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MORPHOLOGICAL INDICES AND STEPWISE REGRESSION OF KOROJI SHEEP

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Morphological indices and stepwise regression of Koroji sheep was done with A total population of 250 koroji sheep and 150 animals were randomly sampled from the population for Morphometric characterization. The morphometric trait measured were; body length (BL), height-at-wither (HTW), 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), 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 values obtained for the following indices for LI, PI, BI, Ipr, TD, BC, CI1, AI and RCTI are 1.63, 81.89, 63.12, 160.18, 0.99, 2.00, 0.01, 4552.80 and 994.178 respectively. The correlation among morphological indices showed significance ($P<0.01$) of both positive and negative correlation. The stepwise regression showed low coefficient of determination R^2 = 59.00 and high of coefficient of determination R^2 = 98.30. This study is relevant in providing genetic information for proper classification of Koroji sheep into type and function. This could help breeders to plan breeding programmes to improve milk production in Koroji sheep

Keywords: Morphological, Indices, Koroji, Sheep, Trait

Nigerian sheep population comprises of large number of flocks managed extensively under harsh environmental and traditional conditions with large variation in size of flock and individual animals (Popoola, 2015). The germplasm of numerous breeds of livestock may become lost in many third world countries due to crossing with exotics. Besides, uncontrolled breeding in extensive management systems pose a great risk for the loss of valuable genes (Groeneveld *et al*., 2010). Morphological indices give general information about livestock breed characteristics in terms of structure and proportions which are the ethnological characteristics as well as functional traits of animals. These characteristics provide information about the type, aptitude and production performance of the animal. The calculation and analyses of different morphological indices give room for ethnological classification and functional classification of livestock breeds, particularly ruminants (Esquivelzeta *et al*., 2011).

Morphological indices are combinations of s everal linear or morphometric measurements ,the results of which are expressed as a percentage and indicate the type and function of a particular breed (Maciejowski and Zieba, 1982). Indices offer accurate estimation of an animal's conformation when compared to individual measurements alone (Salako, 2006). Structural indices also provide tested empirical values which are limited in the use of single measurements. They are also used for the assessment of type, weight and function as well as enhance the ability of breeders to select potential breeding stock (Salako, 2006). Index system had been used for assessment of type and function in cattle, but information on the application of this system to other species like sheep is scares. This study was therefore designed to evaluate morphological indices

and correlation among the indices of Koroji sheep in a stepwise regression analysis.

MATERIALS AND METHODS

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 8 months duration (Borno State Ministry of La nd and Survey, BMLS, 2016).

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. The sheep 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.

Morphometric Differentiation of Koroji Sheep

A total population of 250 koroji sheep was selected as base population. Of this number, 150 animals of age two years and above were randomly sampled and morphometric measurements taken for characterization. The parameters measured were body length (BL), height-at-withers (HTW), 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 (HTR), foreleg (FLG), hind leg (HLG), height at rump (HTR) and neck length (NL). The measurement (cm) was done using a meter rule and tape.

Morphological Indices

Morphological indices were calculated based on Salako (2006), Alderson (1999) and Chiemela *et al*. (2016) 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. The morphological indices were calculated based of the following formulars;

LI = Body length / Height at Wither

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

RESULTS AND DISCUSSION

The results of average value of morphological indices, mean and standard deviation of Koroji sheep are presented in Table 1. The length index 1.63 was observed in this study was higher than 1.01 of West African Dwarf (WAD) sheep and 0.93 of Yankasa sheep reported by Salako (2006).

The result of this study was also higher than 0.87 of WAD reported by Popoola (2015). The variation of length index among these breeds could be due to differences in breeds and environment. The length index showed relative to height, Koroji sheep is longer body than WAD and Yankasa sheep. The pelvic index showed value of 81.89 which is lower than 108.14 of WAD reported by Popoola (2015). The author further stated that pelvic index indicates concave is the breed, with the amplitude predominating in relation of its rump length. Therefore, it can state that WAD is more concave than Koroji sheep. The body index in the study showed 63.12. This means that the Koroji breeds are longiline and are fit for traction (Mariante *et el*., 2002). The proportionality (Ipr) value (160.18) is higher than IPr (95.90). The higher value records in this study showed that Koroji breed have to taller shoulders. The variation in the Ipr is due to species differences. The Thoracic development (TD) value 0.99 is lower than 1.2 recommended by Alderson (1999) for animal with good thoracic development. TD may be good indicator of animal physical vigor and allowing for good resistance to long journeys This agreed with the report of Zamborlini (2001) who opined that TD is good indicator of wide, deep and muscular thorax is a factor for determine physical vigor. The baron crevet value 2.00 observed in this study is close to 2.1 recommended by Alderson (1999) and Chiemela *et al*. (2016) as a good indicator of animals that are fit for traction, while value less than 2.1 is an indication of weaker animal. The compact index 1 value 0.01 showed is this study, indicates that Koroji breed are milk type.

Table 1: Average Value of Morphological Indices, Mean and Standard Deviation of Koroji Sheep

Indices	Mean	Std Deviation
LI	1.63	0.04
PI	81.89	9.35
BI	63.12	4.40
Ipr	160.18	9.73
TD	0.99	0.04
BC	2.00	0.09
CII	0.01	0.001
AI	4552.80	882.59
RCTI	994.178	4.41

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

Table 2: Correlation among Morphological Indices of Koroji

	LI	**PI**	**BI**	**Ipr**	**TD**	**BC**	**CII**	**AI**
LI								
PI	-0.02							
BI	0.77**	0.13						
Ipr	-0.99**	0.01	-0.78**					
TD	0.13	-0.20	-0.53**	-0.12				
BC	0.13	-0.20	-0.53**	-0.12	1.00**			
CII	0.04	-0.20	-0.37*	-0.06	0.65**	0.65**		
AI	0.28	-0.04	0.16	-0.31*	0.13	0.13	0.77**	
RCTI	0.13	-0.20	-0.53**	-0.12	1.00**	1.00**	0.65**	0.13

**. 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

According to recommended values above 3.15 is meat type, 3.14 – 2.75 dual purpose and 2.60 and below are suitable for milk type. Although Koroji breed are being kept for meat. The milk production of this breed should be studied to identify its potential within the system and help to identify a commercial niche, as well as contribute for *in situ* conservation. More information on the breed would also help to implement structured crossbreeding systems and help to maintain purebred animals (Chancon *et al*., 2011). The Area Index (AI) of 4552.80 observed in this study is higher than 3167.127 of WAD sheep reported by Popoola (2015). The variation in AI could be due to breed differences. The Relative Cannon Thickness Index of 994.178 observed in this means that Koroji sheep are long legs which is a determine factor for grazing in desert with less difficulty. Salako (2006) suggested that indices that are produced from measurements that are more closely associated with bone growth such as foreleg length, height slope and length index (RBI) are more appropriate for assessment of type. Assessment of type by using body measurements is more objective than those obtained by visual appraisal, though both are still inferior to 'function' as criteria for selecting breeding stock.

The results of correlation among morphological indices of Koroji sheep are presented in Table 2. The correlation among morphological indices showed low, medium and high degree association. Length index correlate positively with all indices parameters except for PI and Ipr showed negatively correlation. LI showed significant ($P<0.01$) high and correlation with BI. TD showed 100% positive with BC and RCTI. This could mean that the indices that showed positive correlation are controlled by same gene. Dauda *et el.* (2018) opined that trait that shows positive could be used for improvement, because improvement in one trait will lead to improvement in the other trait. Yakubu and Ayoade (2009) reported that those parameters that are positively correlated with each other are under the controlled by the same gene (pleiotropic), similarly it is an indication that any of these body dimension could serve as a predictor of body weight. LI showed significant ($P<0.01$) high negative correlation with Ipr. Ipr showed negative correlation with all the morphological indices. Dauda *et al*. (2018) reported trait that showed negative correlation is controlled by different gene. This implies that improvement in one trait lead to decrease in the other traits.

The results of Stepwise Regression Morphological traits of Koroji Sheep are presented in Table 4. All the morphological

Table 3: Stepwise Regression Morphological traits of Koroji Sheep

Prediction Equation	**R^2**	**SEM**	**LOS**
-50.3+2.15BL	59.0	10.5	
-82.81-0.14BL+1.83CC	97.5	2.57	
-84.36-0.13BL+1.82CC+0.06EL	97.5	2.60	
-83.76-0.05BL+1.85CC+0.09EL-0.13FL	97.5	2.59	
-84.12-0.06BL+1.83CC+0.06EL-0.16FL+0.07HDL	97.5	2.61	
-85.81-0.09BL+1.75CC+0.13EL-0.23FL-0.04HDL+0.23HDW	97.5	2.60	
-85.75-0.09BL+1.74CC+0.13EL-0.23FL-0.07HL+0.24HW+0.04HTR	97.4	2.65	
-86.35-0.05BL+1.73CC+0.11EL-0.37FL-0.02HL+0.36HW+0.05HTR-036HLG	97.6	2.52	
-87.82-0.01BL+1.68CC+0.17EL-0.43FL-0.01HL+0.31HW+0.12HTR-0.44HL+0.71HW	97.9	2.39	
-89.96-0.03BL+1.70CC+0.14EL-0.45FL-0.03HL+0.31HW+0.13HTR-0.39HL+0.62HW-0.05NL	97.8	2.41	
-89.79-0.03BL+1.71CC+0.1EL-0.37FL-0.06HL+0.26HW+0.12HTR-0.47HL+0.62HW+0.04NL+0.20RL	97.8	2.41	
-89.14-0.03BL+1.61CC+0.19EL-0.50FL-0.12HL+0.57HW+0.13HTR-0.31HL+0.58HW+0.07NL+0.38RL-0.97RW	98.4	2.11	
-86.33-0.004BL+1.62CC+0.12EL-0.54FL-0.12HL+0.55HW+0.17HTR-0.36HL+0.58HW+0.07NL+0.41RL-0.88RW-0,97TR	98.3	2.11	

significant at the 0.01level 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)

traits showed significance (P<0.01). The coefficient of determination showed range of R^2 = 59.00 – 98.30. The highest R^2 = 98.3 is between all the morphological traits and the lowest is between the constant and body length. The lower value of R^2 obtained could be due to the only trait used in the prediction of the weight. Cam (2010) stated that the predictions of live body weight from the measurement of wither height, rump height and body length is unplausible. Prediction of body is not suitable with few morphological traits thus, using of many morphological traits is suitable and will give good prediction of body weight. The relationship between morphological traits could give insight to the fattening status of the animal.

CONCLUSION

Based on this study, Koroji sheep are milk type, long body, longiline and fit for traction. The correlation among morphological indices of Koroji sheep showed both positive and negative correlation. The stepwise regression showed that prediction of body weight with single or few morphological traits is not suitable and good for prediction. Beside use of many morphological traits is suitable and good for body weight prediction. The relationship between morphological traits could give insight to fattening status of the animal. This study is relevant in providing genetic information for proper classification of Koroji sheep into type and function. This could help breeders to plan breeding programmes to improve milk production in Koroji sheep

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