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RELATIONSHIP BETWEEN BODY WEIGHT AND LINEAR BODY MEASUREMENTS IN MATURED MUSCOVY AND KHAKI CAMBELL DUCKS

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ABSTRACT
The study was conducted at Bauchi local government area of Bauchi state, Nigeria to determine the relationship between body weight and body linear measurements in two breeds of ducks. Data on 150 ducks comprising 78 (fourty male and thirty-eight female) Muscovy and 72 (thirty-two male and fourty female) Khaki Campbell were obtained and subjected to analysis of variance, Pearson correlation and regression analysis. Significant ($P < 0.001$) effects of breed and sex on body weight and body linear measurements were detected. Muscovy duck had higher values in all the parameters compared to khaki Campbell. Males exhibited higher values among the parameters measured than their female counterpart. Most of the correlation coefficients among body weight and linear body measurements were strong positive and significant. The most reliable prediction from regression analysis was between body weight and body length + chest width + chest circumference ($R^2 = 0.919$). The research has shown that body linear measurements could be used to predict body weight in matured ducks. Under field conditions, body length, chest width and chest circumference can be combined in a multiple regression equation to predict the body weight of mature ducks with some level of accuracy.

Keywords: Breed, Ducks, Muscovy, Khaki Cambell Body weight, Body Linear Measurement

Introduction
There is continues increased demand for animal protein to meet the nutritional requirements of growing world population of humans. Increased duck rearing would be a great supplement to total poultry production. The relationship existing among body characteristics provide useful information on performance and that these quantitative measures of size and shape are necessary for estimating genetic parameters in animal (Chineke *et al.,* 2002). correlation between weight and body measurement can be used for assessment and selection of body weight (Raji *et al.,* 2009). Therefore, this study is aimed to determine the relationship between body weight and linear body measurements among two breeds of ducks reared under the Nigeria environmental conditions.

Materials and Method
Description of Study Location
This study was carried out in Bauchi local government area of Bauchi State, Nigeria. Bauchi is located between latitude 10.18^o and 57.00^o N of the Equator. Longitudinally, longitude 9.50^o and 39.00^o E of the Greenwich. the climatic condition of the area is characterized by two distinct seasons, dry and wet. It receives rains late, usually around May or June and the average rainfall is about 1091.4mm per annum (BASADP, 2007)

Management of Ducks
The ducks were managed extensively. They are allowed roam freely during the day and scavenge for food and sometime their meals are supplemented with kitchen wastes.

Data Collection

Measurements on body weights (BW) and body linear measurements (BLM) of 150 ducks comprising 78 Muscovy and 72 khaki Campbell were collected within Bauchi local government area. Using a weighing scale, the BW of matured ducks were individually taken in kilograms (kg). The measurements of various body components of matured ducks were taken using a measuring tape calibrated in centimeters (cm). The parameters taken were body length (BL), chest girth (CG), chest width (CW), femur length (FL), femur circumference (FC), metatarsus length (ML), metatarsus circumference (MC), beak length (BKL) and wing length (WL).

Statistical Analysis

Data collected were analyzed using general linear model of SPSS version 25 (2017). Effect of breed and sex on BW and body BLM were determined. Significantly different means were compared using the Duncan multiple range test (DMRT). Pearson correlation analysis was used to determine the relationships among BW and BLM. Separate models (Linear and Multiple) for body measurements singly and combined were enumerated. The regression model adopted was as follows:

$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$, Where Y = body weight (kg), X_1 to X_3 = body measurements, a = Intercept b (1-3) = regression coefficients of Y on X (i = 1, 2, 3).

Effect of Breed on Body Weight and Body Linear Measurement

Effect of breed on BW and BLM are presented in Table 1. Significant ($P< 0.001$) effect of breed on BL, BW, CW, CG, FL, FC, ML, MC, BKL and WL was noticed. Muscovy duck recorded the higher values in all the parameters recorded except BKL in which the higher value was observed among Khaki Campbell. The observed influence of breed in current study is in line with the findings of Purwantini *et al*. (2013) who reported the effect of breed on BW and BLM among ducks. This may be attributed to the genetic differences among the birds. However, the result contradicts the findings of Padhi (2010) who noticed non-significant effect of genotype between pure and crossbreeds.

Effect of sex on body weight and body linear measurement of duck

Means and standard error of the effect of sex on BW and BLM of ducks are presented in Table 2. The duck exhibited a high degree of sexual dimorphism. The drakes were superior ($P < 0.001$) to the ducks for BW and all the body characteristics recorded. The average BW for males and females were 2.60kg and 2.02kg respectively. Higher BW and BLM in drakes than ducks in the present study agreed with the finding of Raji *et al.*, (2009) and Taguia *et al.*, (2007) who reported sexual dimorphism in favour of drakes. This may be attributed to the differential hormonal action between the sexes which invariably leads to differential growth rates (Baeza *et al*., 2001).

Table 1: Effect of breed on body weight and linear measurement of duck

	BREEDS		
	Muscovy	**Khaki Campbell**	**LOS**
BW	2.58±0.07[a]	1.85±0.30[b]	***
BL	45.26±0.87[a]	40.31±0.26[b]	***
CW	25.35±0.20[a]	18.52±0.12[b]	***
CG	39.06±0.54[a]	28.49±0.19[b]	***
FL	12.31±0.13[a]	10.39±0.09[b]	***
FC	11.16±0.16[a]	9.17±0.12[b]	***
ML	5.50±0.11[a]	4.54±0.04[b]	***
MC	4.79±0.07[a]	3.86±0.02[b]	***
BKL	5.54±0.07[b]	6.29±0.06[a]	***
WL	30.88±0.26[a]	25.41±0.16[b]	***

*** = Significant (P< 0.001) CG = Chest Circumference CW = Chest width ML = Metatarsus length BL = Body length MC = Metatarsus circumference BKL = Beak length FL = Femur length BW = Body weight WL = Wing length FC = Femur circumference

Table 2: Effect of sex on body weight and body linear measurement of duck.

	SEX		
	Male	Female	LOS
BW	2.60±0.99[a]	2.02±0.23[b]	***
BL	46.95±0.97[a]	39.97±0.26[b]	***
CW	23.68±0.49[a]	21.50±0.38[b]	***
CG	38.03±0.94[a]	31.76±0.42[b]	***
FL	12.42±0.18[a]	10.72±0.09[b]	***
FC	11.38±0.20[a]	9.42±0.10[b]	***
ML	5.73±0.12[a]	4.55±0.03[b]	***
MC	4.80±0.09[a]	4.10±0.04[b]	***
BKL	6.19±0.06[a]	5.60±0.08[b]	***
WL	30.30±0.42[a]	27.14±0.30[b]	***

*** = Significant (P< 0.001) CG = Chest Circumference CW = Chest width ML = Metatarsus length BL = Body length MC = Metatarsus circumference BKL = Beak length FL = Femur length BW = Body weight WL = Wing length FC = Femur circumference

Correlation between Body Weight and Body Measurements

Correlation coefficients of body weight and linear measurements of local ducks are presented in Table 3. Positive and significant (P < 0.01) correlations were observed. The association among the parameters ranged from 0.57 (between CW and WL) to 0.95 (between ML, BW, CC, FC and BKL). The highest correlation value (0.95) was between BL and CG and ML while the least (0.57) was between WL and CW. The result is in agreement the with findings of Raji *et al,* (2009) who reported high and positive correlation between linear measurements and body weights among Muscovy ducks and Ogah (2011) who observed strong and positive correlation between body weight and body linear measurement in turkey.

Regression Analysis

Table 4 presented the regression equations and coefficient of determination (R^2) of linear measurements of local ducks. The R^2 values observed in this study ranged from 0.485 to 0.919. The highest value (0.919) was obtained when BL and CW and CG were combined in a multiple regression equation. The least R^2 (0.485) value was determined between BW and BL. When used singly, CG had the highest R^2 of 0.899 followed by ML and FL (R^2 = 0.897 and 0.886). Raji *et al.* (2009) and Tulki (2017) reported similar findings among Muscovy ducks and Turkish geese. The higher association of body weight with chest girth was possibly due to relatively large contribution to body weight by chest girth consisting of bones, muscles and viscera (Raji *et al.,* 2009).

Table-3. Correlation between Body Weight and Body Linear Measurements among Two Breeds of Ducks.

Parameter	BW	BL	CW	CC	FL	FC	ML	MC	BKL	WL
BW										
BL	0.70**									
CW	0.74**	0.58**								
CC	0.95**	0.66**	0.70**							
FL	0.94**	0.62**	0.72**	0.94**						
FC	0.93**	0.63**	0.65**	0.95**	0.92**					
ML	0.95**	0.66**	0.65**	0.95**	0.91**	0.95**				
MC	0.91**	0.64**	0.68**	0.91**	0.86**	0.90**	0.90**			

Variable	Regression equation	R^2	LOS	SE of estimate
BL	Y = 0.37 + 0.056 BL	0.485	**	0.444
CW	Y = -4.131 + 0.265 CW	0.550	**	0.415
CC	Y = -2.210 + 0.123 CC	0.899	**	0.197
FL	Y = -3.482 + 0.492 FL	0.886	**	0.209
FC	Y = -1.942 + 0.405 FC	0.859	**	0.233
ML	Y = -0.858 + 0.624 ML	0.897	**	0.199
MC	Y = -2.113 + 0.978 MC	0.832	**	0.254
BKL	Y = -2.752 + 0.961 BKL	0.855	**	0.234
WL	Y = -3.584 + 0.199 CW	0.538	**	0.420
CC, FL	Y = -2.925 + 0.071 CC + 0.223 FL	0.917	**	0.181
FC, ML	Y = -1.253 + O.121 FC + 0.451 ML	0.904	**	0.193
MC, BKL	Y = -2.779 + 0. 563 MC + 0.566 BKL	0.898	**	0.199
BL, CW	Y = -3.492 + 0.032 BL + 0.182 CW	0.657	**	0.365
BL, CC	Y = -2.254 + 0.011 BL + 0.111 CC	0.909	**	0.188
CC, CW	Y = -3.065 + 0.108 CC + 0.055 CW	0.911	**	0.186
BL, CW, CC	Y = -2.965 + 0.008 BL + 0.047 CW + 0.102 CC	0.919	**	0.177

BKL	0.93^{**}	0.62^{**}	0.67^{**}	0.95^{**}	0.91^{**}	0.94^{**}	0.92^{**}	0.88^{**}	
WL	0.73^{**}	0.60^{**}	0.57^{**}	0.79^{**}	0.69^{**}	0.74^{**}	0.81^{**}	0.68^{**}	0.78^{**}

** = Significant (P< 0.01) CC = Chest Circumference CW = Chest width ML = Metatarsus length BL = Body length MC = Metatarsus circumference BKL = Beak length FL = Femur length BW = Body weight WL = Wing length FC = Femur circumference

Table 4: Regression equations and coefficient of determination (R^2) of body weight and body linear measurements of ducks.

** = Significant (P< 0.01) CC = Chest Circumference CW = Chest width ML = Metatarsus length BL = Body length MC = Metatarsus circumference BKL = Beak length FL = Femur length BW = Body weight WL = Wing length FC = Femur circumference.

Conclusion and Recommendation

Muscovy drakes were superior to the ducks for body weight and all the body characteristics studied. Therefore, Prediction of body weight by use of body linear measurements should be by sex within breed rather than by breed only.

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