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Estimation of live weight in Red Sokoto kids using linear body traits

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Target Audience: *Farmers, Breeders and Goat sellers*

Abstract

The study was carried out in Akko, Kwame and Yamaltu/Deba Local Government Areas of Gombe State, between August and November, 2019 to estimate body weight of Red Sokoto kids using linear body measurements. A total of 460kids (219 males and 241 females) were used to obtain the following parameters; live weight (LW), body length (BL), chest girth (CG), wither height (WH), leg length (LL), loin girth (LG), ear length (EL) and face length (FL). The animals were sampled from four local markets across the study area (Kashere, Kumo, Malam Sidi and Kwadom). Data generated were subjected to descriptive statistics, analysis of variance, Pearson's correlation and linear regression analyses. The coefficients of variation of the variables observed ranged from 21.14 % for body weight to 7.86 % for chest girth. The mean LW, BL, CG, WH, LL, LG, EL and FL were 11.09 kg, 37.94 cm, 50.95 cm, 43.84 cm, 14.21 cm, 54.47 cm, 11.13 cm and 8.23 cm, respectively. Location had effect on leg ($P<0.01$), ear and face lengths ($P<0.001$). Similarly, significantly wider chest, longer ear and face ($P<0.05$) were observed in males. The correlation coefficients observed among the parameters were mostly moderate to high, positive and significant ($P<0.01$). The step-wise multiple regression analysis showed that CG had coefficient of determination (R^2) of 0.44 (44 %) when used in the prediction of LW, while subsequent inclusion of LG and BL yielded better result (0.47 and 0.49, respectively). Therefore, the study revealed that both location and sex had no effect on most of the linear body measurements and the accuracy of these traits (linear body measurements) in the prediction of LW is moderate.

Keywords: *Red Sokoto kids, Prediction, Body weight, Linear body traits*

Description of Problem

Small ruminant production (goats) plays a significant role in the economy of farmers. It is an enterprise that has been practiced by a large section of rural population. Goats are highly prolific animals with lower requirements in terms of capital and maintenance costs. They can survive on available shrubs and trees, in adverse harsh environment and in low fertile lands where no other crop can be grown (marginal lands). They contribute to livestock industry in terms of milk, meat and skin.

Live weight plays an important role in determining several characteristics of the farm animals especially the ones having economic importance such as birth weight, early growth and feed conversion ratio. Feeding requirements of animals could also be predicted by the live weights (1). Live weight prediction using linear measurement is practical, faster, easier and cheaper in the rural areas where weighing scales are not available (2). Researches on the prediction of body weight of goats using linear body measurements have been conducted in other regions of the world and their possible applications in the estimation of live weights (3; 4; 5). The present study was carried out to establish the relationship between live weight and some body measurements in Red Sokoto

kids. Results obtained would be useful and helpful to farmers and animal scientists who are involved in small ruminant's research.

Materials and Methods

Location and climate

The study was conducted at Akko, Kwame and Deba Local Government Areas of Gombe State from August to November, 2019. The State falls within the northern guinea savannah zone of Nigeria and is 431m above the sea level. It is located between longitudes 11°10' and 11.16°70' East and latitudes 10°15' and 10.25°00' North (6). Gombe State has two distinct climates, the dry season (November - March) and the rainy season (April - October) with an average rainfall of 850mm/annum. The relative humidity observed in the state varied from 15 - 60 % in the northern zone, 25 - 50 % in the central zone, and up to 80 % in the southern zone. It has an ambient temperature of 16.60℃ inharmattan period and as high as 39.40℃ during the dry hot season (7).

Table 1: Locations and annual rainfall of the selected local government areas

Local government	Longitude	Latitude	Elevation above the sea level	Annual rainfall
Akko	11°13'E	10°03'N	446m	930mm
Kwame	11°15'E	10°30'N	400m	850mm
Yamaltu/Deba	11°23'E	10°13'N	390m	1000mm

Source: (8)

Data collection

A total number of 460 Red Sokoto kids were used for this study, out of which, 217 were males and 241 females. They were sampled from some selected local markets of Akko, Kwame and Deba Local Government Areas of Gombe State (Kashere, Kumo, Malam Sidi and Kwadon). Live weight was measured along with seven linear body measurements on each animal. They were body length (BL), chest girth (CG), wither height (WH), leg length (LL), loin girth (LG), ear length (EL) and face length (FL). A graduated measuring stick was used for the height measurements, while the length and circumference were done using a tailors' tape. All measurements were taken according to the method described and adopted by (9).

Live weight: Live body weight of the animal was obtained using bath room scale.

Body length: This was measured from the tip of the scapula to the pin bone of the tail.

Chest girth: This was obtained as the circumference of the body, slightly behind the shoulders.

Wither height: This 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.

Leg length: This was obtained as the distance from the tips of the hoofs to the point where the tarsal joined to the tibia and fibula.

Loin girth: This was determined as the circumference around the animal just before the hind leg

Ear length: This was measured from the point where the ear is attached to its tip.

Face length: This was measured from mid-point of the zygomatic arches to the upper lip.

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 (10), version 23 (2015). Significantly different means were compared using the least significant differences (LSD). The model utilized was as

follow:

$\mathbf{Y}_{ij} = \mathbf{U} + \mathbf{L}_i + \mathbf{S}_j + \mathbf{e}_{ij}$ - - - (1)

$\mathbf{Y}_{ij}$ = Observation on dependent variables

U = Common mean

$\mathbf{L}_i$ = Effect of i^{th} location (1, 2, 3, 4)

$\mathbf{S}_j$ = Effect of j^{th} sex (1, 2)

$\mathbf{e}_{ij}$ = Random error term

The relationships between body weight and linear body measurements were determined using the Pearson's product moment correlation. Prediction of body weight using linear body measurements (those with highest correlation coefficient with body weight) was carried out using the following models:

$Y_1 = a + bx$ -- (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 (body weight)

a = the Intercept

b = the slopes

x= independent variable

Results

In Table 2, the coefficients of variation (CV) of morphometric traits (live weight and linear body measurements) observed in this study are presented. It ranges from 21.14 % for body weight to 7.50 % for girth circumference. Average morphometric traits according to location and sex are presented in Table 3. Significant effect of location was observed on leg length ($P<0.05$), ear and face lengths ($P<0.001$). Kids with lengthier legs were observed in Kashere while the shortest was recorded in Kwadom (14.56±0.19 cm vs 13.75±0.17 cm). For ear and face lengths, the latter had the highest values for both traits than the former (11.42±0.11 and 8.61±0.08 cm vs 10.86±0.13 and 8.33.0.09 cm). However, non-significant influence of location on live weight, body length, chest girth, wither height and loin girth was observed. Significant influence of sex on chest girth, leg and face lengths ($P<0.05$) was observed. Buck kids had higher values for all the significantly affected traits than doe kids (51.40±0.26, 14.41±0.13 and 8.32±0.06 cm vs 50.50±0.25, 14.01±0.13 and 8.15±0.06 cm). Non-significant effect of sex on live weight and length, wither height, loin girth and ear length was however observed. The phenotypic correlation coefficients among the morphometric characteristics are presented in Table 4. The coefficients observed among the traits were generally moderate to high, positive and significant except between the ear length and leg length in which lower value was recorded (0.15).The step-wise multiple linear regression models of live weight from some linear measurements (those with high correlation coefficient with the predictant) are presented in Table 5. Chest girth predicted live weight in red Sokoto kid with an accuracy of 0.44, while subsequent inclusion of loin girth and body length yielded better value (0.47 and 0.49, respectively).

Table 2: Descriptive statistics of recorded variables

Variable	Mean	Standard deviation	Coefficient of variation
LW	11.12	2.35	21.14
BL	38.01	3.10	8.15
CG	50.93	3.82	7.50
WH	43.81	4.03	9.20
LL	14.20	1.91	13.43
LG	54.42	5.15	9.47
EL	11.16	1.26	11.26
FL	8.24	0.92	11.20

LW = Live weight, BL = Body length, CG = Chest girth, WH = Wither height, LL = Leg length, LG = Loin girth, EL = Ear length, FL = Face length, STD = Standard deviation and CV = Coefficient of variation.

Discussion

The coefficient of variation (CV) gives an indication of the variability in characters and allows comparisons between traits that are measured in different unit. The high CV observed in body weight and linear body traits could be attributed to individual differences present in the morphometric characters and this indicates the possibility for improving these traits through selection. (11) and (12) similarly reported high CV in morphometric characteristics of Red Sokoto goats.The mean live weight (11.09±0.11 kg) observed among Red Sokoto kids is below the range value reported by (13) in Hararghe highland goats of Ethiopia. Higher live weight means of 16.00±0.40, 16.55±1.15, 41.03±1.01 and 14.12±3.71 kg were reported as above by (14), (15) and (16) and (17), respectively. However, the mean value reported by (18) among uncastrated savannah brown kids is below the value recorded in the present observation.The significant effect of sex observed on chest girth, face and leg lengths agrees with the report of (19) who revealed that both live weight and body measurements are sexually dimorphic. Except ear length, body condition score and pelvic width, the authors observed consistently higher values in male than female goats and attributed the wider pelvic observed in the latter to reproductive activities (specifically, pregnancy and parturition). (20) revealed that sex is an important source of variation in morphometric traits (body weight and linear body measurements) of goats and linked this effect to the presence or absence of androgenic hormones in both sexes. According to (11) and (21) sex had effect on morphometric characters of red Sokoto goats and bucks weighed heavier and had wider chest than does while the latter had longer body length and higher height at wither. (22) indicated that buck kids weighed more at birth and were heavier up to 90 days. (23) also pointed out the superiority of male kids over the female counterpart, but contradicted with the report of (24) that the latter were heavier than the former. (25) attributed this difference to the effect of the sex hormone (androgen) which is responsible for the development of male sexual characteristics. (26) and (27) favoured of bucks over does in terms morphometric traits. Contrary to the present finding, (28) reported heavier weights for adult does than bucks. Working on West African Dwarf (WAD) breed, (9) showed that sex had effect on the body mass of goats with higher values recorded in females. Similar observation was also made by (29) and related this effect to small sample size of buck used during the study or negative selection where bigger males were castrated, fattened and sold as source of income to the rearers. The author further explained that most bucks were sold by the farmers at yearling age thereby leaving behind few to serve the females. (30) in his report stated that the morphological traits of male and female kids were similar.

The significant effect of location observed on leg, ear and face lengths agrees with the finding of (29) who noticed the effect of zone (Katsina, Daura and Malumfashi) on body conformation traits of Red Sokoto goats (body weight and length, heart girth, thoracic depth, height at withers, ear, tail and horn lengths) and attributed it to variations in nutrition and management practices in the study areas. (31) compared the morphometric measurements of Yankasa sheep in some selected local government of Bauchi state (Bauchi, Dass and Tafawa Balewa) and detected a significant influence of location on these traits. The authors attributed this to differences in the genetic constitution of this breed in various locations. (32) reported a significant variation on egg and live weights, and body length of local chickens sampled from some selected villages of Shelleng and Song Local Government Areas of Adamawa State and stressed that the differences on these traits

reflect the genetic constitution subpopulations. (33) detected a considerable effect of location on conformation traits of Ethiopian sheep breed. They related this to differences in nutrition plane across the study locations. Most authors (34; 35; 36) however, contradicted these findings.

Table 3: Average morphometric traits according to location and sex

Factors	LW	BL	CG	WH	LL	LG	EL	FL
Overall mean±S.E	11.09±0.11	37.94±0.15	50.95±0.18	43.84±0.20	14.21±0.09	54.47±0.25	11.13±0.06	8.23±0.04
Location	NS	NS	NS	NS	**	NS	***	***
Kashere	10.76±0.24	37.44±0.31	51.07±0.38	43.70±0.41	14.56±0.19^{a}	54.36±0.51	10.86±0.13^{b}	8.33±0.09^{b}
Kumo	11.46±0.19	38.39±0.25	50.92±0.31	43.98±0.33	14.42±0.16^{a}	54.73±0.42	11.06±0.10^{ab}	8.03±0.07^{bc}
Malam Sidi	11.12±0.26	37.75±0.35	51.03±0.43	43.99±0.45	14.11±0.21^{ab}	55.24±0.57	11.08±0.14^{ab}	7.96±0.10^{c}
Kwadon	11.03±0.21	38.19±0.27	50.78±0.34	43.58±0.36	13.75±0.17^{b}	53.53±0.45	11.42±0.11^{a}	8.61±0.08^{a}
Sex	NS	NS	*	NS	*	NS	NS	*
Male	11.29±0.16	38.23±0.21	51.40±0.26	44.08±0.28	14.41±0.13	54.86±0.35	11.09±0.09	8.32±0.06
Female	10.90±0.16	37.66±0.21	50.50±0.25	43.59±0.27	14.01±0.13	54.07±0.34	11.16±0.08	8.15±0.06

LW = Live weight, BL = Body length, CG = Chest girth, WH = Wither height, LL = Leg length, LG = Loin girth, EL = Ear length and FL = Face length. NS = Non-significant, * = P<0.05, ** = P<0.01 and *** = P<0.001

The correlation coefficients observed between body weight and linear body measurements and among the linear body measurements were in general moderate to high and significant. This is in line with the work of (19) who reported coefficients of 0.91, 0.96, 0.93, 0.79 and 0.45 between the body weight and body length, chest girth, wither height, pelvic width and ear length, respectively in males and the corresponding values of 0.84, 0.87, 0.71, 0.83 and 0.41 in females. Similarly, (29) also reported a low, positive and significant relationship among the morphometric traits of Red Sokoto goats.

Table 4: Correlation coefficients among the linear body measurements and live weight

Variable	1	2	3	4	5	6	7	8
LW (1)	1	0.545**	0.662**	0.465**	0.322**	0.627**	0.205**	0.344**
BL (2)		1	0.655**	0.539**	0.339**	0.536**	0.245**	0.414**
CG (3)			1	0.599**	0.384**	0.792**	0.301**	0.479**
WH (4)				1	0.544**	0.514**	0.327**	0.411**
LL (5)					1	0.408**	0.150**	0.258**
LG (6)						1	0.218**	0.395**
EL (7)							1	0.260**
FL (8)								1

LW = Live weight, BL = Body length, CG = Chest girth, WH = Wither height, LL = Leg length, LG = Loin girth, EL = Ear length and FL = Face length. ** = P<0.01

The value obtained for coefficient of determination (R^2) when chest girth was used in the prediction of body weight in Red Sokoto kids was moderate (0.44), this is similar to the work of (37) who reported R^2 of 0.42 among the West African Dwarf goat reared in transitional zone of Ghana and that of (22) in short eared Somali goats (0.48). However, (13) reported higher R^2 of 0.82 and 0.73 for male and female Hararghe highland goats, respectively. The fact that prediction accuracy (R^2) increased with subsequent inclusion of some linear body measurements corroborate the findings of several investigators (15; 29;

13). They noticed higher precision in the predictive equation of live weight from body measurement when some quantitative body traits (those with higher correlation coefficient with live weight) were included.

Table 5: Prediction equation of live weight from some linear measurements

Model equation	Coefficient of determination (R^2)
LW = -9.86 + CG (0.42)	0.44
LW = -9.88 + CG (0.28) + LG (0.13)	0.47
LW = -11.36 + CG (0.21) + LG (0.12) + BL (0.14)	0.49

LW = Live weight, CG = Chest girth, LG = Loin girth and BL = Body length

Conclusions and Applications

1. The results indicated that the coefficients of variation observed among the morphometric traits were high.
2. Location and sex had no effect on most morphometric traits.
3. The correlation coefficients observed among the morphometric characters were in general moderate to high, positive and significant.
4. The coefficient of determination observed when chest girth was used in the prediction of live weight and in combination with loin girth and body length was moderate.

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