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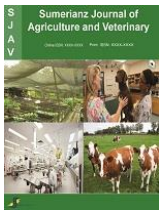

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Morphological Indices in Evaluation of Type and Function and Stepwise Regression Analysis in Balami Sheep

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Abstract

A total of 227 Balami breeds (50 males and 177 females) were randomly sampled from the population of Balami sheep for body characterization. The morphometric trait measured were; body weight (BW), body length (BL), height at wither (HW), chest circumference (CC), head length (HDL), head width (HDW), ear length (EL), horn length (HNL), horn circumference (HNC), tail length (TL), rump width (RW), rump length (RL), foreleg (FLG), hind leg (HLG), height at rump (HTR) and neck length (NL). From the morphometric traits morphological indices were calculated such as Length Index (LI), Pelvic Index (PI), Body Index (BI), Proportionality (Ipr), Thoracic Development (TD), BC=Baron Crevet (BC), Compact Index 1 (CI1), Area Index (AI) and Relative Cannon Thickness Index (RCTI). SPSS was used for stepwise regression and Excel was used for calculation of morphological indices. The result of average value of morphological indices for LI, PI, BI, Ipr, TD, BC, CI1, AI and RCTI are 1.65, 73.92, 64.37, 155.22, 1.01, 2.01, 0.01, 653.80 and 676.23 respectively. The result of correlation among morphological indices of Balami showed that LI was significantly ($p<0.01$) and positively correlate with most of the morphological indices except Ipr and PI . The highest correlation was between TD and BC (1.00) and least between LI and PI (-0.01). There was a significant relationship between body weight and morphological traits with coefficient of determination range from ($R2 = 92.61$ to 96.60) except the relationship between body weight and body length with coefficient of determination $R2=56.30$. Information emanating from this study will be useful in classifying Balami sheep into type and function.

Keywords: Morphology; Indices; Balami; Regression; Sheep.

1. Introduction

The assessment of the powers of body measurements in the estimation of weights and the accuracies of body weights in the estimation of size among livestock species has been widely reported (Source). Body weight is the commonly reported measure of size [1]. The reliability of single measurements such as wither height, body length, heart girth, rump height and width in the estimation of weight at both traditional and institutional levels have been widely documented (Source). Others have even used cephalic dimensions as indicators of breed, origin and relationships within species [2]. By type, it is meant the body form and structure which is supposed to be ideal for the purpose for which the animal is produced. It includes something more than just size and scale. Before now, type has been traditionally estimated by visual appraisal and not by ruler or tape. Type score (usually taken at weaning time) is useful in the selection of breeding stock because a visual appraisal is rather simple and because the price per kilogram of feeder and slaughter animal is dependent to a considerable extent on this trait [3]. Alderson [4] developed an index system for assessment of type and function in cattle which suggested the application of the system to other species. This investigation explores the possibility of extending the use of morphological indices beyond the on-farm within-herd comparisons, to determination of type and function between breeds within species. Therefore, this study was design to describe production indices and prediction ability of morphological indices on body weight of Balami Sheep.

2. Materials and Method

2.1. Study Area

Maiduguri is the capital and the largest urban center of Borno State, North Eastern Nigeria. The state lies between latitude 11°32′ North and 11°40′ North and latitude 13°20′ East and 13°25′ East between the Sudan Savanna and Sahel Savanna vegetation zones, characterized by short rainy season of 3-4 months (June-September) followed by a prolonged dry season of more than 8 months duration Borno State Ministry of Land and Survey [5].

2.2. Management System of the Experimental Animals

The animals were managed under the traditional extensive system, with little or no provision for shelter in the day and night. They grazed during the day on natural pasture containing forages such as northern gamba grass (*Andropogon gayanus*), stylo (*Stylosanthes gracilis*) and leucaena (*Leucaena leucocephala*). Occasionally, supplements such as cassava and yam peels, cereal offal and crop residues were provided prior and/or after grazing of natural pastures. Adequate health care was virtually non-existent while non-directional breeding was the practice [6].

2.3. Morphometric Traits Measured of Balami Sheep

A total of 60 animals were used for morphometric characterization out of total population of 233 balami sheep were randomly sampled from the population for body characterization. The parameters measured were body length (BL), height at wither (HW), chest circumference (CC), head length (HDL), head wide (HDW), ear length (EL), horn length (HNL), horn circumference (HNC), tail length (TL), rump wide (RW), rump length (RL), height at rump (HR), foreleg (FLG), hind leg (HLG), height at rump (HTR) and neck length (NL). The measurement (cm) was done using a graduated measuring stick and tape.

2.4. Morphology Indexes

Morphology indexes were calculated based on Salako [3], Alderson [4] and Chiemela, *et al.* [7] methods, in order to assess the type and function of the breed. The indexes, formular and description is presented in Table 1. Data collected were also subjected to Pearson Correlation Analysis using SPSS (2015) version to determine the phenotypic correlation of values among the morphological indices. Stepwise regression was used to determine the best prediction equation of body weight

Table-1. Methods used for assessing structural indices of Balami Sheep

Indices	Formulars	Description
LI	Body length/Wither Height	
PI	(Rump width/ Rump length) *100	
BI	(Body length/ Heart girth)* 100	When this measure is greater than 0.90, the animal is longiline; between 0.86 to 0.88 is medigline; and less than 0.85, it is brevigline
Ipr	(Height at withers/ Body length)*100	
TD	Heart girth/ Height at withers	This indicates thoracic development of animal, with values above 1.2 indicating animal with good TD
BC	(Heart girth) 2/ Height at withers	The result should be close to 2.1 The bigger the index, the closer the animal is to the traction type; the smaller this index, the weaker the animal will be
CI1	(Weight/ Height at withers)/ 100	Compact index indicates how compact the animal is. Meat type animals have values above 3.15. Value close to 2.75 indicates dual purpose and close to 2.60 indicates that the animals are more suitable for milk purpose.
AI	Height at withers x Body length	
RCTI	(Cannon circumference/ Height at withers) x 100	

LI=Length Index, PI=Pelvic Index, BI=Body Index, Ipr=Proportionality, TD=Thoracic Development, BC=Baron Crevet, CI1=Compact Index 1, AI=Area Index and RCTI=Relative Cannon Thickness Index

3. Result and Discussion

The results of average value of morphological indices are presented in Table 2. The length index in this study is 1.65 which is higher than the value 1.01reported in West African dwarf (WAD) sheep and 0.93 of Yankasa sheep reported by Salako [3]. This implies that Balami sheep is longer bodied than WAD and Yankasa sheep. The pelvic index 73.92 was observed in this study is lower than 108.14 of WAD sheep reported by Popoola [8]. Pelvic index gives an idea of the structure of the croup; this reason is closely related to reproductive fitness [9]. The variation in the pelvic index could be due to breed difference. The body index (BI) in this is 64.37 which mean that Balami breed are longiline and are fit for traction [10]. The proportionality value 155.22 in this study is higher than 107.451 reported in Creole sheep reported by Israel, *et al.* [9]. The author further stated that the higher the Ipr value, the animal gets away from the rectangular shape that is the predominant feature in meat production animals. This may implies that Balami sheep could also be classified as meat type. The TD value of 1.01 obtained in this study is less than 1.2 stated by Alderson [4] and Chiemela, *et al.* [7] which is an indication of animal with good TD. Zamborlini [11] opined that TD showed animals with good thoracic development and that it could also be affected by sex. The author further stated that a wide, deep and muscular thorax is a factor for determine physical vigor. The BC value 2.01 found in this study is closer to 2.1 recommended by Mariante, *et al.* [10]. The author further stated that a value close to 2.1 is a good indicator of animal that is traction type while value less than 2.1 is an indication of weaker animal. The compact index 1 value 0.01 observed in this study implies that Balami breed of sheep may be classified as milk type. Since Compact index 1 (CI1) indicates how compact the animal is. Meat type animals have values above 3.15 to 2.75 indicating dual purpose and 2.60 below indicates that the animals are more suitable for milk purpose [4, 7]. The area index 653.80 and Relative Cannon Thickness Index 676.23 observed in this study mean that Balami sheep are medium legs, which is a determined factor for grazing animals to graze in large areas with less difficulty.

Table-2. Average Value of Morphological Indices, Mean and Standard Deviation of Balami Sheep

Indices	Mean	Standard Deviation
LI	1.65	0.05
PI	73.92	7.38
BI	64.37	4.06
Ipr	155.22	10.49
TD	1.01	0.06
BC	2.01	0.11
CI 1	0.01	0.001
AI	653.80	139.53
RCTI	676.23	91.23

LI=Length Index, PI=Pelvic Index, BI=Body Index, Ipr=Proportionality, TD=Thoracic Development, BC=Baron Crevet, CI1=Compact Index 1, AI=Area Index and RCTI=Relative Cannon Thickness Index

The results of correlation among morphological indices are presented in Table 3. Correlations analysis of the morphological indices showed strong association ($p<0.01$). LI is significantly ($p<0.01$) and positively correlate with all the morphological indices except Ipr and PI which are negatively correlated.Ipr significance ($P<0.01$) and negatively correlated with TD, BC, CI1, AI and RCTI. The positive correlation means the traits are controlled in same direction while the negative correlation means that the traits are controlled in different gene [12]. TD correlate with BC1.00 (unity) followed TD with CI1. This could be considered suitable as an indicator of function in sheep. This finding is not in agreement with report of Salako [3] who opined that Cumulative index considered suitable as an indicator of function in cattle, was considered as an indicator of both type and function but more important for function in sheep. The difference could also provide species difference in the use of indices in the assessment of type and function. The correlation between type (LI, PI. BI, Ipr, TD, AI and RCTI) and Function (BC and CI1) are medium to low genetic correlation. This result concurred with the report of Salako [3] who stated that the body form (type, structure or proportions) supposed to be ideal for the purpose for which the animal is produced. Theoretically, in sheep, it seems that type and performance (function) have low genetic correlation and as a result, they are likely to be inherited independently. The author further stated that an indication that the group of genes responsible for inheritance of 'type' is independent of those responsible for 'performance/function.

Table-3. Correlation among Morphological Indices of Balami sheep

	LI	PI	BI	Ipr	TD	BC	CII	AI
LI								
PI	-0.01							
BI	0.66**	-0.23					.	
Ipr	-0.99**	-0.02	-0.65**					
TD	0.53**	0.27*	-0.29*	-0.54**				
BC	0.53**	0.27*	0.03	-0.54**	1.00**			
CII	0.51**	0.33*	-0.12	-0.53**	0.81**	0.81**		
AI	0.51**	0.11	0.47**	-0.52**	0.14	0.14	0.45**	
RCTI	0.06	0.32*	-0.46**	-0.07	0.59**	.59**	0.54**	-0.37**

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). LI=Length Index, PI=Pelvic Index, BI=Body Index, Ipr=Proportionality, TD=Thoracic Development, BC=Baron Crevet, CI1=Compact Index 1, AI=Area Index and RCTI=Relative Cannon Thickness Index

The results of Stepwise regression of body weight on morphological traits of Balami sheep are presented in Table 4. There was a significant relationship between body weight and morphological traits with coefficient of determination range from (R^2 = 92.61 to 96.60) except the relationship between body weight and body length with coefficient of determination R^2=56.30. This finding agreed with the report of Cam, *et al.* [13] who stated that the predictions of live body weight from the measurement of wither height, rump height and body length is un-plausible. The relationship between body weight and morphological traits that revealed high coefficient of determination may reflect an animal's fattening status. Heinrichs, *et al.* [14] suggested that some morphological traits such as wither height and hip width may be best skeletal parameters to measure in certain instants because they are not influenced by body condition. Hence, fattening performance would not change the relationships and balance between body parts under the acceptable ranges. The knowledge of the association between body weight and morphometric traits of Balami sheep will go a long way in providing necessary information which will guide the animal breeder in his weight improvement programmes.

Table-4. Stepwise Regression Morphological traits of Balami Sheep

Prediction Equation	R^2	SEM	LOS
-45.4+2.01BL	66.3	8.30	
-74.74+0.22BL+1.51CC	92.61	3.90	
-69.63+0.30BL+1.53CC-0.46EL	95.4	3.67	
-69.43+0.30BL+1.54CC-0.46EL-0.01FL	93.3	3.71	
-72.56+0.22BL+1.56CC-0.48EL-0.33FL+0.36HDL	93.3	3.71	
-68.83+0.31BL+1.66CC-0.45EL-0.13FL+0.36HDL-0.34HDW	93.4	3.68	
-79.03+0.36BL+1.63CC-0.37EL-0.42FL+0.44HDL-0.29HDW+0.19HTR	93.7	3.56	
-80.95+0.33BL+1.62CC-0.35EL-0.50FL+0.43HDL-0.29HDW+0.30HTR-0.10HLG	94.0	3.51	
-81.68+0.40BL+1.61CC-0.32EL-0.52FL+0.49HDL-0.30HDW+0.31HTR-0.10HLG-0.15HW	93.9	3.54	
-81.12+0.40BL+1.61CC-0.25EL-0.53FL+0.43HDL-0.32HDW+0.30HTR-0.1HLG-0.21HW+0.14NL	93.8	3.57	
-77.80+0.39BL+1.61CC-0.19EL-0.50FL+0.31HDL-0.35HDW+0.32HTR-0.1HLG-0.29HW+0.09NL+0.29RL	93.7	3.58	
-87.30+0.38BL+1.75CC-0.37EL-0.30FL+0.71HDL-0.48HDW+0.26HTR-0.08HLG-0.36HW-0.28NL+0.77RL-1.08RW	94.00	3.5	
-89.62+0.24BL+1.55CC+0.35EL+0.37FL-0.65HDL-0.06HDW+0.15HTR-0.02HLG-1.47HW+0.35NL+0.15RL-0.27RW+0.55TL	96.60	2.62	

significant at the 0.01 level body length (BL), height at wither (HW), chest circumference (CC), head length (HDL), head wide (HDW), ear length (EL), horn length (HNL), horn circumference (HNC), tail length (TL), rump wide (RW), rump length (RL), height at rump (HR), foreleg (FLG), hind leg (HLG), height at rump (HTR) and neck length (NL)

4. Conclusion

The study concluded that Balami is a long bodied sheep, have good reproductive fitness, longiline, milk type and fit for traction. The correlation between type and function indices showed medium to low phenotypic correlation. The stepwise regression showed that all the morphometric traits are good predictors of body weight except BL. Information emanating from this study will be useful in classifying Balami sheep based on type and function.

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