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Prediction of Body Weight of Savanna Muturu Cattle (*Bos brachyceros*)

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Authors' contributions

This work was carried out in collaboration with all authors. Author SID designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DMO and AJA managed the analyses of the study. Author UAD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Stepwise multiple regression technique was used to predict body weight from linear body measurements in the savannah muturu cattle (*Bos brachyceros*). Sexual dimorphism was a significant (P<0.05) source of variation for body weight (BW), ear length (EL), body length (BL), chest girth (CG), horn length (HL) and height at withers, with higher values reported for the males. Correlation coefficients between body weight and linear body measurements and within linear body measurements were all positive and significant (P<0.01) irrespective of the sex of the cattle. The regression technique established highly reliable equations for predicting body weight from chest girth, body length and horn length. The best model for predicting body weight was BW = -72.908 + 1.738 CG + 3.511 HL. Information derived from this study may find application in selection for improvement of traits of economic importance in the muturu cattle.

Keywords: Muturu cattle; regression; sexual dimorphism; correlation; body dimensions.

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1. INTRODUCTION

Cattle occupy a place of pride in Nigeria's meat supply and livestock industry. Their population in Nigeria is estimated at 15.3 million [1,2]. In Nigeria, there exist different breeds of cattle which make up a rich source of genetic diversity that have not been well exploited. The savanna muturu cattle (*Bos brachyceros*) is one of such breed.

The muturu is reported to be the smallest breed of cattle [3]. Their high fertility, tolerance to trypanosomiasis and cultural roles make them an important breed wherever they are found [4]. [5] reviewed the history, distribution, management and productivity of the muturu cattle.

The bodyweight of an animal is essential in assessing the market value, nutritional requirements, growth rate and drug doses of farm animals. It is also important in animal breeding plans for genetic improvement. However, bodyweight is not easily measured under field condition. Where it is impossible to use weighing scales, or where they are not readily available, body measurement have been found useful in estimating bodyweights in cattle [6]. Body dimensions of cattle have attracted attention for sometime as possible predictors of body weight [7,8,6].

The objective of this study, therefore, is to estimate body weight from body measurements of muturu cattle as a means of evaluating their potential for genetic improvement.

2. MATERIALS AND METHODS

2.1 Study Location

The study was conducted in Logo Local Government Area of Benue State, Nigeria. Logo lies on longitude 9°4'E and latitude 7°40'N in the guinea savannah zone of North Central Nigeria [9]. The area is characterized by open savanna woodland. The climate of the area is the tropical climate with distinct wet and dry season. The rainy season starts in April and ends in October with mean annual rainfall of 800-1500 mm. The mean temperature range is between 32°C to 33°C, while relative humidity ranges from 50% to 80% being lowest during the dry season and highest during the rainy season. Logo is composed majorly of Tiv speaking people, the 6th most populous ethnic group in Nigeria. It has an area of 1,408 km^2 and a human population of 169,063. Logo has nine (9) council wards (Mbater, Mgabber, Tombo, MbayamYonov, Mbadyul, Nen Zev, Mbavuur, Turn and Ukemberagya/Tswarev) and all the areas were covered in the study.

2.2 Experimental Animals

One hundred and sixteen mature muturu cattle of both sexes reared through the extensive system of management were utilized for this study. The animals were carefully screened to avoid measuring sick and pregnant ones.

2.3 Traits Measured

Body weight (BW) and nine linear body measurements were taken on each cattle. Linear body measurements were taken using a flexible measuring tape calibrated in centimetres while body weight was estimated using a cattle weighing band. All measurements were done by one person to avoid between individual variations. Body measurements recorded were: Ear length (EL), body length (BL), chest girth (CG), horn length (HL), tail length (TL), muzzle circumference (MC), height at withers (HW), hock circumference (HC) and facial length (FL). Ear length is the distance from the point of attachment to the tip of the ear; body length is the distance from the point of the last cervical vertebra to the lumba vertebra; chest girth is the body circumference just behind the fore-legs; horn length is the distance from the tip to the base of the horn; tail length is the distance from the pin bones of the sacrum to the base of the tail switch; muzzle circumference is the circumference of the muzzle ; height at withers is the distance from the highest point of the processus spinalis of the vertebra thoracica to the ground and facial length is the distance from between the horn site to the lower lip.

2.4 Statistical Analyses

Data generated were subjected to the General Linear Model Procedure of [10] to compute means for body weight and each of the linear body measurements by sex. Pearson's coefficient of correlation (*r*) among body weight and various linear body measurements were estimated.

The General Linear Model fitted to the data was:

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where Y_{ij} is the body weight or linear body measurement, μ is the population mean, S_i is the fixed effect of sex and e_{ij} is the residual random error.

Prediction of bodyweight from linear body measurements using stepwise multiple regression method was accomplished using the following model:

$$BW = a + b_i X_i + \ldots\ldots\ldots\ldots + b_k X_k$$

Where BW = bodyweight, a = regression intercept, b_i = the i^{th} partial regression coefficient of the i^{th} linear body measurement, X_i = the i^{th} linear body measurement, b_k = the k^{th} partial regression coefficient of the k^{th} linear body measurement and X_k = the k^{th} linear body measurement.

3. RESULTS AND DISCUSSION

The mean and standard error values for body weight and linear body measurement of muturu cattle are presented in Table 1.The height at withers, chest girth and body length estimates observed in this study were comparable to those reported by [3,11]. Sex influenced (P<0.05) differences were observed in body weight, ear length, body length, chest girth, horn length and height at withers with higher values recorded for the male cattle. This result agrees with the findings of [12,13,14,15]. These obvious sexual dimorphism in favour of males could be due to the between sex differential hormonal effects on growth which is responsible for greater skeletal and muscle development in males than in females.

Pearson's correlation coefficients (*r*) between body weight and linear body measurements and within linear body measurements are presented in Table 2. Values for males are above the diagonal while those for females are below. All correlations were positively significant (P<0.01) irrespective of sex. The values ranged from 0.400 - 0.937 and 0.541- 0.941 for male and female muturu cattle, respectively. The highest correlation coefficient was observed between bodyweight and chest girth (*r* = 0.937) in males. The females also recorded the highest correlation between body weight and chest girth (*r* = 0.94). [16] suggested that chest girth could be used as a reliable predictor of body weight in most livestock species. The positive and significant correlations reported in this study agrees with the findings of [12,17]; in Bunaji and Rahaji breeds of cattle. The strong, positive and significant correlation coefficients reported in this study implies that selection for any of these traits will lead to improvement in the other. More importantly, any of these linear body measurements could be applied to predict body weight of muturu cattle.

Table 3 shows the stepwise multiple regression equations of body weight on linear body measurements of the muturu cattle. In the male and female cattle, chest girth alone accounted for 87.9 and 88.5% variations in the bodyweight. The high association between chest girth and body weight could be attributed to the large deposits of bones, muscles and viscera in the chest region of cattle. Similar observation was reported by [18,19] in geese and Muscovy ducks. In the male cattle, an addition of body length increased the accuracy of bodyweight prediction by 90.0%. This showed that body weight of cattle could be predicted with a high degree of accuracy from chest girth and body length. Similar findings were reported by [20] in goats and [21] in sheep. However, the best prediction equation (R^2= 0.911) for body weight was obtained when chest girth, body length and horn length were included in the model.

Table 1. Descriptive statistics of the morphometric traits of muturu cattle by sex

Trait	Male (n= 42) Mean± SEM	Female (n=74) Mean± SEM
Body weight (kg)	156.84±7.82[a]	139.0±4.22[b]
Ear length (cm)	17.28±0.27[a]	15.97±0.43[b]
Body length (cm)	92.35±2.55[a]	85.23±3.88[b]
Chest girth (cm)	113.94±3.37[a]	106.71±1.51[b]
Horn length (cm)	13.35±1.73[a]	7.55±1.30[b]
Tail length (cm)	71.04±2.42	67.10±3.87
Muzzlecircumference (cm)	21.84±0.61	20.45±1.07
Height at withers (cm)	91.42±2.32[a]	83.55±3.64[b]
Hock circumference (cm)	15.62±0.31	14.42±1.26
Facial length (cm)	35.78±1.01	33.81±1.29

[a,b] Means within rows with different superscript are significantly (P<0.05) different

Table 2. Coefficients of correlation of the morphometric traits of muturu cattle

	BW	EL	BL	CG	HL	TL	MC	HW	HC	FL
BW		0.719	0.922	0.937	0.642	0.815	0.777	0.885	0.732	0.784
EL	0.583		0.706	0.733	0.415	0.685	0.675	0.665	0.764	0.657
BL	0.835	0.566		0.923	0.591	0.826	0.767	0.915	0.741	0.805
CG	0.941	0.645	0.927		0.567	0.812	0.795	0.907	0.743	0.779
HL	0.875	0.556	0.710	0.815		0.553	0.460	0.524	0.400	0.568
TL	0.860	0.582	0.901	0.911	0.748		0.673	0.828	0.638	0.771
MC	0.790	0.541	0.742	0.769	0.727	0.810		0.757	0.725	0.660
HW	0.803	0.589	0.910	0.893	0.680	0.844	0.579		0.709	0.794
HC	0.788	0.765	0.710	0.772	0.739	0.720	0.770	0.654		0.597
FL	0.907	0.628	0.884	0.951	0.824	0.923	0.863	0.809	0.767	

Significant at P<0.01 for all correlation coefficients. Above diagonal = correlation coefficients for male muturu cattle. Below diagonal = correlation coefficients for female muturu cattle

Table 3. Stepwise multiple regression of body weight on body measurements of muturu cattle

Variable	Model	R^2	Significance
Male cattle			
Chest girth	BW= - 91.242+2.177 CG	0.879	***
Chest girth and body length	BW= -106.168+1.362 CG+1.168 BL	0.900	***
Chest girth, body length and horn length	B= - 92.090+1.318CG+0.984BL+0.589 HL	0.911	***
Female cattle			
Chest girth	BW= -118.692+2.415 CG	0.885	***
Chest girth and horn length	BW= -72.908+1.738CG+3.511 HL	0.920	***

In the female cattle, the proportion of the explained variance increased to 92.0% when horn length was included in the model. All regression models were significant at P<0.01.

In general, this study indicated that body weight of muturu cattle can be predicted with a high degree of accuracy from body dimensions. Similar observations have been reported by other researchers [22,23,24].

4. CONCLUSION

The muturu cattle are sexually dimorphic. There were considerable correlation between body weight and linear body measurements that can be used to improve the body weight. Stepwise multiple regression technique established highly reliable equations for predicting body weight from chest girth, body length and horn length of the muturu cattle. Information provided in this study will enrich the muturu data bank and is useful in selection for improvement of traits of economic importance.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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