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TESTICULAR MORPHOMETRY AND PREVALENCE OF CRYPTORCHIDISM AMONG THREE GOAT BREEDS IN SOUTHERN NIGERIA

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ABSTRACT

This study determined the testicular morphometry of three goat breeds namely: Borno Sahel (BS), Red Sokoto (RS) and West African Dwarf (WAD). Testicular morphometric traits measured were scrotal circumference (cm), length (cm) and weight (kg). In addition, incidence of cryptorchidism was monitored by palpating the scrotum and noting number of descended testes as well as position of non-descended testes in individual goats among the breeds. A total of 90 goats (30 per breed) aged between 1 and 3 years old were used in the study. Data obtained from the study were subjected to one - way analysis of variance (ANOVA) for Completely Randomized Design (CRD). Significant means were separated using Duncan's Multiple Range Test. Result showed that WAD goat had the highest mean scrotal circumference (23.11cm) and testicular length (14.38 cm) with significant difference ($p<0.05$). The effect of age showed that 3 years old goat bucks had the highest testicular length (17.25 cm) and testicular circumference (26.97cm) with significant difference ($p<0.01$), while 1 year old bucks had the heaviest testicular weight (13.9 kg). Correlation analysis showed a strong positive (0.741) relationship between the testicular length, circumference and weight and body weight of the goats. There were comparable results on the effect of age and breed and their interaction on their testicular morphometry. Out of 90 bucks examined, three bucks were found to be unilaterally cryptorchids on the right testis; two in Borno Sahel breed (6.67 %) and one in the Red Sokoto breed (3.33%). The West African Dwarf goats, by reason of their heavier testicles, had better sperm production and storage capacity in the study area than the Red Sokoto and Borno Sahel breeds. The study concluded that the high degree of association between body weight and scrotal length, scrotal circumference and testicular weight of bucks implied that goats can be selected for scrotal traits based on their body weight. Similarly, scrotal morphometry of goat bucks in Calabar is a good indication of their breeding soundness.

Key words: Breeding, genetic, goat breeds, sperm production, testicular morphometry, reproduction

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INTRODUCTION

Goat keeping is one of the veritable sources of revenue and food security for many rural dwellers in developing countries like Nigeria [1]. Goats adapt easily and quickly to tropical climate with good production potential. Ivanovic *et al.* [2] reported that goats are very popular animals in the world for meat and milk production being surpassed in number only by cattle, pigs, sheep and chickens . Their ability to scavenge from limited available resources and produce meat and milk, make them the species of choice in countries with scarcity of feed resources [3].

Productivity of goats may be endangered by testicular anomalies as a healthy reproductive system is essential to achieve high reproductive performance. Margetin *et al.* [4] opined that efficient controlled breeding programme for high reproductive performance could be achieved by understanding the factors that influence reproduction in goats. The assurance of viable reproductive capacity of sires is a sinequanon in good breeding programmes, but in the absence of adequate technical and laboratory support for semen evaluation, farmers need a reference range of testicular sizes, which might be related with adequate sperm reserve for reproductive efficiency [5]. The measurement of testicular size during the period of adolescence can provide fair indication to find out the age at which the males can be used for breeding purpose [6]. It has been reported that bucks having naturally high libido can be reliably selected for breeding based on measurements of scrotal circumference, length or width of the testes [7]. Marked increase in testicular size indicates onset of active spermatogenesis [8]. Cryptorchidism is a failure of one or both testicles to descend from the abdominal cavity into the scrotum. Cryptorchidism could be unilateral or bilateral. It has been observed that 3.8 - 70% prevalence rates of testicular abnormalities have been reported in Nigeria [9], 70% prevalence for cryptorchidism being reported among the West African Dwarf bucks of southeastern Nigeria [10]. Olusa *et al.* [11] reported concurrent unilateral cryptorchidism with a scrotal and inguinal hernia in the West African dwarf sheep.

Reproductive performance of the buck depends upon the standard structure and functions of genital organs. In a bid to increase and improve goat production in Nigeria, the effect of breed on testicular morphometry is essential for an optimal and rational utilization of the breeding stock. Testicular characteristics in bucks include scrotum circumference, length and width, right and left testicular length and diameter. These parameters are used most often because it is easy to measure and display a high correlation with body weight and reproductive capacity (libido), particularly sperm production [12]. It has been reported that measurement of scrotal circumference, testes length, weight and width would be a reliable predictor of the sperm-producing capacity of bucks and they can be used to select for improved sperm production and breeding males [13]. Reduced testicular size associated with

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the incidence of testicular hypoplasia may constitute a risk factor for abnormal spermatogenesis [8]. The testicular size of a hypoplastic testis is symmetrically reduced to half the normal or seven times the normal when testicular length/mid-circumference or weight was considered, which is visually obvious from gross examination. Accordingly, farmers would be capable of diagnosing such cases in order to cull them from breeding programmes and avoid reproductive inefficiency [14].

Thus, this study was carried out to examine the testicular morphometry and prevalence of hypoplasia among three local goat breeds (Red Sokoto, Borno Sahel and West African Dwarf).

MATERIALS AND METHODS

Study location

The study was carried out at the Small Ruminant Unit of the Teaching and Research Farm, University of Calabar, Calabar, Southern Nigeria. Calabar is located within the tropical rain forest zone of Nigeria. It is located on latitude 4°57′ N of the equator and longitude 8°19′ E of the Greenwich meridian with a land mass of 604 km^2. Its relative humidity is between 55 and 99 %, with an elevation above sea level of 32 meters. The average annual rainfall is 1830 mm and average daily temperature is 28.20 °C (77 °F), respectively.

Experimental animals and management

Animals for the study were sampled across five abattoirs within Calabar metropolis in Cross River State, Nigeria. Data were collected from a total of 90 goat bucks (30 per breed) aged between one and three years, with average body weight range (35 - 45 kg). Age of bucks was determined using rostral dentition. Breed was determined using their coat colour and other breed characteristics and also further confirmation from the goat sellers. The scrotum of bucks was palpated to determine if testicles were descended or not and locations of the testicular anomaly (cryptorchidism) were noted.

Determination of testicular morphometry

The testicular morphometry of three breeds of goat bucks namely; Red Sokoto, Sahel and West African Dwarf was determined. The testicular samples were collected after slaughtering. Measurements of individual goat testicles were carried out using a measuring tape graduated in centimetres. The weight of individual goat testicles was taken using New Spring Laboratory Digital Weighing Balance and live weight of goats using a spring balance. Measurement of testicular parameters of the goats was carried out following the procedures of Oyeyemi *et al*. [15].

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Scrotal Length (SL)

This was measured along the longitudinal axis of each testis beginning from one pole of the testis to the other pole. It was carried out with the use of tailor's measuring tape and recorded in centimetres.

Scrotal circumference (SC)

This was obtained with tailor's measuring tape. It was measured at the largest diameter of the testes and scrotum recorded in centimeters.

Testicular weight (TW)

This was measured by placing the testes on a sensitive weighing scale, recorded in kilograms.

Data analysis

Data obtained in this study were analyzed using one - way Analysis of Variance (ANOVA) for Completely Randomized Design (CRD). Significant means were separated using Duncan's Multiple Range Test (DMRT). Pearson correlation coefficients were equally analyzed utilizing Statistical Package for Social Sciences (SPSS) Version 22 Computer Package to assess the association between measured traits.

The statistical model used was:

$Y_{ijk} = \mu + B_i + A_j + BA_{ij} + e_{ijk}$

Where:

Y_{ijk} = Individual reading
μ = Overall mean
B_i = Fixed effect of breed
A_j = Fixed effect of age
BA_{ij} = Effect of interaction between breed and age
e_{ijk} = Experimental error

RESULTS AND DISCUSSION

The result of the effect of breed on testicular parameters of goats is presented in Table 1. Testicular weight was shown to be significantly ($p<0.05$) affected by goat breeds. The WAD goats had significantly ($p<0.05$) heavier testicles than the Red Sokoto and Bornu Sahel goat breeds. Larger scrotal circumference signifies propensity to accommodate greater semen storage [10]. The superiority of the WAD breed in scrotal weight could indicate high reproductive potential of this breed. Brito *et al*. [12] asserted that heavier testes produce more spermatozoa than smaller ones, while Soderquist and Hulten [16] argued that males with larger testes sire daughters that reach puberty earlier and ovulate more ova in each oestrus. This observed difference corroborates the report of Bitto and Aroh [17] of reproductive differences

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based on genotype. Scrotal circumference values obtained in this study were similar to the findings of Raji *et al.* [18] in Red Sokoto (23.99 cm) and Borno Sahel (20.75 cm) bucks. Marked increase in testicular size indicates onset of active spermatogenesis [8]. Scrotal length and circumference of the goats were not significantly ($p>0.01$) different among the breeds. Value of testicular traits obtained in this study were generally higher than figures reported by Sahi *et al.* [19] in Algerian indigenous bucks. Incidence of cryptorchidism was not widespread among the breeds, however, the few cryptorchid incidences were unilateral.

Effect of age on testicular morphometry of goats is presented in Table 2. Results showed that age affected scrotal length, circumference and testicular weights of goats with significant ($p<0.001$) effect at different ages. Testicular parameters increased significantly ($p<0.001$) with age; the three-year old goats were superior. The number of descended testicles remained relatively constant across all the three age groups. Incidence of cryptorchidism was low (2.50 and 0.5%) among one and three-year olds, respectively, but non-existent among two-year old bucks. Mean testicular weights (3.28 - 4.37 kg) in this study were higher than the range (0.03-0.10 g) reported by Abba and Igbokwe [20] in Red Sokoto goats aged 12-36 months. Sarlos *et al.* [21] observed that growth in testicular weight was higher before 12 months of age, but decreased by 24 months in the WAD goats. This trend was in tandem with the outcome of the present study as testicular weight of one-year-old bucks was numerically higher, though not statistically different ($p>0.001$) from the two-year olds. Sahi *et al*. [19] reported that there is a linear relationship between testicular measurements and age, while Bongso *et al.* [22] agreed that testicular measurements increased with age and body weight in Malaysian goats. Foc *et al*. [23] asserted that sexual maturation takes place during puberty and that testicular growth is sustained in this period which is when the proliferation of seminiferous tubule epithelium is associated with an increase in sperm production. Sahi *et al*. [19] reported that testes grow until mature body weight is attained and that age of sexual maturity in male goats is 12- 18 months. Testicular parameters in this study were highest at three years of age, it therefore implies that sperm production and storage could be highest at this period as well. It is therefore pertinent that breeding bucks could be selected in the study area from three years of age. Sperm production and storage are highly related to organ weights [17], by the findings of this study, the goats in the study area were expected to exhibit good sperm production and subsequent reproductive performance.

Cryptorchidism prevalence in this study was not rampant but out of the three cases observed, two were in one-year old bucks and one in a three-year old. The three incidences were unilateral and on the right testes. Adeyeye *et al*. [5] reported a similar trend of unilateral cryptorchidism among rams in the right testes. Bousmaha

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and Khoudja [24] and Abba *et al.* [8] reported 8.4 and 15.1% testicular abnormalities among rams and bucks, respectively. The low prevalence of cryptorchidism in Calabar could be because goats slaughtered by private individuals in the city are not brought to the abattoirs for examination before slaughter.

Table 3 shows the interaction of age and breed on mean testicular morphometry of goats. There were significant interactions between age and breed on testicular morphometry, as goats get older, their testicular measurements increase in size. Three-year old bucks were significantly ($p<0.001$) higher in testicular length, circumference and weight among the three breeds than the two and one-year olds. Bucks of same age compared favourably in their testicular measurements irrespective of breed. The observed increment in testicular parameters with increment in age of the bucks is expected as the animals are still within active growth stages (1- 3 years). This observation is in tandem with reports of previous workers [19].

Linear correlation of body weight and testicular parameters of goats at ages 1-3 years is presented in Table 4. Body weight was highly and significantly ($p<0.01$) associated with scrotal length, scrotal circumference and testicular weight at three years of age. High and positive correlation coefficients were equally recorded between scrotal length and scrotal circumference at ages one, two and three years old than between other pairs of parameters. The magnitude of associations between body weight and testicular parameters recorded in this study indicate that bucks in the study area could be selected as breeding males based on their body weight. Sahi *et al.* [19] reported correlation coefficients of 0.74, 0.70 and 0.86 between body weight and scrotal circumference, testicular length and testicular weight, respectively in Algerian indigenous bucks. Findings of the present study are in agreement with reports of Bourn *et al*. [25] and Sahi *et al*. [19]. It has been reported by Ogwuegbu *et al*.[26] that testicular weight and circumference are positively correlated with sperm storage, therefore bucks in the present study exhibited good performance in this respect and could be selected for improved sperm production as breeding males based on their testicular parameters.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The West African Dwarf goats, by reason of their heavier testicles, had better sperm production and storage capacity in the study area than the Red Sokoto and Borno Sahel breeds. Three-year old bucks had higher testicular length, circumference and weight among the three breeds. Incidence of cryptorchidism was low among one and three-year olds, but non-existent among two-year old bucks. Cryptorchidism incidences were recorded among the Borno Sahel and Red Sokoto breeds. The high degree of association between body weight and scrotal length, scrotal circumference

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and testicular weight of bucks implied that goats can be selected for scrotal traits based on their body weight. Similarly, scrotal morphometry of goat bucks in Calabar is a good indication of their breeding soundness.

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Conflict of interest

The authors declare unequivocally that there is no conflict of interest in this study.

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Table 1: Effect of breed on testicular morphometry of goats

	Breeds			
Parameter	**Borno Sahel**	**Red Sokoto**	**WAD**	**SEM**
Scrotal Length (cm)	14.91	14.38	14.38	0.17
Scrotal Circumference (cm)	22.59	22.34	23.11	0.26
Testicular Weight (kg)	3.61^{ab}	3.56^{b}	3.81^{a}	0.05
Cryptorchidism incidence (%)	6.67	3.33	0.00	0.01

^{a,b} Means on the same row with different superscripts are significantly different ($p<0.05$)
SEM = Standard error of mean
WAD= West African dwarf

Table 2: Effect of age on testicular morphometry of goats

	Age (1-3 years)			
Parameters	**1**	**2**	**3**	***p - value***
Scrotal Length (cm)	11.81^{c}	14.17^{b}	17.25^{a}	0.001
Scrotal Circumference (cm)	19.41^{c}	21.25^{b}	26.97^{a}	0.001
Testicular Weight (kg)	3.39^{b}	3.28^{b}	4.37^{a}	0.001
Cryptorchidism incidence (%)	6.67	0.00	3.33%	0.001

^{abc} Means on the same row with different superscripts are significantly different ($p<0.05$)

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Table 3: Age and breed and interaction on mean testicular morphometry of goats

		1 year			2 years			3 years		
Parameter	**Borno**	**Red**	**WAD**	**Borno**	**Red**	**WAD**	**Borno**	**Red**	**WAD**	***p - value***
Testicular Length (cm)	12.95±0.42^{c}	11.20±0.41^{c}	11.27±0.33^{c}	14.47±0.28^{b}	13.56±0.29^{b}	14.49±0.33^{b}	16.75±0.33^{a}	17.60±0.33^{a}	17.38±0.33^{a}	0.001
Testicular Circumference (cm)	20.05±0.65^{b}	18.00±0.63^{c}	20.17±0.51^{b}	21.27±0.44^{b}	20.43±0.45^{b}	22.05±0.51^{b}	26.01±0.51^{a}	27.78±0.51^{a}	27.10±0.51^{a}	0.008
Testicular Weight (kg)	3.51±0.14^{b}	3.37±0.13^{bc}	3.28±0.11^{c}	3.22±0.09^{c}	3.09±0.09^{c}	3.54±0.11^{b}	4.19±0.11^{b}	4.31±0.11^{a}	4.59±0.11^{a}	0.026
Percentage of descended testes	95+0.02	100±0.02	100±0.02	100±0.02	100±0.02	100±0.02	98.5+0.02	100±0.02	100+0.02	0.005

$^{a, b}$ Means on a row with different superscripts are significantly different ($p<0.05$)
Mean ± Standard error

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Table 4: Linear correlation of body weight and testicular parameters of goats at ages 1-3 years

Age		SL	SC	TW	BW
	SL	1.000			
1	SC	0.649**	1.000		
	TW	0.293*	0.471**	1.000	
	BW	0.483**	0.561**	0.600**	1.000
	SL	1.000			
2	SC	0.680**	1.000		
	TW	0.519**	0.539**	1.000	
	BW	0.685**	0.572**	0.695**	1.000
	SL	1.000			
3	SC	0.572**	1.000		
	TW	0.348*	0.514**	1.000	
	BW	0.741**	0.652**	0.714**	1.000

*(P<0.05), SL= scrotal length, SC= scrotal circumference, TW= testicular weight
BW= body weight
**(P<0.01)

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