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Sperm Production Rate, Gonadal and Extragonadal Sperm Reserves in the Sokoto Red (Maradi) Buck in a Tropical Environment

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***Abstract*—**28 healthy adult Maradi bucks were used to evaluate sperm production and sperm storage capacity in the breed. Daily sperm production (DSP) averaged $0.55\pm0.05x10^{9,}$ while the daily sperm production/g (DSP/g) was 1.37 ± 0.12 $x10^{7}$. Gonadal sperm reserve was 1.99 ± 0.18 $x10^{9}$, while the caput, upper corpus and lower corpus averaged 0.58 ± 0.04 $x10^{9}$, 0.36 ± 0.02 $x10^{9}$ and 0.33 ± 0.08 $x10^{9}$ respectively. The proximal cauda, mid cauda, distal cauda and ductus deferens had values of 0.68 ± 0.10 $x10^{9}$, 1.23 ± 0.16 $x10^{9}$,$1.87\pm0.$ $x10^{9}$and 0.17 ± 0.05 $x10^{9}$ respectively. The relative contributions of the respective epididymal sections and ductus deferens to the total extragonadal sperm reserves were, 11.11%, 6.89%, 6.32%, 13.03%, 23.56%, 35.82% and 3.26% respectively. Gonadal sperm reserves were significantly higher ($p<0.05$) than caput reserves, upper corpus reserves, lower corpus reserves, proximal cauda reserves and ductus deferens reserves. Gonadal reserves were however similar ($p>0.05$) to mid cauda and distal cauda epididymal reserves.

***Keywords*—**Goats, Reserves, Sperm, Tropics

I. Introduction

GOATS are very important animals in subsistence Agriculture in the humid tropics. Of the many breeds of goats found in the West African sub-region, the Sokoto Red (Maradi) genotype is very popular, has a wide geographical spread and is particularly of great economic importance, being the source of the Moroccan leather, known in Europe from the medieval period onward. Even though the Sokoto Red is the most popular goat breed in Nigeria, it still remains unimproved like the West African Dwarf (WAD) genotype, reported to be one of the most prolific in the world; going by the number of young produced per doe per year [1].

The genetic improvement of goats elsewhere has however brought about much higher economic gains elsewhere [2].Preparatory to the improvement of these indigenous genotypes therefore, several aspects of the reproductive physiology of the bucks of these breeds in their native environment have been documented [3]-[9] in the WAD and [10]-[12] in the Maradi. None of these reports however borders on sperm production rate, gonadal and extragonadal sperm reserves in Maradi bucks in the derived Guinea Savannah which is a wide geographical belt with distinctive climatic conditions unlike in the WAD [5]. Such information will however be useful in the determination of the male /female ratio at natural mating as well as contribute to a better understanding of the kinetics of spermatogenesis in male goats raised under tropical conditions [13], [5].

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Moreover, with sperm production rate and sperm storage capacity being specie and breed specific, it becomes necessary to evaluate these key aspects of testicular function in Maradi bucks under the current traditional rearing system in the tropics. Such information will thus provide a base line for comparism when controlled breeding schemes commence in these regions. This work was thus designed to characterize the sperm production rate, gonadal and extragonadal sperm reserves in Maradi bucks, raised extensively in a lowland humid tropical environment.

II. Materials And Methods

A. Location

This study was conducted at a State Government Abattoir at Wurukum in Makurdi, the State Capital of Benue State, Nigeria and the Animal Physiology Laboratory of the University of Agriculture Makurdi. Makurdi lies 90m above sea level in the Benue Valley, located on longitude 8^{0} 31' East and latitude 7^{0} 45' North with distinctive dry (November - March) and wet (April -October) seasons.

B. Sampling

Reproductive tracts were obtained *intoto* from healthy adult Sokoto Red bucks immediately after slaughter between 0600 and 0700 h and transported to our laboratory in an ice-box for analyses. Samples were collected twice a week in the early dry season for a period of two months. A total of 28 samples were evaluated in this study. The testes and epididymides were dissected out, trimmed free of fat and adhering connective tissue. Beyond the three basic anatomical divisions (caput, corpus, cauda), each epididymis was further dissected into caput, upper corpus, lower corpus, proximal cauda, mid cauda and distal cauda. Each testis, epididymal section and ductus deferens were then weighed, homogenized and sperm concentration determined haemocytometrically as earlier reported by Bitto and Egbunike [5]. Gonadal and extragonadal sperm reserves were evaluated by the method of Amann and Almquist [13] as we earlier reported [5]. Data was analyzed using the student's t test between pairs of organs and the one way analysis of variance (ANOVA) between regions of the reproductive tract [14]. Where significant effects were obtained, the means were separated using the Duncan's Multiple Range Test (DMRT).

III. Results and Discussion

A summary of Daily sperm production (DSP) in the Red Sokoto buck in a Southern Guinea Savannah is presented in Table I while that of Gonadal sperm reserves is shown in Table II. DSP values obtained in this study were slightly lower than the mean values reported for the same breed in Ibadan (with a semi-hot equatorial climate) by Carew and Egbunike [10].

The Daily sperm production/g testis (DSP/g) in the present study was however comparable to values in the report of Carew and Egbunike [10]. While the similarity between the two reports in the efficiency of spermatogenesis may be said to be characteristic of the breed in the tropics, the lower DSP in Makurdi may imply differences in nutrition and sexual behavior of the animals in both locations. These differences may also be due to diurnal variations as Thimonier *et al*. [15] implicated photoperiod as the primary factor affecting reproduction in small ruminants in the tropics with high ambient temperature as a secondary factor. Both DSP and DSP/g in the Sokoto Red buck in the present study as well as in the report of Carew and Egbunike [10] are respectively much lower than corresponding values reported by Bitto and Egbunike [5] in the WAD, thus implying breed differences in spermatogenesis and its efficiency. Gonadal sperm reserves in the present study were similar to values reported by Ogwuegbu *et al*. [11] in Ibadan, Western Nigeria. Although total caput and total corpus sperm reserves in the present study are comparable to values reported by Ogwuegbu *et al*. [11] in Ibadan, total cauda reserves in the present study are higher than what was reported for the same breed in Ibadan. While the similarities confirm the characteristic sperm storage capacity of these animals during the maturation phase, the differences in cauda reserves indicate possible differences in sexual behavior, exposure and probably photoperiod [15]. DSP, DSP/g testis, gonadal and extragonadal sperm reserves obtained in the present study and in the report of Carew and Egbunike [10] in Ibadan are likewise respectively lower than corresponding values reported in West African (WAD) bucks [5]. These results thus confirm breed differences in the reproductive capacity of goats in the tropics which are in turn dependent on a number of factors including nutrition, health, frequency of ejaculation photoperiod and ambient temperature. With regard to percentage sperm storage capacity, the superiority ($p<0.05$) of the gonads over the caput, corpus epididymis and ductus deferens as well as the similarities ($p>0.05$) between the gonads and the cauda epididymis in sperm storage capacity is expected going by the normal physiological functions of these regions of the reproductive tract in relation to spermatogenesis, testicular and sperm physiology. The caput, upper corpus and lower corpus contributed 11.11%, 6.89% and 6.32% respectively while the proximal cauda, mid cauda, distal cauda and ductus deferens respectively contributed 13.03%, 23.56%, 35.82% and1.37% to sperm storage. In the absence of literature values to compare our sub divisions of the epididymis with, we consider these values as base line and foundational for further research. Also as the animals in this study were managed extensively, we expect higher values in the parameters evaluated when these animals become intensively managed.

IV. Conclusion

We conclude from the reproductive capacity of the Sokoto Red buck reared extensively that good sires can be obtained from these animals as genetic resources to support planned breeding programmes for the goats in the derived Guinea Savannah.

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TABLE I
DAILY SPERM PRODUCTION (DSP) AND DAILY SPERM PRODUCTION/G TESTIS (DSP/G) IN MARADI BUCKS IN A HUMID TROPICAL ENVIRONMENT (MEANS ± SEM)*

Parameters	Values		Level of Significance
DSP (x 10^9)	Left	0.28±0.03	ns
	Right	0.27±0.02	ns
	Paired	0.55±0.05	ns
DSP/g (x 10^7)	Left	0.68±0.06	ns
	Right	0.69±0.05	ns
	Paired	1.37±0.12	ns

sem = Standard error of mean, ns = ($p>0.05$) (between left & right organs).

TABLE II
GONADAL AND EXTRAGONADAL SPERM RESERVES IN MARADI BUCKS IN A HUMID TROPICAL ENVIRONMENT (MEANS ± SEM)

Parameters	Values		Level of Significance
Testis (x10^9)	Left	1.01±0.09	Ns
	Right	0.98±0.08	ns
	Paired	1.99±0.18[a]	ns
Caput (x10^9)	Left	0.28±0.02	Ns
	Right	0.28±0.03	ns
	Paired	0.58±0.04[b]	ns
% Contribution of caput	11.11%		
Upper corpus (x10^9)	Left	0.17±0.01	Ns
	Right	0.18 ±0.02	
	Paired	0.36± 0.02[b]	
% contribution of upper corpus	6.89%		
Lower corpus (x10^9)	Left	0.17±0.03	Ns
	Right	0.16±0.04	
	Paired	0.33±0.08[b]	
% contribution of lower corpus	6.32%		
Proximal cauda (x10^9)	Left	0.35±0.05	Ns
	Right	0.33±0.05	
	Paired	0.68±0.10[b]	
% contribution of proximal cauda	13.03%		
Mid cauda (x10^9)	Left	0.64±0.09	ns
	Right	0.60±0.08	
	Paired	1.23±0.16[a]	
% contribution of mid cauda	23.56%		
Distal cauda (x10^9)	Left	0.89±0.11	ns
	Right	0.93±0.09	
	Paired	1.89±0.18[a]	
% contribution of distal cauda	35.82		
Ductus deferens (x10^9)	Left	0.08±0.03	
	Right	0.08±0.02	
	Paired	0.17±0.05[b]	
% contribution of ductus deferens	1,37		

sem = Standard error of mean; ns= ($p>0.05$) between left & right organs; a,b : paired values bearing different superscripts (vertically) differ significantly ($p<0.05$).