ± 2.80	8.02	33.79 ± 3.45	10.21
Dressed Weight	1646 ± 230.09	13.98	1692.00 ± 131.45	7.77	1278.5 ± 637.65	49.87
Drumstick	102.50 ± 20.72	20.21	115.25 ± 25.00	21.69	1126.50 ± 12.38	1.10
Thigh weight	264.500 ± 40.39	0.15	262.00 ± 43.59	16.64	236.50 ± 41.30	17.46
Wing weight	198.00 ± 45.95	23.20	198.50 ± 15.07	7.60	213.00 ± 26.56	12.47
Breast Weight	184.00 ± 32.73	17.79	286.00 ± 28.90	10.10	250.50 ± 117.13	41.76
Neck	38.50 ± 5.64	14.65	52.50 ± 14.36	27.35	55.50 ± 11.57	20.85

Table 2: Correlation coefficients between body weight, morphometric and carcass traits Arbor Acres, Ross 308 and Cobb 500 broiler strain

	BWT	WL	KL	TL	BG	BH	DRSWT	TWT	BRSWT
					Arbor Acres				
BWT	1	0.893**	0.993*	0.621*	0.232	0.211	0.068	0.071	0.704*
WL		1	0.676*	0.119	0.837*	0.446*	0.871*	0.766**	0.635*
KL			1	0.337*	0.212	0.430*	0.427*	0.455*	0.639*
TL				1	0.225	0.392*	0.694*	0.804**	0.475*
BG					1	0.504*	0.680*	0.596*	0.400*
BH						1	0.773*	0.525*	0.238
DRSWT							1	0.967**	0.435*
TWT								1	0.558*
BRSWT									1
					Ross 308				
BWT	1	0.285*	0.263*	0.268	0.340*	0.216	0.951**	0.537*	0.586*
WL		1	0.314*	0.502*	0.262*	0293*	0.567*	0.381*	0.932*
KL			1	0.209	0.332*	0.440*	0.201	0.215	0.204*
TL				1	0.871*	0.231	0.461*	0.742*	0.544*
BG					1	0.538*	0.390*	0.829*	0.621*
BH						1	0.779*	0.882*	0.585*
DRSWT							1	0.860**	0.742*
TWT								1	0.327*
BRSWT									1
					Cobb 500				
BWT	1	0.798*	0.990**	0.626*	0.946*	0.133	0.530*	0.920*	0.900*
WL		1	0.641*	0.889**	0.454*	0.214	0.728*	0.417*	0.310*
KL			1	0.382*	0.472*	0.461*	0.224	0.622*	0.936*
TL				1	0.320*	0.027	0.680*	0.746*	0.774*
BG					1	0.795*	0.265	0.575*	0.469*
BH						1	0.308*	0.703*	0.359*
DRSWT							1	0.152*	0.388*
TWT								1	0.622*
BRSWT									1

BWT=Body weight, WL= Wing length, KL= Keel length, TL= Thigh length, BG= Body girth, BH=Body height, DRSWT= Dressed weight, TWT=Thigh weight, BRSWT=Breast weight

Prediction of Body Weight and Carcass Traits from Morphometric Traits in Arbor Acres Strain: The regression equations for predicting body weight and carcass traits from morphometric traits are shown in Table 3.

The values for coefficient of determination (R^2) obtained from predicting live body weight from morphometric traits were 51.19, 50.00, 57.07, 72.23, 71.21, 51.01, 58.30,74.24 and 77.20% for using WL, KL, TL, BG, BH, WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively. These results indicated that in prediction of live body weight that BG contributes 73.23% of variation which was the highest when single traits were used in the model. But when more than one trait was used, the combination of all the five traits (WL, KL, TL, BG, BH) had the highest R^2 that is contributing 77% of variability in body weight. The result from this study indicated that these morphometric traits can be used to predict body weight in Arbor Acres strain of broiler. Nosike *et al*. (2017) had earlier stated that R^2 value above 50% could be used to predict body weight accurately. The results from this study was in agreement with reports of several authors who indicated that morphometric traits were good predictors of body weight in broiler chicken (Ojedapo *et al.,* 2012; Nosike *et al*., 2017; Behiry, 2019).

The values for R^2 obtained when morphometric traits were used to predict dressed weight were 52.23, 61.13, 55.05, 58.01, 54.04, 61.14, 65.50, 66.05 and 71.05% for using WL, KL, TL, BG, BH, WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively. It was observed that the highest R^2 was obtained when KL was used to predict the dressed weight. The variability contributed by KL was 61.13%, when single traits were used but the combination of the traits measured gave the best fit with R^2 value of 71.05%. This report was in agreement with the work of Behiry (2019) who reported that morphometric traits in Arbor Acres strain of broiler chicken predicted carcass weight accurately with R^2 value range of 60 – 80% when single variable were used in the regression model. The authors also reported that there was no improvement in the value of R^2 when more than three body measurements were included in the regression model. This however, was contrary to the present study in which R^2 value increased as more morphometric traits were added to the model. This observation was in agreement with the reports of Shafey *et al.* (2013) who also observed increased in R^2 values as more morphometric traits were included in the regression model.

When morphometric traits were used to predict the thigh weight, the R^2 values obtained were 92.42, 61.10, 53.35, 57.01, 59.02, 61.40, 64.50, 65.10 and 67.02% for WL, KL, TL, BG, BH, WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively; also the WL gave the best fit with R^2 of 62.42%. Also, the combination of all the traits measured (WL, KL, TG, BG, and BH) gave the highest R^2 of 67.02%. This report indicated that any of the morphometric traits can be used to predict thigh weight in Arbor Acres strain of broiler chicken because all the traits included in the model gave R^2 value above 50% as earlier stated by Nosike *et al*. (2017) that R^2 above 50% is a fit. The increase in R^2 as more variable were added to the model was in consonance with the reports of Shafey *et al*. (2013).

When the breast weight was predicted using morphometric traits, the following R^2 values were obtained 56.05, 56.81, 51.10, 61.19, 73.80, 59.90, 61.20, 65.39 and 74.50% for WL, KL, TL,BG, BH,WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively. However, BG gave the best fit with the highest R^2 of 56.05% when individual traits were fitted into the model. However, the combination of all the traits gave the highest R^2 of 74.50%. It was observed that body height best predicted breast weight in Arbor Acres strain of broiler with R^2 value of 73.80 when one morphometric traits were included in the regression model. These findings differed from the reports of Kleczek *et al*. (2006) and Raji *et al*. (2010) who all concluded that body girth or chest girth was the best predictor of breast weight; the differences could be due to strains of birds used in the various studies.

Table 3: Regression equations for predicting live weight, dressed, thigh and breast weights in Arbor Acres

Equation number	Equation	R^2
Live weight		
1.	2.969 + 0.002WL	51.19
2.	3.012 - 4.86KL	50.00
3	2.832 + 0.009TL	57.07
4	2.419 + 0.016BG	73.23
5	2.486 + 0.015BH	71.21
6	2.968 + 0.002WL + 9.85KL	51.01
7	2.762 + 0.004WL + 0.004KL + 0.012TL	58.30
8	2.38 + 0.002WL + 0.008KL + 0.006TL + 0.0166BG	74.24
9	2.294 + 0.003WL-0.15KL + 0.01TL + 0.011BG + 0.013BH	77.20
Dress weight		
1.	1687.98-2.081WL	52.23
2.	1459.62-12.00KL	61.13
3	1763.82-6.189TL	55.05
4	1522.65-3.262BG	58.01
5	1562.19-2.448BH	54.04
6	1491.22-1.486WL + 11.905KL	61.14
7	1712.93-3.548WL + 15.88KL-12.705TL	65.50
8	1636.54-3.548WL + 14.936KL-13.945TL + 3.26BG	66.05
9	1639.64-4.00WL + 15.14KL-13.795TL + 3.418BG-0.420BH	71.05
Thigh weight		
1.	277.96-0.667WL	62.42
2.	233.68 + 1985KL	61.10
3	277.57-0.687TL	53.35
4	236.66 + 0.736BG	57.01
5	232.05 + 0.94884	59.02
6	245.80-0.570WL + 1.945KL	61.40
7	277.16-0.862WL + 2.508KL-1.797TL	64.50
8	259.95-0.957WL + 2.294KL-2.076TL + 0.735BG	65.10
9	255.39-0.900WL + 1.99KL-2.29TL + 0.502BG + 0.618BH	67.0.2
Breast weight		
1.	167.106 + 0.862WL	56.05
2.	200.184 – 1.01KL	56.81
3	214.88-1.596TL	51.10
4	220.257-0.946BG	61.19
5	253.84-2.026BH	73.80
6	182.86 + 0.815WL-0.953KL	59.90
7	204.34 + 0.615WL-0.567KL-1.232TL	61.20
8	223.52 + 0.721WL-0.329KL-0.921TL-0.818BG	65.39
9	299.103 + 0.528WL + 0.708KL-0.158TL-0.025BG-2.112BH	74.50

BWT=Body weight, WL= Wing length, KL= Keel length, TL= Thigh length, BG= Body girth, BH=Body height, DRSWT= Dressed weight, TWT=Thigh weight, BRSWT=Breast weight

Prediction of Body Weight and Carcass Traits from Morphometric Traits in Ross 308 Strain: The prediction equations and R^2 for predicting carcass yield from morphometric traits in Ross 308 are presented in Table 4. The R^2 values recorded for predicting live weight from morphometric traits were 78. 25, 76.30, 78.80, 84.40 and 71.16% for WL, KL, TL and BG and BH respectively with BG having the highest value of 84.40% when single traits were included in the model. This showed that body girth fitted best to the model predicting body weight from morphometric traits of the Ross 308 broiler strains. The findings from this study was in agreement with the reports of Shafey *et al.* (2013) who also worked with Ross 308 broiler strain obtained high R^2 values for predicting body weight from morphometric traits, Nosike *et al.* (2017) also had high R^2 values for predicting body weight from morphometric traits of three strains of broiler chicken at different ages.

Table 4: Regression equations for predicting live weight, dressed, thigh and breast weights Ross 308

Equation number	Equation	R^2
Live weight		
1	2.08 + 0.048WL	78.25
2	2.367 + 0.04KL	76.30
3	2.245 + 0.040TL	78.80
4	1.760 + 0.033BG	84.40
5	2.188 + 0.024BH	71.16
6	1.803 + 0.038WL + 0.029KL	83.38
7	1.307 + 0.037WL + 0.023KL + 0.032TL	89.39
8	0.625 + 0.029WL + 0.011KL + 0.034TL + 0.026BG	96.69
9	0.35 + 0.028WL + 0.004KL + 0.032TL + 0.027BG + 0.012BH	97.25
Dressed weight		
1	1578.78 + 5.794WL	58.18
2	1480.08 + 12.93KL	73.01
3	1565.482 + 6.507TL	70.03
4	1883.205-5.042BG	62.22
5	1757.20-1.867BH	54.40
6	1458.77 + 1.431WL + 12.528KL	72.02
7	1397.11 + 1.282WL + 11.719KL + 4.003TL	71.11
8	1635.05 + 4.050WL + 15.77KL + 3.260TL-9.070BG	79.93
9	1841.29 + 0.426WL + 20.984KL + 4.965TL + 9.556BG-8.905BH	83.25
Thigh weight		
1	204.601 + 2.938WL	62.24
2	186.678 + 4.597KL	71.15
3	242.983 + 0.978TL	54.47
4	277.946 + 0.420BG	53.31
5	250.52 + 0.329BH	52.21
6	164.59 + 1.48WL + 4.176KL	72.23
7	164.609 + 1.483WL + 4.177KL-0.001TL	72.23
8	211.50 + 2.029WL + 4.975KL-0.147TL-1.788BG	75.54
9	248.76 + 248.76WL + 5.917KL + 0.161TL-1.875BG-1.609BH	77.01
Breast weight		
1	289.729-0.191WL	51.12
2	238.615 + 2.892KL	70.04
3	309.24-1.196TL	58.86
4	261.786 + 0.639BG	57.70
5	258.092 + 0.799BH	57.78
6	258.412-1.330WL + 3.269KL	71.19
7	286.652-1.261WL + 3.640KL-1.833TL	75.55
8	284.68-1.262WL + 3.589KL-1.859 + 0.091BH	75.02
9	281.87-1.293WL + 3.54KL-1.844TL + 0.101BG + 0.098BH	79.04

BWT=Body weight, WL= Wing length, KL= Keel length, TL= Thigh length, BG= Body girth, BH=Body height, DRSWT= Dressed weight, TWT=Thigh weight, BRSWT=Breast weight

The results also indicated that R^2 recorded in WL, KL, TL, BG and BH for predicting dressed weight were 58.18, 73.01, 70.03, 62.22 and 54.40% respectively. When more than one morphometric traits were included in the model, it was observed that the R^2 values increased as the number of variables increase as follows: 72.02, 71.11, 79.93 and 83.25% for WL + KL, KL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively. The R^2 values observed in this report is within the values reported by Shafey *et al.* (2013) and the authors also explained that R^2 values is used the measure the goodness of fit in a regression equation.

Similarly, the R^2 relating to thigh weight were 62.24, 71.15, 54.45, 53.31 and 52.21% for WL, KL, TL, BG and BH respectively. When more than one variable was included in the model, R^2 values obtained were 72.23, 72.23, 75.54 and 77.01% for WL + KL, KL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG +

BH respectively. The R^2 values obtained in this study in predicting thigh weight from morphometric traits when all the variables (77.01) were included was higher than the report of Shafey *et al.* (2013) who reported 48.30%. This could be due to the age of the birds used as well as the stage at which the carcass was processed (Musa *et al*., 2006; Ojedapo *et al*., 2008). The R^2 values describing, the accuracy of predicting breast weight from morphometric traits indicated that WL, KL, TL, BG, BH were 51.12, 70.04, 58.86 and 57.70% respectively. Also 71.19, 75.55, 75.02 and 79.04% were R^2 values for WL + KL, KL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively. In all the carcass part studied (dressed weight, thigh weight and breast weight), it was observed that the R^2 values were more than 50% in all the morphometric traits used, suggesting that any of the morphometric traits can be used to predict carcass yield in Ross 308. It is had been reported by Nosike *et al*. (2017) that R^2 value above 50% can be used to accurately predict any parameter.

Prediction of Body Weight and Carcass Traits from Morphometric Traits in Cobb 500 Strain: The R^2 values obtained when morphometric traits were used to predict live weight of Cobb 500 strain were 53.83, 52.02, 57.04, 94.46, 63.13,53.08, 53.90, 69.97 and 97.24% for WL, KL, TL, BG, BH, WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively, with BG having the highest R^2 value of 94.46% when single traits were included in the regression model (Table 5). Similarly, the coefficient of determination values recorded for predicting dressed weight from morphometric traits were 55.05, 67.17, 56.01, 76.05, 55.10, 69.09, 73.28, 86.23 and 92.63% for WL, KL, TL, BG, BH, WL + KL, WL + KL + TL, WL + KL + TL + BG and WL + KL + TL + BG + BH respectively with BG having the highest value 76.05%. This report contradicts the findings of Sadick *et al*. (2020) who found shank circumference to be the best predictor of body weight in Cobb 500 strain of broiler. In the present study BG was the best predictor of live weight when one morphometric trait was included in the model. The difference may be due to age of birds and location of study. These results were agreement with the findings of Behiry *et al.* (2019) that BG was the best predictor of carcass weight in broiler chicken strain used in their study.

The R^2 values recorded for thigh weights were 57.73, 62.20, 54.08, 58.56, 55.06, 63.82, 63.91, 67.02 and 69.01% for WL, KL, TL, BG, BH, WL + KL, WL + KL + TL,WL + KL + TL + BG and WL + KL + TL + BG + BH respectively with KL having the highest value of 62.20%. This implied that KL having the highest R^2 value can be used as a major determinant of the thigh weight of Cobb 500 strain. Limited information is available in literature on the use of morphometric traits to predict thigh weight in Cobb 500 broiler.

Also, the R^2 values recorded for breast weight were 51.03, 65.51, 54.65, 76.34, 63.25, 65.15, 66.05, 83.34 and 85.86% for WL, KL, TL, BG and BH respectively with BG having the highest value 76.34% when single traits were included in the regression model. This implies that the BG having the highest R^2 can be use to determine the live weight, dress weight and breast weight of Cobb 500 strain. The findings of this study were similar to reports of Raji *et al.* (2010) who also observed that breast girth was the best predictor of breast weight in the strain of birds they used. Similar reports were also documented by Zuidof (2005).

Conclusion: The reports from this study showed that significant and positive correlation exists among body weight, morphometric traits and different carcass traits measured. Thus, suggesting that morphometric traits are good indicators for body weight and carcass traits. All morphometric traits in the three strains of broiler chicken studied recorded R^2 values above 50%, which implies that any of the morphometric traits can be used to predict the body weight and carcass yield of the three strains of broiler chicken, although, the accuracy of prediction increased when more than one trait was included in the regression model. It could be recommended that more than one trait should be included in the regression model for greater accuracy.

Table 5: Regression equations for predicting live weight, dressed, thigh and breast weights Cobb 500

Equation number	Equation	R^2
Live weight		
1	3.182 + 0.012WL	53.83
2	3.416 + 0KL	52.02
3	3.707-0.079TL	57.04
4	0.358 + 0.079BG	94.46
5	2.802 + 0.018BH	63.13
6	3.163 + 0.012WL + 0.001KL	53.08
7	3.354 + 0.013WL + 0.008KL-0.018TL	53.90
8	2.628 + 0.024WL-0.009KL-0.025TL + 0.028BH	69.97
9	-0.301 + 0.007WL-0.002KL-0.013TL + 0.078BG + 0.025BH	97.24
Dressed weight		
1	841.807 + 21.54WL	55.05
2	378.387 + 51.558KL	67.17
3	1598.87-16.625TL	56.01
4	3701.169-62.420BG	76.05
5	2215.847-27.739BH	55.10
6	-187.83 + 26.832WL + 52.83KL	69.09
7	264.38 + 29.90WL + 70.13KL-42.371TL	73.28
8	2824.26 + 42.74WL + 66.17KL-52.27TL-65.96BG	86.23
9	3915.22 + 25.23WL + 94.29KL-39.50TL-63.11BG-46.81BH	92.63
Thigh weight		
1	170.677 + 3.247WL	57.20
2	260.267-1.361KL	62.73
3	252.853-0.849TL	54.08
4	285.73-1.269BG	58.56
5	259.292-0.674BH	55.06
6	194.30 + 3.126WL-1.212KL	63.82
7	199.97 + 3164WL-0.995KL-0.531TL	63.91
8	265.23 + 3.492WL-1.096KL-0.784TL-1.681BG	67.02
9	263.66 + 3.51WL-1.136KL-0.802TL-1.68BG + 0.067BH	69.01
Brest weight		
1	17.850 + 11.47WL	51.03
2	239.490 + 0.631KL	65.51
3	291.55-2.130TL	54.65
4	702.542-11.647BG	76.34
5	405.291-4.581BH	63.25
6	-5.210 + 11.596WL + 1.183KL	65.15
7	28.814 + 11.827WL + 2.484KL-3.188TL	66.05
8	535.209 + 14.366WL + 1.703KL-5.147TL-13.049BG	83.34
9	636.58 + 12.73WL + 4.315KL-3.969TL-12.784BG-4.350BH	85.86

BWT=Body weight, WL= Wing length, KL= Keel length, TL= Thigh length, BG= Body girth, BH=Body height, DRSWT= Dressed weight, TWT=Thigh weight, BRSWT=Breast weight

ACKNOWLEDGEMENTS

The authors acknowledged the of Head of Poultry Unit and the entire staff of poultry unit Department of Animal Science, Akwa Ibom State University for their cooperation throughout the duration of this study.

REFERENCES

ACOURENE, S., BELGUEDJ, M., TAM, M. and TALEB, B. (2001). Caractérisation, évaluation de la qualité de la datte et identification des cultivars rares de palmier dattier de la région des Ziban. *Recherche Agronomique,* 5(8): 19 – 39.

ADEBAMBO, A. O., FAYBENVO, O. I., FRAGITE, S. O., IKEOBI, C. O. N. and ADEBAMBO, O. A. (2005). Preliminary assessment of growth and reproductive data of three strains of chickens' broiler development in Nigeria. *In: Proceeding of International Poultry Summit,* Ota, Ogun State, Nigeria.

ADELEKE, M. A., OZOJE, M. O., OLUFUNMILAYO, A. A., PETERS, S. O. and BAMGBOSE, A. M. (2004). Estimation of body weight from linear body measurements among crossbred egg-type chickens. Pages 88 – 91. *In: Proceedings of the 29th Annual Conference of the Genetics Society of Nigeria,* University of Agriculture, Abeokuta.

ADENIJI, F. O. and AYORINDE, K. L. (1990). Prediction of body weight of broilers at different ages from linear body measurements. *Nigerian Journal of Animal Production*, 17: 42 – 47.

AJAYI, F. O., EJIOFOR, O. and IRONKWE, M. O. (2008). Estimation of body weight from linear body measurements in two commercial meat-type chicken. *Global Journal of Agricultural Sciences*, 7(1): 57 – 59.

AKANNO, E. C., OLE, P. K., OKOLI, I. C. and OGUNDU, U. E. (2007). Performance Characteristics and Prediction of body weight of broiler strains using linear body measurements. Pages 162 – 164. *In: Proceeding of the 2nd Annual Conference of Nigerian Society of Animal Production*, Calabar, 18 – 22 March 2007.

AKSG (2022). *Akwa Ibom State: Geography and Location*. Akwa Ibom State Government. https://www.aksgonline.com/aboutgeography.html September 22, 2022.

AMAO, S. R., OJEDAPO, L. O., OYEWUMI, S. O. and OLATUNDE, A. K. (2012). Body Conformation characteristics of Marshall strain of commercial broiler chickens reared in derived savanna environment of Nigeria. Pages 1 – 3. *In: Proceedings of the 37th Nigerian Society of Animal Production Conference,* University of Agriculture, Makurdi, Benue State, Nigeria, 18th – 21st March 2012.

AVIAGEN (2018). *Arbor Acres Broiler Management Handbook.* Aviagen.com. https://aviagen.com/assets/Tech_Center/AA_Broiler/AA-BroilerHandbook2018-EN.pdf

BEHIRY, F. M. (2019). Using some body measurements as predictors of live body weight and carcass traits in four broiler strains. *Egyptian Poultry Science Journal*, 39(4): 835 – 849.

BIRTEEB, P. T., PETERS, S. O. and OZOJE, M. O. (2014). Analysis of the body structure of Djallonke sheep using a multideterminant approach. *Animal Genetic Resources /Resources Génétiques Animales /Recursos Genéticos Animales*, 54: 65 – 72.

DE VRIES-TEN HAVE, J., OWOLABI, A., STEIJNS, J., KUDLA, U. and MELSE-BOONSTRA, A. (2020). Protein intake adequacy among Nigerian infants, children, adolescents and women and protein quality of commonly consumed foods. *Nutrition Research Reviews*, 33(1): 102 – 120.

DUROSARO, S. O., ILORI, B. M., AJANI, A. O. and OZOJE, M. O. (2019). Description of body conformation of Nigerian indigenous Turkeys using exploratory factor analysis. *Nigerian Journal of Animal Science*, 21(2): 30 – 38.

FAO (2011). Dietary protein quality evaluation in human nutrition: report of an FAO expert consultation. *FAO Food and Nutrition Paper,* 92: 1 – 66.

IBE, S. N. (1989). Measures of size and conformation in commercial broilers. *Journal of Animal Breeding and Genetics*, 106(1-6): 461 – 469.

IGE, A. O., MUDASIRU, I. T. and RAFIU, B. R. (2016). Effect of genotype on growth traits characteristics of two commercial broiler chickens in a derived savannah zone of Nigeria. *International Journal of Research Studies in Agricultural Sciences,* 2: 26 – 32.

IYANGBE, C. O. and OREWA, S. I. (2009). Determinants of daily protein intake among rural and low-income urban households in Nigeria. *American-Eurasian Journal of Scientific Research*, 4(4): 290 – 301.

KLECZEK, K., WAWRO, K., WILKIEWICZ-WAWRO, E. and MAKOWSKI, W. (2006). Multiple regression equations to estimate the content of breast muscles, meat, and fat in Muscovy ducks. *Poultry Science*, 85(7): 1318 – 1326.

MUSA, H. H., CHEN, G. H., CHENG, J. H., LI, B. C. and MEKKI, D. M. (2006). Study on carcass characteristics of chicken breeds raised under the intensive condition. *International Journal of Poultry Science*, 5(6): 530 – 533.

NOSIKE, R. J., ONUNKWO, D. N., OBASI, E. N., AMADURUONYE, W., UKWU, H. O., NWAKPU, O. F., EZIKE, J. C. and CHIJIOKE, E. I. (2017). Prediction of body weight with morphometric traits in some broiler chicken strains. *Nigerian Journal of Animal Production*, 44(3): 15 – 22.

OJEDAPO, L. O., AKINOKUN, O., ADEDEJI, T. A., OLAYENI, T. B., AMEEN, S. A. and AMAO, S. R. (2008). Effect of strain and sex on carcass characteristics of three commercial broilers reared in deep litter system in the derived savannah area of Nigeria. *World Journal of Agricultural Sciences*, 4(4): 487 – 491.

OJEDAPO, L. O., AMAO, S. R., AMEEN, S. A., ADEDEJI, T. A., OGUNDIPE, R. I. and IGE, A. O. (2012). Prediction of body weight and other linear body measurement of two commercial layer strain chickens. *Asian Journal of Animal Sciences*, 6(1): 13 – 22.

OKON, B., OGAR, I. B. and MGBERE, O. O. (1997). Interrelationships of live body measurements of broiler chickens in a humid tropical environment. *Nigerian Journal of Animal Production*, 24(1): 7 – 12.

RAJI, A. O., IGWEBUIKE, J. U. and KWARI, I. D. (2010). Regression models for estimating breast, thigh and fat weight and yield of broilers from non invasive body measurements. *Agriculture and Biology Journal of North America*, 1(4): 469 – 475.

ROSARIO, M. F., SILVA, M. A. N., COELHO, A. A. D., SAVINO, V. J. M. and DIAS, C. T. D. S. (2008). Canonical discriminant analysis applied to broiler chicken performance. *Animal*, 2(3): 419 – 424.

SADICK, A. M., ARYEE, G., JNR, P. A. P. and KYERE, C. G. (2020). Relationship between body weight and linear body measurements in the Cobb broiler chicken. *World Journal of Biology Pharmacy and Health Sciences*, 4(2): 001 – 006.

SAM, I. M., AKPA, G. N., ALPHONSUS, C. G., IYEGHE-ERAKPOTOBOR, I. and AGUBOSI, O. C. P. (2010). Effect of sex separation on growth performance and carcass characteristics of broilers raised to maturity. *Continental Journal of Animal and Veterinary Research*, 2(1): 35 – 40.

SAM, I. M., ESSIEN, C. A., UKPANAH, U. A. and EKPO, J. S. (2019). Influence of sex on relationship between morphometric trait measurement and carcass traits in broiler chicken raised in humid tropic. *Journal of Animal and Veterinary Advances*, 18(11): 309 – 314.

SHAFEY, T. M., ALODAN, M. A., HUSSEIN, E. O. S. and AL-BATSHAN, H. A. (2013). The effect of sex on the accuracy of predicting carcass composition of Ross broiler chickens. *The Journal of Animal and Plant Sciences*, 23(4): 975 – 980.

SPSS (2011). *Statistical Package for Social Sciences.* SPSS Version 20, IBM incorporated, 444 North Michigan Avenue, Chicago, IL60611, USA.

UDEH, I. and OGBU, C. C. (2011). Principal component analysis of body measurements in three strains of broiler chicken. *Science World Journal*, 6(2): 11 – 14.

UDEH, I., ISIKWENU, J. O. and UKUGHERE, G. (2011). Performance characteristics and prediction of body weight using linear body measurements in four strains of broiler chicken. *International Journal of Animal and Veterinary Advances*, 3(1): 44 – 46.

ZUIDHOF, M. J. (2005). Mathematical characterization of broiler carcass yield dynamics. *Poultry Science*, 84(7): 1108 – 1122.