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Morphometric characteristics of Red Sokoto and Sahel goats in Maigatari Local Government Area of Jigawa State

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Abstract

The initial step involved in any animal genetic improvement program is to describe the morphometric traits considered. Therefore, a study was conducted in Maigatari Local Government Area of Jigawa State to determine some morphometric characteristics of Red Sokoto and Sahel goats. A total of 250 goats (187 Red Sokoto and 63 Sahel) of mixed sex and age were used for the study. The animals were sampled from Maigatari main livestock market. Data generated were subjected to simple descriptive, analysis of variance, Pearson's correlation analysis and stepwise linear regression. The coefficients of variation obtained for the parameters ranged from 8.96 % for wither height to 56.89 % for udder circumference. Red Sokoto had mean BW, BCS, BL, HG, WH, UL, UC, TL and TC of 20.58 kg, 3.20, 22.45 cm, 25.28 cm, 22.93 cm, 3.48 cm, 5.99 cm, 4.97 cm and 7.88 cm, respectively. The corresponding values for Sahel were 22.91 kg, 3.00, 23.58 cm, 25.07 cm, 24.55 cm, 4.14 cm, 7.06 cm, 4.75 cm and 7.52 cm. Sahel goats had significantly higher BL (P<0.01) and WH (P<0.001). Female goats were heavier than male and had longer body, wider chest and higher height at wither. Except TC, goats of 36 - 48 months had the highest for all the significantly affected traits (BW, BCS, BL, HG and WH; P<0.001). The correlation coefficients observed among the morphometric traits were in general high, positive and significant, while the accuracy of the predictive equation when HG and in combination with BL were used to predict live weight was also high. This study indicated that breed had no effect on most body characters and that live weight can best be predicted using HG.

Keywords: Morphometrics traits, breed, sex, age, goat.

Introduction

Small ruminants are important genetic resources and play a predominant role in the sustenance of the livelihoods of impoverished families especially in the rural areas of tropical countries. Caprine species specifically goats play an important role in the social life of many Africans and supply human population with meat, milk, skin, manure and other products. The Red Sokoto goat (RSG) or Maradi is the most predominant breed and accounts for about 70% of Nigeria's total goat population (Ademosun, 1994), it is commonly found with the agro pastoralist mainly within the northern sub-humid and semi-arid zones of the country (Akpa *et al.,* 2001). The Sahel goat is an extant meat and milk type goat in Nigeria (Otoikhian and Orheruata, 2010), it is large in size, predominantly white colour, pied with black or white and brown spots around the ear, nose and udder. Upon all these benefits derived from this important livestock species, the genetic of indigenous goats remain untapped. The output is low compared to improved exotic breeds. Therefore, the genetic resources of this important species need to be exploited. The initial step involve in any animal genetic improvement program is to describe the important morphometric traits. Morphometric characteristics are essential in breed identification and classification. Gizaw *et al*. (2007) stated that

morphostructural description of traits remained essential component of characterization that can be used to physically identify, describe and recognize a breed. It also helps in the classification of livestock breeds. The knowledge of morphometric traits aids in appropriate breeding design, feeding and health management (Thiruvenkadan, 2005).

Materials and methods

Study location

The study was conducted at Maigatari Local Area of Jigawa State. Maigatari is located between longitude 48.26^0 12' N and latitude 25.50^0 9'E and is 352m above sea level (Encarta Encyclopedia, 2009 PC version). It has an average annual rainfall of 418 mm per annum, which starts from late April or early May and ends in mid-October.

Experimental animal and management

A total of 250 goats (187 Red Sokoto and 63 Sahel) of mixed sexes and ages (1 year = 1 Pair of permanent incisors, 2 years = 2 Pair of permanent incisors, < 2-3 years = 3 Pair of permanent incisors and 3.5 - 4 years above = 4 Pair of permanent incisors) were used for the study. The animals were randomly selected from Maigatari main livestock market.

Data collection

Body weight and seven linear body measurements were recorded. They include; body length (BL), heart girth (HG), wither height (WH), testicular length (TL), testicular circumference (TC), udder length (UL) and udder circumference (UC). The measurement was done using a flexible tailors tape, while the wither height was accessed with a measuring stick. The body measurements were taken according to the method described and adopted by Rotimi *et al*. (2015).

Body weight (BW) of the animal was obtained by placing them on the weighing scale; Body length (BL) was measured from the tip of the scapula close to the neck region to the pin bone of the tail region

Heart girth (HG) was measured as the circumference of the body, slightly behind the shoulders and perpendicular to the body axis; Wither height (WH) was measured at the highest point on the dorsum of the animal to the platform at the level of the forelegs while the animal was standing; Testicular length (TL) which is the distal length of the testicle was measured using tailor's tape (Podany, 1964); Testicular circumference (TC) was obtained when the scrotal content was palpated to ensure normal position. Then the testes were pulled into the bottom of the scrotum gently and evenly so that the testicles were side by side and scrotal skin was devoid of any wrinkles. Then the area of greatest circumference was measured with flexible cloth tape in centimeter (Coulter *et al*., 1987); Udder length (UL) was obtained from the attachment to middle of the udder (Abu *et al*., 2013); Udder circumference (UC) was taken as distance round the mid udder region above teats measured with a flexible tape (Adewumi *et al*., 2012); Body condition score (BCS) was achieved through palpation of visible bone structure. Animals were palpated over the back bone, loin and rump. Fat condition was smooth to palpate while bone structure with little or no fat cover felt rough to touch. These general assessments were used to place each goat in a category of body condition (very thin = 1, thin = 2, moderate = 3, fat = 4 and obese = 5).

Data analysis

Data generated were subjected to descriptive statistics (mean, standard deviation and coefficient of variation) and analysis of variance (ANOVA) using the general linear model (GLM) procedure of SPSS, version 22 (2013). Significantly different means were compared using the least significant differences (LSD). The model utilized was as follows:

$Y_{ijk} = U + B_i + S_j + A_k + e_{ijk}$---------- (1)

Y_{ijk} = Observation on dependent variables
U = Common Mean
B_i = effect of i^{th} breed (1, 2)
S_j = effect of j^{th} sex (1, 2)
A_k = effect of k^{th} age (1, 2, 3, 4)
e_{ijk} = random error term

The relationships among the linear body measurements and body weight were estimated using Pearson's correlation analysis. Stepwise regression procedure was used to find the best linear combination of morphometric traits that can predict body weight. This was performed for male, female and the pooled data. The following linear and multiple regression models were applied:

$Y_1 = a + bx$------(2) simple regression model

$Y_1 = a + b_1x_1 + b_2x_2 + \ldots + b_kx_k$-(3) multiple regression model

Where Y = dependent variable
a = the Intercept, bs = the slopes and x = independent variable.

Results

The means, standard deviations and coefficients of variability of live weight and linear body measurements observed in both breeds (Red Sokoto and Sahel goats) are presented in Table 1. The coefficient of variation observed in this study ranged from 8.96 % for wither height to 56.82 % for udder circumference. Average morphometric traits according to breed, sex and age are presented in Table 2. There was significant effect of breed on BL ($P<0.001$) and WH ($P<0.01$). Sahel goats had lengthier body and higher wither height than Red Sokoto (23.88±0.43 and 24.55±0.41 cm vs 22.45±0.50 and 22.93±0.44 cm). However, non-significant effect of breed on BW, BCS, HG, UL, UC, TL and TC was observed. Significant effect of sex on BW, BL, HG ($P<0.001$) and HG ($P<0.05$) was observed. Females were heavier and had longer body, wider chest and higher wither height than males (25.28±1.00 kg, 24.54±0.41 cm, 26.48±0.40 cm and 24.25±0.38 cm vs 18.51±1.34 kg, 21.80±0.55 cm, 24.47±0.53 cm and 23.24±0.50 cm). Non-significant influence of sex on BSC was however evident. Significant influence of age on BW, BCS, BL, HG, WH ($P<0.001$) and TC ($P<0.01$) was observed. Except TC, goats of 36 - 48 months had the highest for all the significantly affected traits.

Table 1: Descriptive statistics of morphometric traits

Parameters	Min.	Max.	Mean	STD	CV
Body weight (kg)	12.00	35.50	24.21	7.01	28.94
Body condition score	2.00	5.00	3.20	0.72	22.56
Body length (cm)	18.20	28.10	23.77	2.96	12.46
Heart girth (cm)	20.50	31.20	26.28	2.64	10.03
Wither height (cm)	19.70	29.10	24.35	2.18	8.96
Testicular length (cm)	3.40	7.10	4.87	0.90	18.47
Testicular circumference (cm)	5.60	9.90	7.62	1.24	16.30
Udder length (cm)	1.10	8.10	4.01	1.80	45.01
Udder circumference (cm)	1.10	14.00	6.9848	3.97359	56.89

CV = Coefficient of variation and STD = Standard deviation

Table 2: Average morphometric traits according to breed, sex and age

Factor	BW	BSC	BL	HG	WH	UL	UC	TL	TC
		Morphometric traits							
Overall mean±S.E.	21.90±1.08	3.14±0.16	23.17±0.42	25.47±0.41	23.74±0.38	3.81±0.48	6.52±1.10	4.86±0.23	7.70±0.23
Breed	NS	NS	**	NS	***	NS	NS	NS	NS
Sahel	22.91±1.11	3.00±0.17	23.88±0.45	25.67±0.44	24.55±0.41	4.14±0.53	7.06±1.19	4.75±0.31	7.52±0.31
Red Sokoto	20.88±1.21	3.20±0.19	22.45±0.50	25.28±0.48	22.93±0.44	3.48±0.60	5.99±1.32	4.97±0.34	7.88±0.33
Sex	***	NS	***	***	*				
Male	18.51±1.34	3.07±0.21	21.80±0.55	24.47±0.53	23.24±0.50	NA	NA	NA	NA
Female	25.28±1.00	3.21±0.16	24.54±0.41	26.48±0.40	24.25±0.38	NA	NA	NA	NA
Age	***	***	***	***	***	NS	NS	NS	**
Yearlings	17.76±1.25[b]	2.88±0.20[c]	20.85±0.51[b]	23.57±0.49[b]	22.02±0.46[b]	3.78±0.71	5.95±1.58	4.44±0.50	7.16±0.50[b]
12-24 months	19.54±0.90[b]	2.72±0.14[c]	21.93±0.37[b]	24.61±0.36[b]	23.40±0.33[b]	3.08±0.58	4.94±1.30	5.95±0.31	6.91±0.31[b]
24-36 months	27.71±0.86[a]	3.65±0.14[b]	25.27±0.35[a]	27.79±0.34[a]	25.61±0.32[a]	4.42±0.44	8.47±0.97	5.53±0.39	9.04±0.38[a]
36-48 months	27.87±2.67[a]	3.43±0.42[a]	25.38±1.10[a]	28.29±1.10[a]	25.79±0.98[a]	5.80±1.23	7.70±2.74	NA	NA

BW = Body weight, BCS = Body condition score, BL= Body length, HG = heart girth, WH= Wither height, TL= Testicular length, TC= Testicular circumference, UL= Udder length, UC= Udder circumference and NA = Not vailable. * = $P<0.05$, ** = $P<0.01$, *** = $P<0.001$, NS = Non-significant and S.E = Standard error

The correlation coefficients for separate and both sexes are presented in Tables 3, 4 and 5. The coefficients observed were in general high, positive and significant except between WH and TL in male and between BW and UC, BCS and BL, WH, UL and UC in females.

Predictive equations of body weight from linear body measurements are shown in Table 6. Of all the body traits recorded, heart girth was observed to have the highest coefficient of determination, while subsequent inclusion of body length in females and pooled data of both sexes yielded better results.

Table 3: Phenotypic correlation coefficients among morphometric traits in male goats

Variable	BW	BCS	BL	HG	WH	TL	TC
BW	1	0.913**	0.919**	0.983**	0.871**	0.523*	0.791**
BCS		1	0.870**	0.885**	0.830**	0.627**	0.833**
BL			1	0.922**	0.834**	0.445**	0.752**
HG				1	0.872**	0.507**	0.752**
WH					1	0.346NS	0.539*
TL						1	0.774**
TC							1

BW = Body weight, BCS = Body condition score, BL= Body length, HG = heart girth, WH= Wither height, TL= Testicular length, TC= Testicular circumference. * = P<0.05, ** = P<0.01 and NS = Non-significant.

Table 4: Phenotypic correlation coefficients among morphometric traits in female goats

Variable	BW	BCS	BL	HG	WH	UL	UC
BW	1	0.395*	0.818**	0.839**	0.720**	0.371*	0.318NS
BCS		1	0.336NS	0.505**	0.194NS	0.154NS	0.152NS
BL			1	0.754**	0.748**	0.509**	0.436*
HG				1	0.650**	0.487**	0.439*
WH					1	0.419*	0.418*
UL						1	0.847**
UC							1

BW = Body weight, BCS = Body condition score, BL= Body length, HG = heart girth, WH= Wither height, UL= Udder length and UC= Udder circumference. * = P<0.05, ** = P<0.01 and NS = Non-significant.

Table 5: Phenotypic correlation coefficients among morphometric traits in both sexes of goats

Variable	BW	BCS	BL	HG	WH
BW	1	0.600**	0.898**	0.917**	0.781**
BCS		1	0.598**	0.681**	0.465**
BL			1	0.867**	0.785**
HG				1	0.758**
WH					1

BW = Body weight, BCS = Body condition score, BL= Body length, HG = heart girth and WH= Wither height. ** = P<0.01.

Table 6: Prediction equation of body weight from heart girth and body length

Sex	Prediction equation	Coefficient of determination (R^2)
Male	BW = -33.54 + 2.13HG	0.96
Female	BW = -35.04 + 2.28HG	0.69
	BW = -39.50 + 1.40HG + 1.15BL	0.77
Pooled	BW = -39.86 + 2.44HG	0.84
	BW = - 37.81 + 1.50HG + 0.96BL	0.88

BW = Body weight, BL= Body length, HG = heart girth. R^2 = Coefficient of determination

Discussion

The higher coefficient of variation (CV) observed in the present study indicates variability in phenotypic
traits of some indigenous goat breed. The result obtained in the current observation showed that the CV for morphometric traits recorded were high (range values of 8.96 to 56.89 %). This agreed with the work of Getew (2014) who reported values of 15.9, 36.1, 12.3, 6.2 and 4.6 % for body weight, body condition score, body length, heart girth and wither-height, respectively among Borena goats. Bedada *et al*. (2019) reported CV values of 17.67, 14.94, 6.1, 6.18 and 5.66 % in the same traits. Working on Red Sokoto goat, Ijomanta (2012) reported higher CV of 25.19, 21.72, 22.15 and 11.6 % for live weight, body length, heart girth and wither height. The facts that breed had effect on BL and WH as observed in the present study agreed with the findings of Guifen *et al*. (2014) who reported a significant variation in morphometric and carcass traits of different genotype of goats. Similarly, the work of Sanni *et al*. (2018) on different breeds of goats (Kalahari and Sokoto reds, Sahel and WAD) native to Africa also detected a significant variation on morphostructural traits and it has been suggested that the wide variation observed between Sahel and WAD goats could lead to heterotic gain (Zaharaddeen *et al*., 2008). Some authors (Gizaw *et al*., 2007; Agaviezor *et al*., 2012) attributed this variation to inherent genetic potential of each breed, geographical isolation and ecological variation. The significantly higher BCS observed in Red Sokoto goats contradicts the work of Brown and Swan (2012). The results obtained in the present study indicated that morphometric characteristic of Red Sokoto goats was sexually dimorphic in favour of females. This agreed with the work of Ma'aruf *et al*. (2018) in Yankasa sheep breed. Contrary to the present observation, Sowande *et al*. (2008) showed that male sheep were superior to female in live weight and most body measurements. They attributed this differences to genes linked with sex chromosomes. Shuaibu *et al*. (2018 and 2019) also made similar assertion in Yankasa sheep that males had higher values for morphometric traits than females.

The effect of age on live weight and linear body measurements observed in this study agrees with the work of some investigators (Afolayan *et al*., 2006; Mavoule *et al*., 2013) who reported that adult sheep were heavier than the younger ones and had higher values for linear body measurements. Similarly, Mekuriawa *et al*. (2013) reported higher values for morphometric traits in adult sheep compared to the younger and yearling ones and suggested that selective improvement of body weight and conformation traits should be emphasized at this stage (adult). The correlation coefficients observed among the morphometric traits were high, positive and significant. This was in line with the work of Afolayan *et al*. (2006) that live weight was highly correlated with body dimensional traits. The finding of Shuaibu *et al*. (2018) on Yankasa sheep also indicated that the relationship between live weight and linear body measurements were mostly moderate to high which shows that they can predict each other. Pesmen and Yerminci (2008) in their study on dairy goat (Saneen), however reported low to moderate relationships among these traits. The highest R^2 observed in this study when BW is predicted from HG conform with the report of Tsegaye *et al*. (2013) that this trait (HG) is positively correlated with live weight (LW) and can indicate it with high precision (R^2 = 0.94). Similar report by Tadesse and Gebremariam (2010) in sheep also showed that heart girth predicted LW with higher accuracy of 0.69. Yakubu (2010) attributed this relationship to pleiotropic gene action that exist between

the two traits. In the present finding, subsequent inclusion of body length in females and in pooled data of both sexes yielded better values. This agreed with the report of Tadesse and Gebremariam (2010) on higher R^2 when BL and WH are included in the predictive equation of BW from HG.

Conclusion

The finding revealed that the major sources of variation on morphometric traits were sex and age and the correlation coefficients among these traits were mostly high, positive and significant. The coefficient of determination observed in the prediction of body weight from heart girth was high, but subsequent inclusion of body length in female and the pooled data of both sexes yielded better result.

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