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PREDICTION OF TESTICULAR-EPIDIDYMAL PARAMETERS IN RELATION TO BREED, AGE, BODY WEIGHT AND BODY CONDITION SCORES OF THREE BREEDS OF GOAT

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Abstract

One hundred and twenty (120) matured randomly selected bucks of Red Sokoto Goat Buck (RSGB) (n = 47), West African Dwarf Buck (WADB) (n = 24), and Sahal Goat Buck (SGB) (n = 49) were collected. The overall mean body weight (BW, kg), Scrotal circumference (SC, cm), testicular weight (TW g), testicular circumference (TC cm), testicular length (TL cm), testicular volume (TV ml), testicular density (TD g/cm3), gonadosomatic index (GSI g/kg), epididymal weight (EW g), epididymal length (EL cm), caput weight (Capwt g), corpus weight (Copwt g), caudal weight (Caudwt g), Epididymosomatic index (ESI g/kg) and Epididymal-Testicular weight ratio (ETW g/g) measurements in all bucks were 13.42 kg, 18.70 cm, 89.15 g, 11.33 cm, 6.54 cm, 86.03 ml 1.03 g/cm, 3.52 g/kg, 12.10 g, 11.17 cm, 6.00 g, 1.39 g, 4.82 g, 0.49 g/kg and 0.14 g/g respectively. Breed had significant (P < 0.01) influence on all the parameters under investigation with Sahel Goat breed displaying greater mean values of BW, SC, testicular-epididymal parameters. The values of all paired testicular- epididymal parameters increased significantly with age with ≥ 3 years with the higher mean values and ≥ 1 year with lower mean values, with the exception of the TD, Copwt, ESI and ETW which decreased with age (P< 0.05). BCS fall within BCS1 –BCS4 which was non-significant differences (P> 0.05) in all the paired testicular-epididymal parameters. The multiple regression analysis of the linear combinations of BW, BCS, SC, TD and TV significantly predicted in all breeds. These findings provide data that can be used in preliminary selection of breeding goat bucks from a sexually mature population.

Keywords: Testicular-Epididymal Parameters Breed, Age Body Condition Scores and Body Weight.

INTRODUCTION

Goats rearing is gaining famous in Nigeria and the major problem is indiscriminate breeding, scarcity of superior bucks and lack of scientific breeding program (Jha *et al*., 2020). Goat are the most numerous of all domesticated ruminants in Nigeria with an estimated population of 76.3 million, representing about 6.56 % of the world's goat population (FAOSTAT, 2021). The indigenous goats play an important role in livelihood of smallholder farmers, especially those in rural areas where they are used as savings, insurance, security, assets, as well as social and cultural roles (Kadurumba *et al.,* 2021). Testicular-epididymal measurements is an important tool to determine normality as well as sperm production capacity of goat bucks, they are good indicator of sperm production potential. (Tizhe, 2011; NseAbasi, 2015; Baldaniya *et al*., 2020; Kumar *et al*., 2023). It is true, an important aspect of breeding soundness examination which is helpful in diagnosis, control and treatment of sub-infertility or infertility and also gives an indication about sperm concentration in the ejaculate of mature buck (Baldaniya *et al*., 2020). Breeding plans require

guarantee reproductive capacity of breeders, but in places with poor technical and laboratory support for semen assessment, breeders or farmers may need information on testicular dimensions. There is the need to establish measurable criteria for judging breeding soundness and guiding selection of goat bucks for breeding. Therefore, the present study was designed and conducted to predict the testicular-epididymal parameters in relation to breed, age, body weight and body condition scores of three breeds of goat.

MATERIALS AND METHODS

The study was conducted on apparently health bucks presented for slaughter in Mubi Slaughterhouse, Mubi is located at an altitude of 200 to 300 meters above sea level, between latitude 9° 20′ and 9° 33′N and longitude 12^0 30′ and 12º 50′ E in Northern Guinea Savanna Zone of Nigeria (Ovimaps, 2018). Ethical approval for the use of experimental goats' buck was obtained from the Animal Welfare and Ethical Committee of the Adamawa State University, Mubi.

One hundred and twenty (120) matured randomly selected bucks of RSGB (n = 47), WADB (n = 24), and SGB (n = 49) were collected at Mubi Slaughter House to be used for the study. Data were measured and collected by same person to minimize human error. The data were collected between 06:30 am and 08:00 am and the owner's bucks are collected at random and request are made for assistance from the Meat Inspectors. The reproductive organs of each breed of bucks were identified, labeled and transported in a cooler to the laboratory for evaluation (i.e. Department of Animal Production Physiology Laboratory of Adamawa State University, Mubi Nigeria). All measurements were performed by the same person to minimize human error.

Before slaughter, age were determine using the dentition method as described by Gatenby (2002), body weight (BW, kg) of each breed of bucks were recorded before slaughter using a portable balance and body condition score (BCS) were determined using scale 0-5 as describe by Gatenby (2002). The Scrotal circumference (SC, cm) was obtained using flexible metric and measured as the largest diameter of the testes and scrotum after pushing the testes firmly into the scrotum. The epididymis was severed from the testicles with surgical scissor before measurements was taken separately on the testicles and epididymis. Measurements of each pair of gonads (right and left) were described according to Goyal and Memon, (2007); Jimenez-Severiano *et al*., (2010), namely: TW g TC cm, TL cm, TV ml, TD g/cm^3, GSI g/kg, EW g, EL cm, Capwt g, Copwt g, Caudwt g, ESI g/kg and ETW g/g were measured.The average data of the paired of organs were used in the analysis. The data obtained were summarized and analyzed using Statistix 9.1 (Statistical Package for Scientists and Engineers, USA 2012). The effect of breed, age, BW, BCS and testicular-epididymal parameters were analyzed using one-way analysis of variance (ANOVA). Multiple regression equations (Separate prediction model) were created for each breed to predict testicular-epididymal parameters. The final modal suited were set out using the following equation:

$$Yi = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \cdots + B_nX_n, \quad (1)$$

Where Yi is the testicular and epididymal parameters; X_1.... X_n are the age, BW, BCS, breed; B_0 is the intercept; B_1,..., are the multiple regression coefficients of the independent variables X_1,...,X_n.

RESULTS AND DISCUSSION

Effect of Breed, Age and Body Condition Score on Body Weight and Scrotal Circumference of bucks

Significant (P < 0.01) breed effects was observed on the BW, with SGB having the highest (14.06±0.31 kg) and the least value (13.33±0.93 kg) recorded in WADB as shown in Table 1. This finding is in concordance with the findings of Tizhe (2011) in a study carried out on same breeds in Mubi, but the values recorded in this study exceeded the values recorded by (Abba and Igbokwe, 2015; Gemeda and Workalemahu, 2017; Ishaku *et al.,* 2023). The discrepancies in values might be due to age, physiological condition of the animals and other environmental factors. Report by Goyal and Memon (2007), show that there exist breed differences in terms of size and other biometric body parameters. Significant (P < 0.01) effect of age was found between all the body measurements. The values of all parameters increased numerically with age as bucks within the age bracket of (≤ 1 year) recorded 11.69±0.77 and those aged (≤ 2 years) recorded 12.96±0.84 and those within age bracket ≥3 years recorded 15.61±0.92 kg) for BW. Among the different age groups, BW and SC were highest in buck's aged ≥3 years. This shows that, the three variables are age dependent as they increased linearly with advancement in age. The results obtained in this study is in consonance with that of Tizhe, (2011) that worked on Sahel and Sokoto Red goats in Mubi. It is

also similar with the report by Sahi *et al.,* (2019) who carried a research on Indigenous Bucks of Algeria and reported that, all scrotal parameters increased linearly with advancement in age. Tizhe (2011) also, reported a significant (P < 0.05) season and age interaction effect on body and scrotal parameters. The mean BW of all the age groups differed significantly (P < 0.05). This scenario is, however, pertinent since the size and shape of the animal is expected to increase with advancement in age. The present findings were in line with those of Patni *et al.* (2016) Rahman *et al*. (2008) and Kabiraj *et al.* (2011). There is no significant (P > 0.05) BCS effect on all the body parameters under investigation. This is contrary to the report made by Tizhe (2011), who recorded a significant (P > 0.05) effect of BCS on all scrotal parameters. The non-significant (P > 0.05) effect of body condition score on most of the scrotal parameters under investigation in this study may be due to seasonal variation in feed availability as reported by Kubkomawa *et al*. (2016).

Effect of Breed on Paired of Testicular Weight, Testicular Circumference, Testicular Length, Testicular Volume, Testicular Density and Gonadosomatic Index Parameters of Bucks

Breed had significant (P < 0.01) influence on all the parameters under investigation. The analysis and comparison of some parameters measured show that breed has no significant (P < 0.05) effect on all testicular parameters. SGB recorded higher values of (97.61±5.99 g) for TW, (12.05±0.32 cm) for TC, (6.77±0.38 cm), for TL, (97.51±5.76 ml) for TV, while TD and GSI values are (0.98±0.05 g/cm^3) and (3.67±0.21 g/kg) respectively. The result obtained from this study is similar to the report by Tizhe, (2011) that worked on Sahel and Sokoto Red bucks. Least values of TW (87.84±6.70 g), TC (10.91±0.36 cm), TL (6.85±0.42 cm), TV (81.09±6.43 ml), TD (1.07±0.05 g/cm^3) and GSI (3.51±0.23 g/kg) were recorded in WAD.

TW was higher (97.61±5.99 g) in SG compared to that of RSG and WAD that recorded values of (87.84±6.70 g) and (81.99±5.56 g) respectively. The values obtained in this study are higher than the values recorded by Gemeda and Workalemahu (2017) in Afar, Long-eared Somali goats, and as well the values recorded by Sahi *et al*. (2019) in indigenous bucks of Algeria. TC was higher (12.05±0.32 cm) in SGB than in RSGB and WADB that recorded values of (11.05±2.77 cm) and (10.91±0.36 cm) respectively. This parameter differed significantly (P < 0.01) among the bucks. A similar report was made by Sofi *et al*., (2022) that worked on TC in adult Local rams, bucks, and bulls in the Duhok province. TV mean value established in this study is higher than the one recorded and reported by Gemeda and Workalemahu (2017) in Afar, Long-eared Somali, and Woyto-Guji breeds of buck and Ouchene-Khelifi *et al.,* (2020) in Algerian Arabia bucks.

TD is believed to be a good predictor of organ weight and fertility from BW and as well an enhancer of early selection of good sires, since sperm production is related to organ weights. TD (gcc^{-1}) of 1.00 ± 0.14, 1.01 ± 0.07, and 1.02 ± 0.13 reported by Ibrahim *et al*. (2012a) and Ezihe *et al*. (2017) were similar to the values recorded in the present study. Since TD in mammals is situated at about 1.0, (Courot *et al*., 1970; Paula *et al.,* 2002), the TW was considered equal to its volume (Melo *et al.,* 2010). The parenchyma volume can be obtained by subtracting the tunica albuginea weight from the testes weight.

The GSI which shows the relationship between total testicular mass and BW, in the current study is having an overall mean of (3.52 g/kg) for RSGB, (3.38±0.19 g/kg) for WADB (3.51±0.23 g/kg) and (3.67±0.21 g/kg) for SGB which is similar to the values reported by Atawalna *et al*. (2021) in Ghanaian WAD bucks and 3.51 ± 0.69g/ kg in Nigerian Sahelian goats (Abba and Igbokwe, 2015), but is higher than the 2.59 ± 0.40 g/kg reported by Sahi *et al.,* (2019) in an indigenous bucks of Algeria. Similarly, the GSI values are comparatively higher than those recorded on Shami, mountain black and hybrid Jordanian goat bucks (Omari *et al*., 2018). An increase in GSI can be induced by increase in gonad weight (Oyeyemi *et al.,* 2009). The results of GSI from this study shows how it is related with age, indicating that testes keep on growing until adult BW is attained and that, at (≥1 year it is about 3.03±0.19, then at ≤ 2 years it is 3.51±0.21 and at ≥3 years it can reach 4.03±0.23 g/kg).

Effect of Age on Paired of Testicular Weight, Testicular Circumference, Testicular Length, Testicular Volume, Testicular Density and Gonadosomatic Index Parameters of Bucks

All the testicular parameters seem to increase linearly (P > 0.05) with advancement in age, as bucks within the age bracket of ≥ 3 years had the highest values as shows in Table 1. Similar reports were made by Tizhe, (2011), Ezihe *et al*., (2017) and Sahi *et al.,* (2019) that most testicular parameters tend to increase with advancement in age. Information on age helps to improve the overall fertility of animals. In addition, age, breed, season and nutritional status

of the animal can have significant influence on testicular parameters, and subsequently the semen production capacity and the overall reproductive efficiency especially in small ruminants (Toe *et al.,* 2000; Mekasha *et al.,* 2007; Ugwu, 2009).

Effect of Body Condition Score on Paired of Testicular Weight, Testicular Circumference, Testicular Length, Testicular Volume, Testicular Density and Gonadosomatic Index Parameters of Bucks

The analysis and comparison of measurements in the four grades show that BCS_1, BCS_2, BCS_3 and BCS_4 did not significantly (P> 0.05) differ from each other for all testicular parameters. For the four grades, there were no variations in the values of all parameters under investigation, however, BCS_4 had highest numerical values (1.09±0.04 g/cm^3) of TD while BCS1 recorded highest values of TW (92.91±20.41 g), TC (11.72±0.97 cm), TV (95.49±19.59 ml) and GSI (4.96±0.70 g/kg) in that order. But, BCS_3 recorded the highest value (6.71±0.16 cm) of TL. BCS index of bucks and does can meet maximum standard for optimum reproductive performance within BCS_2 – BCS_5 as reported by Ouchene-Khelifi *et al*. (2020) that recorded a mean BCS for all the bucks at 2.01±0.24 which is synonymous with the result obtained from this study and that of (Gemeda and Workalemahu, 2017) in Ethiopia.

Effect of Breed on Paired Epididymal Weight, Epididymal Length, Caput Weight, Corpus Weight, Caudal Weight, Epididymosomatic Index and Epididymal-Testicular Weight Ratio Parameters of Bucks

Breed significantly (P < 0.001) influenced all the epididymal parameters as shown in Table 2. SGB breed recorded higher values of EW, Capwt, Copwt, Caudwt, EL, and ESI the values being, (13.23±0.74 g), (11.92±0.37 cm), (6.60±0.49 g), (5.18±0.34 g) (1.50±0.13 g), and (0.51±0.03 g/kg) respectively. RSGB recorded the highest value (0.15±0.03g/g) of ETW, but higher value (11.25±0.82 g) of EW was recorded in WADB as well as the least values (10.52±0.41 cm) of EL, (5.84±0.49 g) of Capwt, (0.48±0.03 g/kg) ESI and (1.24±0.13 g) of Copwt . Similar results were recorded and reported by Oyeyemi *et al*. (2012) in Sahel bucks, Bhattacharyya *et al*. (2010) in local sheep of Kashmir valley, AL-Mahmodi *et al*. (2017) in rams and bucks. The higher values of epididymal weight recorded among RSGB breed in this study contradicts the report of Muhmud *et al.* (2015) that reported a lower epididymal values (7.18±0.35 g) in Red Sokoto bucks.

Effects of Age on Paired Epididymal Weight, Epididymal Length, Caput Weight, Corpus Weight, Caudal Weight, Epididymosomatic Index and Epididymal-Testicular Weight Ratio Parameters of Bucks

The effect of age significantly (P<0.01) influenced epididymal parameters as depicted in Table 2. In the three age categories, the values of EW, EL, Capwt, Caudwt and ESI increased linearly with advancement in age. Bucks within the age bracket ≥ 3 years had highest values of EW (14.58±0.81 g), EL (12.27±0.40 cm), Capwt (7.29±0.44 g), Caudwt (5.63±0.38 g) and ESI (0.53±0.03 g/kg), but surprisingly, those aged ≤ 1 and ≥ 2 years had the highest value of ETW (0.16±0.01 g/g) and Copwt (1.49±0.14 g) respectively.

Table 1. Means ± SE by Breed, Age and Body Condition Score of Some Testicular Parameters of Buck

Variable	N	BW(kg)	SC (cm)	TW (g)	TC (cm)	TL (cm)	TV (ml)	TD (g/cm^3)	GSI (g/kg)
Overall mean	120	13.42	18.70	89.15	11.33	6.54	86.03	1.03	3.52
Breed		**	***	**	***	**	**	***	**
RSGB	47	12.88±0.77^{b}	18.62±0.38^{a}	81.99±5.56^{b}	11.05±2.77^{b}	5.99±0.35^{a}	79.49±5.34^{b}	1.04±0.05^{ab}	3.38±0.19^{a}
WADB	24	13.33±0.93^{ab}	18.40±0.45^{a}	87.84±6.70^{ab}	10.91±0.36^{b}	6.85±0.42^{a}	81.09±6.43^{b}	1.07±0.05^{a}	3.51±0.23^{a}
SGB	49	14.06±0.31^{a}	19.42±0.40^{a}	97.61±5.99^{a}	12.05±0.32^{a}	6.77±0.38^{b}	97.51±5.76^{a}	0.98±0.05^{b}	3.67±0.21^{a}
Age		**	***	**	***	**	**	***	**
≥1 year	53	11.69±0.77^{c}	17.31±0.38^{c}	66.43±5.58^{c}	10.09±0.30^{c}	5.11±0.35^{c}	64.08±5.36^{c}	1.05±0.05^{a}	3.03±0.19^{c}
≤2 years	42	12.96±0.84^{b}	18.47±0.41^{b}	85.94±6.69^{b}	11.36±0.33^{b}	6.38±0.38^{b}	86.09±5.83^{b}	0.98±0.05^{a}	3.51±0.21^{b}
≥3 years	25	15.61±0.92^{a}	20.31±0.45^{a}	115.07±6.63^{a}	12.54±0.36^{a}	8.31±0.39^{a}	107.93±6.36^{a}	1.05±0.05^{a}	4.03±0.23^{a}
BCS		**	***	**	***	**	**	***	**
BCS_0	0	-	-	-	-	-	-	-	-
BCS_1	1	9.56±2.83	18.84±1.34^{ab}	92.91±20.41	11.72±0.97	6.64±1.23^{a}	95.49±19.59	0.19±0.17^{a}	4.96±0.70^{a}
BCS_2	46	12.30±0.43	18.01±0.21^{b}	79.67±3.13	10.81±0.17	6.65±0.19^{a}	78.52±3.01	1.02±0.03^{a}	3.23±0.11^{b}
BCS_3	56	14.19±0.40	18.85±0.19^{a}	91.53±2.92	11.31±0.16	6.71±0.16^{b}	85.92±2.80	1.08±0.02^{a}	3.22±0.10^{b}
BCS_4	17	17.64±0.69	19.07±0.33^{a}	92.48±4.95	11.49±0.27	6.55±0.29^{c}	84.20±4.75	1.09±0.04^{a}	2.67±0.17^{c}
BCS_5	0	-	-	-	-	-	-	-	-
SEM		0.35	0.17	2.62	0.14	0.15	2.45	0.14	0.07

* = p<0.05 ** = p<0.01 *** = p<0.001 ns: no significant Note: means for groups in homogenous subsets and same superscript (s) are statically similar

It was generally observed that higher epididymal values were recorded in bucks aged ≥ 3 years than the younger bucks aged ≤ 1 year and ≤ 2 years in each breed. This trend is similar for all the parameters measured. However, SGB recorded highest values in all the epididymal measurement. Similar observation was made and reported by Tizhe, (2011).

Effect of Body Score Condition on Paired Epididymal Weight, Epididymal Length, Caput Weight, Corpus Weight, Caudal Weight, Epididymosomatic Index and Epididymal-Testicular Weight Ratio Parameters of Bucks

There significantly effect on BCS variation on some paired the epididymal parameters ($P < 0.001$). In the four grades, BCS_3 had highest values of EW (12.83±0.36 g), while BCS_4 recorded higher values of EL (12.17±0.30 cm) and Capwt (6.28±1.37 g). BCS_1 and BCS_3 had higher values of Copwt (1.88±0.48 g) and Caudwt (5.40±0.17 g), respectively. Still, BCS_1 recorded higher value of ESI (0.68±0.10 g/kg) while BCS_2 and BCS_3 had higher values of ETW (0.15±0.01 g/g) each.

Regression Coefficient and R^2 Values of Testicular Parameters of Bucks

The Regression Coefficient and R^2 Values of Testicular and Variables from Live Body Parameters in Red Sokoto Goat Buck

In Table 3, the linear combinations of BW, BCS, SC, TD, TV and TW significantly predicted testicular parameters in RSGB ($p < 0.001$). The R^2 indicated that SC, TW, TD and TV described successfully the variation of testicular variables in RSGB with SC (75%), TW (98%), TD (89%) and TV (98%) respectively. These parameters can conveniently be used and more reliable in predicting live body weight. The standardized coefficients suggested that SC contributed most to predicting TW and TV whereas, BW stood out as most linear predictor for TD. Thus, RSGB, weighing 12.88 Kg with a BCS ranges from BCS_1-BCS_4 and SC of 18.62 cm, would have TD, TV and TW, of 1.04 g/cm^3, 79.49 ml, and 81.19 g, respectively show in Table 1.

The Regression Coefficient and R^2 Values of Testicular Variables from Live Body Parameters in West African Dwarf Buck

In Table 5, the linear combinations of BW, BCS, SC, TD, TV and TW significantly predicted testicular parameters in WADB ($P < 0.001$). The R^2 indicated that SC, TW, TD and TV described successfully the variation in testicular variable of WADB where the values are SC (60 %), TW (99%), TD (92%) and TV (99%) respectively and can reliably predict live body weight. In WADB, the standardized coefficients suggested that SC contributed most to predicting TW and TV whereas BCS stood out as most linear predictor for TD and TV. Thus, WADB, weighing 13.33 Kg with a BCS ranges BCS_1-BCS_4 and SC of 18.40 cm, would have TD, TV and TW, of 1.07 g/cm^3, 81.09 ml, and 87.84 g respectively show in Table 1. TW and TV can reliably be used in predicting BW as observed in this study. This suggests that, combined with another variables, TW can be used to select males for testicular size at puberty since it is a reliable variable for estimating the sperm production capacity even when it varies depending on the breed (Ibrahim *et al.,* 2012). In order that weight could be estimated more accurately by combination of two or more measurements (Mohammed and Kibon, 2003; Thiruvenkanden, 2005) made similar observations as well.

The Regression Coefficient and R^2 Values of Testicular and Variables from Live Body Parameters in Sahel Goat Buck

In Table 4, the linear combinations of BW, BCS, SC, TD, TV and TW significantly predicted testicular parameters in SGB ($p < 0.001$).

Table 2. Mean±SE by Breed, Age and Body Condition Scores of Some Epididymal Parameters of Buck

Variable	N	BW (kg)	SC (cm)	EW (g)	EL (cm)	Capwt (g)	Copwt (g)	Caudwt (g)	ESI (g/kg)	ETW (g/g)
Overall mean	120	13.42	18.70	12.10	11.17	6.00	1.39	4.82	0.49	0.14
Breed		**	***	**	***	**	**	**	**	**
RSGB	47	12.88±0.77	18.62±0.38	11.82±0.68^{b}	11.08±0.38^{b}	5.84±0.37^{b}	1.24±0.13^{b}	4.79±0.32^{ab}	0.50±0.03^{a}	0.15±0.03^{a}
WADB	24	13.33±0.93	18.40±0.45	11.25±0.82^{b}	10.52±0.41^{b}	5.84±0.49^{b}	1.46±0.16^{ab}	4.79±0.32^{b}	0.48±0.03^{a}	0.14±0.01^{a}
SGB	49	14.06±0.31	19.04±0.40	13.23±0.74^{a}	11.92±0.37^{a}	6.60±0.49^{a}	1.50±0.13^{a}	5.18±0.34^{a}	0.51±0.03^{a}	0.14±0.01^{a}
Age		**	***	**	***	**	**	**	**	**
≥1 year	53	11.69±0.77	17.31±0.38	9.85±0.68^{c}	10.23±0.34^{c}	4.98±0.37^{c}	1.31±0.13^{a}	4.01±0.32^{c}	0.46±0.03^{b}	0.16±0.01^{a}
≤2 years	42	12.96±0.84	18.47±0.41	11.86±0.74^{b}	11.02±0.37^{b}	5.84±0.41^{b}	1.49±0.14^{a}	4.80±0.35^{b}	0.50±0.03^{ab}	0.14±0.01^{ab}
≥3 years	25	15.61±0.92	20.31±0.45	14.58±0.81^{a}	12.27±0.40^{a}	7.29±0.44^{a}	1.39±0.16^{a}	5.63±0.38^{a}	0.53±0.03^{a}	0.13±0.01^{b}
BCS		**	***	**	***	**	**	**	**	**
BCS_0	0	-	-	-	-	-	-	-	-	-
BCS_1	1	9.56±2.83	18.84±1.38	11.95±2.50^{ab}	10.59±1.25	6.28±1.37^{a}	1.88±0.48^{a}	4.46±1.17	0.68±0.10^{a}	0.13±0.03^{a}
BCS_2	46	12.30±0.43	18.01±0.21	11.43±0.38^{ab}	10.74±0.19	5.61±0.21^{a}	1.27±0.07^{a}	4.51±0.18	0.47±0.05^{b}	0.15±0.01^{a}
BCS_3	56	14.19±0.40	18.85±0.19	12.83±0.36^{a}	11.19±0.18	5.12±0.20^{a}	1.25±0.07^{a}	5.40±0.17	0.49±0.01^{b}	0.15±0.01^{a}
BCS_4	17	17.64±0.69	19.07±0.33	12.19±0.35^{ab}	12.17±0.30	6.02±0.33^{a}	1.20±0.12^{a}	4.89±0.28	0.36±0.02^{c}	0.14±0.01^{a}
BCS_5	0	-	-	-	-	-	-	-	-	-
SEM		0.35	0.17	0.29	0.15	0.15	0.04	0.13	9.41	3.10

* = p<0.05 ** = p<0.01 *** = p<0.001 ns: non-significant Note: means for groups in homogenous subsets and same superscript (s) are statistically similar

Table 3. Multivariable Regression Analysis of Testicular Parameter of Red Sokoto Goat Buck

Parameter	Predictor	Coefficient	S.E	T	Sig.	R^2	Adj. R^2	RMSE
SC (cm)	Constant	12.54	2.97	4.23	***	0.75	0.72	**0.99**
	BW	0.06	0.09	0.67	***			
	BCS	0.19	0.30	0.65	***			
	TD	-0.40	2.48	-0.16	ns			
	TV	0.03	0.05	0.55	ns			
	TW	0.04	0.04	0.81	***			
TW (g)	Constant	-6.83	6.83	-9.14	ns	0.98	0.98	**11.11**
	BW	0.04	0.31	0.14	ns			
	BCS	1.60	0.98	1.64	***			
	SC	0.42	0.52	0.81	***			
	TD	48.84	3.25	15.02	***			
	TV	1.01	0.04	23.49	***			
TD (g/cm^3)	Constant	1.10	0.13	9.16	***	0.89	0.87	**3.94**
	BW	3.01	5.77	0.52	ns			
	BCS	-0.03	0.02	-1.88	ns			
	TV	-0.02	1.10	-16.88	ns			
	TW	0.02	1.15	15.02	***			
	SC	-1.59	9.84	-0.16	ns			
TV (ml)	Constant	52.59	7.82	6.73	***	0.98	0.98	**10.09**
	BW	0.05	0.29	0.19	ns			
	BCS	-1.81	0.92	-1.19	ns			
	TW	0.92	0.04	23.49	***			
	SC	0.27	0.50	0.55	ns			
	TD	-47.30	2.80	-16.88	ns			

S.E: standard error and RMSE: Root mean squares error. $***p < 0.001$, $**p < 0.01$, $*p < 0.05$, and ns: non-significant.

Table 4. Multivariable Regression Analysis of Testicular Parameters of West African Dwarf Buck

Parameter	Predictor	Coefficient	S.E	*T*	Sig.	R^2	Adj. R^2	RMSE
SC (cm)	Constant	14.19	5.69	2.49	***	0.60	0.49	**1.73**
	BW	0.34	0.42	0.83	***			
	BCS	0.06	0.11	0.53	ns			
	TD	-0.68	0.27	-0.13	ns			
	TV	0.01	0.08	0.13	ns			
	TW	0.02	0.07	0.30	ns			
TW (g)	Constant	-77.21	10.86	-7.11	ns	0.99	0.98	**17.76**
	BW	0.52	1.35	0.40	ns			
	BCS	-0.30	0.34	-0.87	ns			
	SC	0.23	0.75	0.30	ns			
	TD	69.10	4.48	15.08	***			
	TV	1.09	0.05	23.53	***			
TD (g/cm^3)	Constant	1.09	0.15	7.40	***	0.92	0.92	**3.45**
	BW	-3.29	0.02	-0.17	ns			
	BCS	3.99	4.77	0.84	***			
	TV	-1.35	0.01	-0.13	ns			
	TW	-0.02	1.03	-14.36	ns			
	SC	0.01	8.89	15.08	***			
TV (ml)	Constant	65.97	11.21	5.89	***	0.99	0.98	**14.09**
	BW	-0.67	1.22	-0.55	ns			
	BCS	0.36	0.31	1.17	***			
	TW	0.09	0.68	0.13	ns			
	SC	0.89	0.04	23.53	***			
	TD	-62.27	4.34	-14.36	ns			

S.E: standard error and RMSE: Root mean squares error. $***p < 0.001$, $**p < 0.01$, $*p < 0.05$, and ns: non-significant.

Table 5. Multivariable Regression Analysis of Testicular Parameter of Sahel Goat Buck

Parameter	Predictor	Coefficient	S.E	*t*	Sig.	R^2	Adj. R^2	RMSE
SC (cm)	Constant	11.22	3.40	3.30	***	0.83	0.81	**2.11**
	BW	-0.07	0.21	-0.34	ns			
	BCS	0.12	0.04	2.99	***			
	TD	1.81	3.42	0.53	ns			
	TV	0.03	0.03	0.92	***			
	TW	0.01	0.04	0.31	ns			
TW (g)	Constant	-88.13	7.16	-12.30	ns	0.99	0.99	**33.34**
	BW	-1.24	0.82	-1.51	ns			
	BCS	0.37	0.16	2.30	***			
	SC	0.18	0.59	0.31	ns			
	TD	86.94	3.73	23.32	***			
	TV	0.95	0.03	28.19	***			
TD (g/cm^3)	Constant	0.93	0.09	10.35	***	0.96	0.95	**4.08**
	BW	0.02	9.03	1.63	***			
	BCS	-3.49	1.82	-1.92	ns			
	TV	-0.01	4.68	-25.85	ns			
	TW	0.01	4.56	23.32	***			
	SC	3.50	6.61	0.53	ns			
TV (ml)	Constant	81.39	9.28	0.77	***	0.99	0.99	**34.62**
	BW	1.30	0.83	1.56	***			
	BCS	-0.39	0.16	-2.35	ns			
	TW	0.99	0.04	28.19	***			
	SC	0.56	0.61	0.92	***			
	TD	-89.22	3.45	-25.85	ns			

S.E: standard error and RMSE: Root mean squares error. $***p < 0.001$, $**p < 0.01$, $*p < 0.05$, and ns: non-significant

The R^2 indicated that SC, TW, TD and TV described successfully the variation of testicular and variable in SGB with SC (83 %), TW (99%), TD (96%) and TV (99%) respectively were more reliable in predicting live body weight. The standardized coefficients suggested that SC contributed most to predicting TD and TV whereas BCS stood out as most linear predictor for SC and TW. Thus, SGB, weighing 14.04 Kg with a BCS ranges BCS_1-BCS_4 and SC of 19.42 cm, would have TD, TV and TW, of 0.98 g/cm^3, 97.51 ml, and 97.61 g, respectively show in Table 1.

Conclusion and Recommendation

In conclusion, this study presented reproductive organs and body measurements on three breeds of goat. Breed was found to influence BW, SC, age, and BCS and testicular-epididymal parameters in RSGB, WADB and SGB. SGB breed displayed higher in BW, SC, testicular-epididymal parameter. The age tends to increase significantly with parameters can be easily measured on live bucks and could be used to predict the BW, SC, BCS, TD, TV and TW. SGB was recommended the best for fertile buck for breeding selection, age should be used for reproductive ability test in their natural environments.

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CONFLICT OF INTERESTS

The authors declared that there are no conflicts of interest concerning this manuscript.

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