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Effect of dietary treatment levels on biometric traits of Red Sokoto goats fed with varying inclusion levels of red forage sorghum stover

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ABSTRACT

This Study was carried out to determine the effect of dietary treatment levels on biometric traits of Red Sokoto goats fed with varying inclusion levels of red forage sorghum stover. Parameters measured were body weight, body length, height at wither, chest girth, hind leg length, fore leg length, ear length, head length, neck length, neck circumference, face length, tail length, horn base circumference, testicular circumference and testicular length. The effect of dietary treatments – T_1 (maize stover 25%), T_2 (sorghum stover variety 12.5%), T_3 (sorghum stover variety 2 at 25%) and T_4 (12.5% variety 1 and 12.5% variety 2), was analysed using General Linear Model Procedure of SAS. Relationships among biometric variables were computed for all the animals using CORR procedure of SAS. The supplementary diets vary between initial and final body weight, and body linear measurements of Red Sokoto goats. High values were recorded in T_1 and T_4. The initial body weight gain was high in T_1 (19.50kg), T_3 (18.00kg) and T_4 (19.00kg) while the least was recorded in T_2 (17.52kg). Final weight gain recorded high value in T_1 (22.45kg) and T_4 (23.60kg). There were perfect correlations between fore leg length and horn base circumference (p<0.01; r=1.00), fore leg length and testicular length (p<0.01; r=1.00), testicular circumference and testicular length (p<0.01; r=1.00). In conclusion, initial body weight, final body weight, body length, height at withers, chest girth, hind leg length, fore leg length, ear length, horn length, neck length, neck circumference, face length, tail length, horn base circumference, testicular circumference and testicular length were highly affected by dietary treatment levels. Also, high correlation coefficients between parameters can be used in breeding for building selection index for the improvement of correlated parameters.

Keywords: Biometric traits, dietary treatment levels, Red Sokoto goats.

INTRODUCTION

Linear body measurements give better information on performance (Afolayan *et al.,* 2006), productivity (Cam *et al.,* 2010) and carcass characteristics of animals (Ige *et al.,* 2006). Goats are known to be efficient browsers and will consume browses ignored by cattle and sheep on range land. They are known for more production units in African farming systems than any other species of domestic livestock except poultry because of their lower feed requirement, their rapid reproduction cycles and the ease with which they can be handle (FAO, 1991). Goats rank next to cattle in income generation and their meat is quite popular and well relished (Ladele, 1996). Ruminant animals in Nigeria are underfed due to high cost of feed ingredients especially plant protein sources like soybean meal, groundnut meal and cotton seed cake. Since quality and quantity of the natural pasture vary with season, animals that dependent on it are subjected to nutritional stress in the dry season when feed resources are senesced and in short supply leading to decreased animal productivity (Millam 2016; Babale *et al.*, 2018). Sorghum stover is an important feed resource in Nigeria particularly during the dry season, but it is poorly utilized when the processing and supplementation is not properly planned, thus, leading to reduced animal performance. Also, cereal straws and stover are high in structural components and their associated fibre contents, their utilisation for animals is limited. Reddy and Reddy (2011) also attributed further treatment i.e grinding and blending of sorghum stover with concentrate into mash which was found to be useful for efficient utilisation of crop residues in ruminant. Growth which is an increase in size or body weight at a given age, usually result from nutrient utilization and it is one of the important selection criteria for the improvement of small ruminants in areas where weighing facilities are unavailable to farmers, linear body measurements can be taken to evaluate the live weight of animals (Ulutas *et al.*, 2002). Thus, body measurements could be used to predict live weight fairly well in such situations (Berge, 1977; Buvanendran *et al.*, 1980; Goonerwardene and Sahaayuraban, 1983; Heinrichs *et al.*, 1992; Van Marle-Koster *et al.*, 2000) especially by smallholder farmers when taking management decisions involving marketing and growth evaluation. This study aimed at determining the effect of dietary treatment levels on biometric traits of Red Sokoto goats fed with varying inclusion levels of red forage sorghum stover and their correlated responses.

MATERIALS AND METHODS

Location of study area

The study was conducted at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University, Samaru Zaria, located on altitude 11^0 11' N and longitude 07^0 38' E. It is situated at an altitude of 686m above sea level and lies within the Northern Guinea Savannah zone (GPS, 2016).

Experimental design

Sixteen (16) intact Red Sokoto bucks of average initial weight range of 10-11±0.05kg were allocated into four treatment groups of 4 treatment diets containing varying inclusion levels of maize variety stover (control 25%) and red forage sorghum variety stover (25V1, 25V2, and 25V1V2%) with 4 goats per treatment (T_1, T_2, T_3 and T_4), consisting of two replicates of which each replicate has two animals in a complete randomized design. The experimental animals were kept in individual pens. Mandatory and routine prophylactic treatments were taken up for all the animals.

Experimental feeds and treatments

The principal ingredient for the experimental feeds is the Maize stover and Red forage sorghum stover which was collected from the irrigation site of the Institute for Agricultural Research (IAR), Samaru-Zaria. The Maize stover and Red forage sorghum stover was sun dried on floor for a period of 3 – 4 days and finally chopped using a forage chopper produce Maize stover and Red forage sorghum stover meals. The composition of the experimental diets consists of maize (25V2 and 25V1V2%). Other feed ingredients include the following: Maize bran, cotton seed cake, Rice offal bone meal and salt which were sourced from commercial suppliers at Samaru market in Zaria, Kaduna State. Prior to feed formulation, proximate compositions of ingredients were determined. On the basis of the nutrient composition of the ingredients (Table 1), the diets formulated were balanced according to recommendations by NRC (1994). Maize stover 25% (control), varying levels of inclusion of the red forage sorghum stover 25%.

Data collection

Linear body measurements (LBMs)

Experimental animals were taken from feeding pens at 8.00 a.m., confined to Animal crushes and body measurements obtained. Measurements were obtained at four weeks' interval through the growth trial (90 days) by two people, with each person taking a specific set of measurements on all the animals. Animals were weighed immediately afterwards before being returned to feeding pens. The following measurements were taken: Horn base circumference, tail length, face length, neck circumference, neck length, poll distance, ear length, hind leg length, fore leg length, chest girth, height at wither, body length and horn length were the parameters measured in this study. Body linear measurements were accomplished with the use of calibrated measuring tape.

Body weight (kg):

Body weight of the Red Sokoto goats was measured using CAMRY EMPERORs. FA0036 scale in (kg).

Statistical analysis

General Linear Model procedure of SAS (2004), version 9.1 statistical package was used to analyze the effect of biometric and age categories as shown in the model below: Duncan Multiple Range Test DMRT (Duncan, 1955) were used to compare the treatments.

$Y_{ij} = \mu + T_i + \varepsilon_{ij}$

Where Y_{ij} = individual observation of the i^{th} treatment on the j^{th} animal.
μ= population mean
T_i= effect of the i^{th} treatment groups (T_1, T_2, T_3 and T_4)

ε_{ij}= residual error.

Correlation analysis

Correlation coefficients were estimated using the following formular:

$\sigma_{xy} = CoV_{xy} / \sqrt{Var_x\ Var_y}$

Where;

$CoVar_{xy}$ = Covariance of traits x and y

Var_x = Variance of trait x

Var_y = Variance of trait y

RESULTS

Chemical composition of two red forage sorghum stover and the control

The Chemical composition of the two red forage sorghum stover and the control is presented in Table 1a and b. The dry matter (DM), crude protein, crude fibre, ether extract, ash, nitrogen free extract, neutral detergent fibre, acid detergent fibre and lignin contents of the control (0%), Sosoki V1 (25%), Ibasa V2, Sosoki: Ibasa (25%) on DM basis were comparable and ranged from 93.00 to 94.60, 4.01 to 5.33, 36.8 to 38.6, 1.26 to 1.31, 5.01 to 6.05, 40.28 to 40.68, 75.20 to 76.60, 41.74 to 43.54 and 9.10 to 10.80%, respectively. Proximate principles and cell wall constituents were comparable among all experimental diets, except crude protein and acid detergent fibre which were lower in Ibasa V2 (4.01%) and Sosoki V1 (41.74%) respectively.

Table 1a: Chemical composition of two red forage sorghum varieties and the concentrate

Parameters (%)	Control (0%)	Sosoki V_1 (25%)	Ibasa V_2 (25%)	Sosoki: Ibasa (12.5: 12.5)
Dry matter	93.80	94.60	93.00	93.8
Crude protein	5.52	5.53	4.01	4.77
Crude fiber	37.90	36.80	38.60	37.7
Ether extract	1.31	1.28	1.26	1.27
Ash	5.01	6.02	6.05	6.03
NFE	40.53	40.64	40.68	40.28
Lignin	10.80	9.90	9.84	9.10
NDF	75.20	76.48	76.60	76.09
ADF	42.54	41.74	43.54	42.61

NFE: nitrogen free extract, NDF: neutral detergent fibre, ADF: acid detergent fibre

Table 1b: Chemical composition of the experimental diets

Parameters	Control (0%)	Sosoki V_1 (25%)	Ibasa V_2 (25%)	Sosoki: Ibasa (25%)
Dry matter	92.46	90.72	89.96	90.21
Crude protein	17.95	17.62	14.21	13.94
Crude fiber	28.15	27.11	28.05	29.19
Ether extract	0.56	0.74	0.61	0.58
Ash	10.76	8.13	9.34	10.00
NFE	35.04	37.12	37.75	36.5
Lignin	17.50	10.00	16.90	12.92
ADF	29.82	30.80	29.98	29.38
NDF	52.68	59.20	53.12	57.70

NFE: nitrogen free extract, ADF: acid detergent fibre, NDF: neutral detergent fibre.

The results of the composition of dry matter supplementary diets fed to Red Sokoto goats are presented in Table 2. Significant (P<0.05) differences were observed among initial body weight, final body weight, body length, height at wither, chest girth, hind leg length, fore leg length, ear length, head length, neck length, neck circumference, face length, tail length, horn base circumference, testicular circumference and testicular length for all the supplemented treatment groups except the total feed intake, which showed non-significant (P>0.05) differences across the treatments. The supplementary diets vary between initial and final body weight, and body linear measurements of Red Sokoto goats. High values were recorded T_1 and T_4. The initial body weight gain was high in TI (19.50kg), T3 (18.00k) and T4 (19.00kg) while the least was recorded in T_2 (17.52kg). Final weight gain recorded high value in T_1 (22.45kg) and T_4 (23.60kg) while the total feed intake did not vary significantly across the treatments. High weight gain recorded in T_1 and T_4 means that treatment groups fed dry matter poultry droppings had better initial and final body weight gain.

Table 2: Composition of dry matter supplementary diets fed Red Sokoto goats

Parameters	T1	T2	T3	T4	LOS
IBWT(kg)	19.50[a]	17.50[b]	18.00[a]	19.00[a]	*
FBWT(kg)	22.45[a]	21.60[b]	21.15[c]	23.60[a]	*
TFI(kg)	23.91	22.23	22.58	23.52	NS
BL(cm)	70.00[a]	64.00[b]	63.50[c]	68.50[a]	*
HW(cm)	83.00[a]	77.50[b]	71.00[d]	77.00[c]	*
CG(cm)	63.50[a]	61.00[a]	58.00[b]	62.50[a]	*
HLL(cm)	58.00[a]	53.50[b]	51.50[c]	50.00[d]	*
FLL(cm)	50.00[a]	47.00[a]	44.50[b]	44.50[b]	*
EL(cm)	12.86[a]	11.20[b]	12.81[a]	12.65[a]	*
HL(cm)	22.50[c]	17.50[d]	26.00[a]	23.50[b]	*
NL(cm)	28.50[b]	26.85[c]	26.85[c]	29.80[a]	*
NC(cm)	34.00[a]	31.30[b]	30.95[c]	34.90[a]	*
FL(cm)	21.45[b]	22.31[a]	20.69[c]	23.26[a]	*
TL(cm)	27.30[b]	28.65[a]	26.35[c]	28.10[a]	*
HBC(cm)	16.75[c]	17.45[a]	17.10[b]	19.01[a]	*
TSC(cm)	26.00[b]	24.00[c]	23.00[d]	28.00[a]	*
TSL(cm)	15.00[a]	12.50[b]	12.50[b]	15.00[a]	*

IBWT: Initial body weight; FBWT: Final body weight; TFI: Total feed intake; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length. NS: Non-significant difference at (P>0.05), [abcd]Means with different superscripts along same row shows significant differences *****P<0.05.

The correlation of body linear measurements as influenced by treatment 1 are shown in Table 3. The traits were significantly (P<0.05, 0.01) and positively correlated among themselves (r=0.39-0.99). The magnitude of correlation between body weight and biometric traits were high (P<0.01; 0.69-0.99) except between body weight and body length (r= 0.41) and horn base circumference (r= 0.47), which showed low significant relationships. Body weight was highly correlated with HW ((r= 0.85), CG (r= (0.99), FLL ((r= 0.95), NL ((r= 0.99) and FL ((r= 0.95). However, BL had high significant relationships with HW ((r= 0.83), HLL (r= 0.94), EL ((r= 0.99), FL (r= 0.64), TL (r= 0.70). High correlated relationships were also observed between HW and CG (r= 0.89), HLL (r= 0.97), FLL (r= 0.65), EL (r=0.76), NL (r= 0.79) and FL (r= 0.96) while low significant relationships were recorded between HW and HL (r= 0.39). Non-significant relationships were recorded among other traits.

The correlation of body linear measurements as influenced by treatment 2 are presented in table 4. High significant correlation (P<0.01) were observed between BWT and BL (r= 0.99), HW (r= 0.89), CG (r= 0.99), FLL (r= 0.99) and TSL (r= 0.95) with the exception of between BWT and HLL (r= 0.47) and FL (r= 0.52), which showed moderate relationships (P<0.05). BWT and EL, HL, NL, NC, TL, HBC and TCR showed non-significant relationships (P>0.05). High significant correlated relationships were also observed among body weight and other biometric traits such as BL and HW (r= 0.89), CG (r= 0.99), FLL (r= 0.99); HW and CG (r= 0.93), FLL (r= 0.97); CG and FLL (r= 0.99), TSL (r= 0.91); HLL and FL (r= 0.99), HBC (r= 0.93), TCR (r= 0.96), TSL (r= 0.72); EL and NL (r= 0.87), HL and NL (r= 0.62), NC (r= 0.93), FL (r= 0.68), TL (r= 0.96), HBC (r= 0.99), TCR (r= 0.89); NL and NC (r= 0.88), TL (r= 0.83); NC and TL (r= 0.82); FL and HBC (r= 0.77); TL and HBC (r= 0.89), TCR (r= 0.72) and, HBC and TCR (r= 0.95).

Table 3: Correlation of body linear measurements as influenced by treatment 1

	BWT	BL	HW	CG	HLL	FLL	EL	HL	NL	NC	FL	TL	HBC	TCR
BWT	-													
BL	0.41*	-												
HW	0.85**	0.83**	-											
CG	0.99**	0.48*	0.89**	-										
HLL	0.69**	0.94**	0.97**	0.75**	-									
FLL	0.95**	0.11^{NS}	0.65**	0.93**	0.45*	-								
EL	0.30*	0.99**	0.76**	0.37*	0.89**	0.00^{NS}	-							
HL	0.81**	-0.19	0.39	0.77**	0.16	0.95**	-0.30	-						
NL	0.99**	0.30*	0.79**	0.98**	0.61**	0.98**	0.19^{NS}	0.89**	-					
NC	-0.51	-0.99	-0.89	-0.57	-0.97	-0.23	-0.97	0.08	-0.41	-				
FL	0.95**	0.64**	0.96**	0.98**	0.87**	0.83**	0.55*	0.63**	0.92**	-0.73	-			
TL	-0.37	0.70**	0.18	-0.30	0.41*	-0.63	0.78**	-0.83	0.47*	-0.62	-0.09	-		
HBC	0.47*	-0.62	-0.07	0.39*	-0.30	0.71**	-0.70	0.89**	0.57*	0.53*	0.20^{NS}	-0.99	-	
TCR	-0.30	-0.99	-0.76	-0.37	-0.89	0.00^{NS}	-1.00	0.30*	-0.19	0.97**	-0.55	-0.78	0.70**	-
TSL	0.21^{NS}	-0.80	-0.33	0.14^{NS}	0.54*	0.50*	-0.87	0.74**	0.33*	0.73**	-0.06	-0.99	0.96**	0.89**

BWT: Body weight; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length

Table 4: Correlation of body linear measurements as influenced by treatment 2

	BWT	**BL(cm)**	**HW**	**CG**	**HLL**	**FLL**	**EL**	**HL**	**NL**	**NC**	**FL**	**TL**	**HBC**	**TCR**
BWT	-													
BL	0.99**	-												
HW	0.89**	0.89**	-											
CG	0.99**	0.99**	0.93**	-										
HLL	0.47*	0.45*	0.01 NS	0.37 NS	-									
FLL	0.99**	0.99**	0.87**	0.99**	0.50*	-								
EL	-0.99	-0.99	-0.82	-0.97	0.58*	-0.99	-							
HL	-0.26	-0.27	-0.67	-0.36	0.73**	-0.22	0.13 NS	-						
NL	-0.91	-0.93	-0.99	-0.96	-0.09	-0.91	0.87**	0.61**	-					
NC	-0.60	-0.62	-0.90	-0.69	0.42*	-0.58	0.50*	0.93**	0.88**	-				
FL	0.52*	0.51*	0.08 NS	0.44*	0.99**	0.56*	-0.63	0.68**	-0.12	-0.16	-			
TL	-0.53	-0.54	-0.86	-0.62	0.50*	-0.50	0.42*	0.96**	0.83**	0.82**	0.44*	-		
HBC	0.10 NS	-0.11	-0.55	-0.20	0.83**	-0.06	-0.03	0.99**	0.51*	0.48*	0.79**	0.89**	-	
TCR	0.21 NS	0.19 NS	-0.27	0.10 NS	0.96**	0.24*	-0.33	0.89**	0.22 NS	0.19 NS	0.94**	0.72**	0.95**	-
TSL	0.95**	0.94**	0.70**	0.91**	0.72**	0.96**	-0.98	0.06 NS	-0.73	-0.76	0.77**	-0.24	0.22 NS	0.50*

BWT: Body weight; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length.

The correlation of body linear measurements as influenced by treatment 3 are presented in Table 5. The correlation of body linear measurements parameters was positively and significantly high, moderate, low, negatively to non-significant correlated relationships (P<0.01, P< 0.05 and P>0.05) among the biometric traits were observed. Body weight had high significant relationships with BL (r= 0.95), CG (r= 0.99), EL (r= 0.80). Other biometric traits had negative correlations, BWT and HW (-0.94), HLL (-0.94), FLL (-0.80), HL (-0.88), NL (-0.21), NC (-0.08), FL (-0.80), HBC (r= -0.92), TCR (r= -0.61) and TSL (r= -0.99) with the exception of TL (r= 0.17), which showed low and non-significant relationship (P<0.05). Other biometric traits also showed high (P<0.01; 0.49-100), low to moderate (P<0.05; 0.17-0.45) and non- significant negative relationships (P>0.05; -0.28 to -1.00) was recorded among the biometric traits.

The correlation of body linear measurements as influenced by treatment 4 are shown in Table 6. The traits were significantly (P<0.05, 0.01) and positively correlated among themselves (r=0.31-0.99). The magnitude of correlation between body weight and biometric traits were high (P<0.01; 0.59-1.00) with exception of other biometric traits which revealed high, moderate, low to non-significant relationships among themselves. BWT and BL (r=0.98) and CG (r=0.99) showed high correlated relationships. High significant correlations (P<0.01) were also observed among biometric traits such as between BL and HW (0.60), BL and CG (0.95), HLL and FLL (0.98), HW and EL (0.94), HLL and EL (0.65), CG and HL (0.68), HLL and NL (0.99), FLL and NL (0.97), HW and NC (0.99), EL and TL (0.94), FLL and HBC (1.00), NL and TCR (0.99), FLL and TSL (1.00) and TCR and TSL (1.00). Negative relationships and non- significant relationships occurred between BWT and other biometric traits such as HLL (-0.68), FLL (-0.80), NL (-0.64), FL (-0.99), TL (-0.22), HBC (-0.80), TCR (-0.79) and (-0.80) respectively.

The correlation of body linear measurements as influenced by pooled treatment 5 are revealed in Table 7. The correlation of the body measurements for pooled treatment groups was significant (P<0.01; 0.05) with the exception of few other biometric traits, which showed low, moderate, non-significant to negative relationships among themselves. The correlation coefficient values obtained for the pooled treatment groups was higher between IBWT and FBWT (r=0.66), TFI (r=0.77), BL (r=0.74), HW (r=0.63), CG (r=0.62), EL (r=0.63), NL (r=0.61), NC (r=0.89), TCR (r=0.67) and TLS (r=0.78). High significant correlation was recorded between FBWT and TFI (r=0.79), BL (r=0.89), CG (r=0.82), NL (r=0.83), HBC (r=0.71), TCR (r=0.95) and TSL (r=0.76); BL and CG (r=0.91), HW and CG (r=0.86), BL and NL (r=0.82), TCR and BL (r=0.84); BL and TSL (r=0.89), HLL and FLL (r=0.96), EL and HL (r=0.81), NC and FL (r=0.71) and; TCR and TSL (r=0.78). Other biometric traits recorded low to moderate correlation relationships among themselves. The significant effect of the majority of the pooled treatment on body linear measurements implies that dietary treatment had effect on all the treatment groups.

Table 5: Correlation of body linear measurements as influenced by treatment 3

	BWT	BL	HW	CG	HLL	FLL	EL	HL	NL	NC	FL	TL	HBC	TCR
BWT	**-**													
BL	0.95**	-												
HW	-0.94	-0.99	-											
CG	0.99**	0.93**	-0.90	-										
HLL	-0.94	-0.99	1.00**	-0.91	-									
FLL	-0.80	-0.94	0.96**	-0.76	0.96**	-								
EL	0.80**	0.94**	-0.96	0.76**	-0.96	-1.00	-							
HL	0.88**	-0.98	0.99**	-0.84	0.99**	0.99**	-0.99	-						
NL	-0.21	-0.49	0.54*	-0.13	0.54*	0.75**	-0.75	0.65**	-					
NC	-0.08	-0.37	0.42*	0.00^{NS}	0.42	0.66**	-0.65	0.54*	0.97**	-				
FL	-0.80	-0.94	0.96**	-0.76	0.96**	1.00**	-0.100	0.99**	0.75**	0.65**	-			
TL	0.17^{NS}	0.45*	-0.50	0.09	0.50*	0.72**	0.72**	-0.61	-0.99	-0.99	-0.72	-		
HBC	0.92**	-0.76	0.72**	-0.94	0.72**	0.50*	-0.50	0.62**	-0.19	-0.33	0.50*	-0.24	-	
TCR	-0.61	-0.82	0.84**	-0.54	0.85**	0.96**	-0.96	0.91**	0.90**	0.84**	0.96**	-0.88	0.24^{NS}	-
TSL	-0.99	-0.98	0.97**	-0.98	0.97**	0.87**	-0.87	0.93**	0.32*	0.19^{NS}	0.87**	-0.28	0.87**	0.69**

BWT: Body weight; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length.

Table 6: Correlation of body linear measurements as influenced by treatment 4

	BWT	**BL**	**HW**	**CG**	**HLL**	**FLL**	**EL**	**HL**	**NL**	**NC**	**FL**	**TL**	**HBC**	**TCR**
BWT	-													
BL	0.98**	-												
HW	0.43*	0.60**	-											
CG	0.99**	0.95**	0.33*	-										
HLL	-0.68	-0.52	0.37*	-0.76	-									
FLL	-0.80	-0.67	0.19 ^{NS}	-0.87	0.98**	-								
EL	0.11 ^{NS}	0.31*	0.94**	0.00	0.65**	0.50*	-							
HL	0.59	0.43*	-0.47	0.68**	-0.99	-0.96	-0.73**	-						
NL	0.64**	0.47*	0.42*	-0.72	0.99**	0.97**	0.69**	-0.99**	-					
NC	0.35*	0.53*	0.99**	0.24 ^{NS}	0.45*	0.28 ^{NS}	0.97**	-0.55	-0.86	-				
FL	-0.99	0.95**	-0.33	-1.00	0.76**	0.87**	0.00 ^{NS}	-0.68	0.70**	0.72**	-			
TL	-0.22	-0.02	0.79**	-0.33	0.87**	0.76**	0.94**	-0.91	-0.44	0.89**	0.84**	-		
HBC	-0.80	-0.67	0.19 ^{NS}	-0.87	0.98**	1.00**	0.50*	-0.96	0.25 ^{NS}	0.97**	0.28 ^{NS}	0.87**	-	
TCR	-0.79	-0.90	-0.89**	-0.72	0.09 ^{NS}	0.28 ^{NS}	-0.69	0.02 ^{NS}	0.99**	0.04	-0.85**	0.72**	-0.42	-
TSL	0.80**	0.67**	0.19	-0.87	0.98**	1.00**	0.50*	-0.96	0.25 ^{NS}	0.97**	0.28 ^{NS}	0.87**	-0.76	1.00**

BWT: Body weight; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length.

Table 7: Correlation of body linear measurements as influenced by pooled treatments

	IBWT	**FBWT**	**TFI**	**BL**	**HW**	**CG**	**HLL**	**FLL**	**EL**	**HL**	**NL**	**NC**	**FL**	**TL**	**HBC**	**TCR**
IBWT	-															
FBWT	0.66**	-														
TFI	0.77**	0.79**	-													
BL	0.74**	0.89**	0.80**	-												
HW	0.63**	0.58*	0.46*	0.70**	-											
CG	0.62**	0.82**	0.58*	0.91**	0.86**	-										
HLL	0.39*	0.03 ^{NS}	0.02 ^{NS}	0.35*	0.65**	0.52*	-									
FLL	0.51*	0.26 ^{NS}	0.22 ^{NS}	0.51*	0.76**	0.86**	0.96**	-								
EL	0.63**	0.41	0.52*	0.60**	0.08 ^{NS}	0.32*	0.22 ^{NS}	0.23 ^{NS}	-							
HL	0.22 ^{NS}	0.07 ^{NS}	0.25 ^{NS}	0.15 ^{NS}	-0.43	-0.22	-0.29	-0.34	0.81**	-						
NL	0.61**	0.83**	0.62**	0.82**	0.38*	0.71**	-0.02	0.13 ^{NS}	0.58*	0.29 ^{NS}	-					
NC	0.89**	0.63**	0.71**	0.57*	0.49*	0.47*	0.08 ^{NS}	0.23 ^{NS}	0.36*	0.08 ^{NS}	0.37*	-				
FL	0.52*	0.68**	0.45*	0.37*	0.50*	0.48*	-0.06	0.15 ^{NS}	-0.14	-0.37	0.67**	0.71**	-			
TL	0.23 ^{NS}	0.58*	0.55*	0.32*	0.44*	0.38*	-0.27	-0.05	-0.39	-0.48	0.65**	0.45*	0.76**	-		
HBC	0.01 ^{NS}	0.71**	0.25 ^{NS}	0.49*	0.22 ^{NS}	0.53*	-0.23	-0.07	-0.11	0.03 ^{NS}	0.37*	-0.02	0.38	0.37*	-	
TCR	0.67**	0.95**	0.71**	0.84**	0.59*	0.78**	-0.04	0.15 ^{NS}	-0.37	0.07 ^{NS}	0.47*	0.71**	0.68**	0.56*	0.64**	-
TSL	0.78**	0.76**	0.60**	0.89**	0.62**	0.85**	0.44*	0.55*	0.67**	0.19 ^{NS}	0.27 ^{NS}	0.65**	0.35*	0.05 ^{NS}	0.34*	0.78**

IBWT: Initial body weight; FBWT: Final body weight; TIF: Total feed intake; BL: Body length; CG: Chest girth; HLL: Hind leg length; FLL: Fore leg length; EL: Ear length; HL: Horn length; NL: Neck length; NC: Neck circumference; FL: Face length; TL: Tail length; HBC: Horn base circumference; TCR: Testicular circumference; TSL: Testicular length.

DISCUSSION

Chemical composition of the two red forage sorghum stover and the control is presented in Table 1a and b. This is consistent with the report of Babu *et al.* (2014), who observed similar chemical composition among sorghum stover and sweet sorghum bagasse based complete diets. The DM and EE values of this study in Table 1a and b is in line with the results of Bello and Tsado (2014), however the values of CP and CF reported were lower than the results of this study. A similar trend was observed in the NFE which was higher than the result of this study.

The results of this study in Table 2 is similar to the findings of Anigbogu and Nwagbara (2013). CG was more positively correlated to live body weight than other body linear measurements as influenced by treatment 3 and this shows that one single measurement can predict body weight of goats in treatment 3. This observation agrees with that reported for heifers fed urea treated maize stover with different levels of concentrate (Iriso *et al.,* 2018). Other authors reported an increase in body weight gain (Jokthan *et al*., 2013; Anigbogu and Nwagbara, 2013; Ibrahim *et al.,* 2014).
Non-significant relationships were recorded among other traits as shown in Table 3. Other biometric traits had low, moderate to high positive correlated relationships among themselves. The results of this study is similar with the findings of (John *et al.*, 2017) who reported low, moderate to high correlated relationships among morphometric traits of donkeys studied.
The result of this study revealed that other biometric traits showed non-significant and moderate relationships amongst themselves as presented in Table 4. Positive correlation suggests that a significant increase in one parameter would result in a significant increase in the other parameter with which they are correlated (Abbaya *et al.,* 2020).

Biometric traits also showed high (p<0.01; 0.49-100), low to moderate (p<0.05; 0.17-0.45) and non- significant negative relationships (p>0.05; -0.28 to -1.00) was recorded among the biometric traits as presented in Table 5. The knowledge of relationship amongst these traits can help in the formulation of programmes for selection and improvement of biometric parameters in goats (Alade *et al.,* 1999; Alphonsus and Essien, 2012).

Negative correlations and non- significant correlations exist between BWT and other biometric traits such as HLL (-0.68), FLL (-0.80), NL (-0.64), FL (-0.99), TL (-0.22), HBC (-0.80), TCR (-0.79) and (-0.80) respectively. As indicated in table 6, the results of this study is in line with the findings of (John *et al*., 2018), who reported negative correlation among some biometric traits of donkeys.

The biometric traits recorded low to moderate correlation relationships among themselves in Table 7. The results obtained in this study is similar with the report of Pearson and Ouassat (1996) who reported strong relationship between live weight and body dimensions of donkeys. The significant effect of the majority of the pooled treatment on body linear measurements implies that dietary treatment had effect on all the treatment groups.

CONCLUSION AND RECOMMENDATIONS

The results of the study showed that linear body measurement were significantly affected by treatments 1 and 4. Fore leg length versus horn base circumference, fore leg length versus testicular length and; testicular circumference and testicular length should be used as traits in determining the associations among Red Sokoto goats because of their high correlation coefficient values. Further study should be carried by including other feed sources in order to determine its effects on biometric traits of Red Sokoto goats in the study area.

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