

Seasonal Variations in the Histometric Characteristics of the Reproductive Organs of Pubertal West African Dwarf Bucks in their Native Tropical Environment

Variaciones Estacionales en las Características Morfométricas de los Órganos Reproductivos de la Cabra Enana Púber Macho del Oeste Africano en su Medio Ambiente Nativo Tropical

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BITTO, I. I.; EGBUNIKE, G. N. & AKUSU, M. O. Seasonal variations in the histometric characteristics of the reproductive organs of pubertal West African dwarf bucks in their native tropical environment. *Int. J. Morphol.*, 26(2):397-401, 2008.

SUMMARY: As ambient temperature and humidity are high all year round within clearly defined dry and rainy seasons in our humid tropical environment, we evaluated the effects of season on the histometric characteristics of the reproductive organs of pubertal West African dwarf bucks using 8 healthy animals. There were no significant differences ($p>0.05$) between the rainy and dry seasons in the basement membrane of the testes, seminiferous tubular diameter, and round spermatid nuclear diameter. There were also similarities ($p>0.05$) between the seasons in epididymal luminal diameters, epididymal epithelial heights as well as in Leydig/sertoli cell ratio and sertoli cell index. Quadratic regression analyses showed that all the histometric characteristics of the testes are highly predictable from the live weights of the animals. It is concluded from these results that the WAD goat would not have a restricted breeding season in its native tropical environment. Young sires could therefore be selected early in life for planned improvement programmes in research institutions and breeding centers thus providing farmers with quicker returns for their investments.

KEY WORDS: Goats; Testes; Histometric; Seasons; Tropics; Farmers.

INTRODUCTION

Goats along with sheep have been reported to have the widest ecological distribution of any domestic livestock (Salem *et al.*, 1982) and seem to be better adapted to hot environments than both sheep and cattle (Coop, 1982; Valez-Nauer *et al.*, 1982). Bianca & Kunz (1978) reported that goats were more susceptible to heat stress than sheep and cattle as measured by a rise in body temperature outward signs of stress and reduction in performance. Other workers also confirmed increases in body temperature in goats with increasing environmental temperature (Hetzel *et al.*, 1988; Egbunike & Bitto, 1980).

High ambient temperatures however have for long been known to depress spermatogenesis, and hot climates tend to negate the effects of the descent of the testes into the scrotum (Egbunike *et al.*, 1985). Moreover, a primary response of most species to heat stress is a reduction in energy intake (Bongso *et al.*, 1982) with a concomitant lowered

productivity. With ambient temperature high all year round in the humid tropics and with significant differences between seasons in the physiologically effective temperature (PET) for goats in the environment (Egbunike & Bitto), it becomes necessary to investigate the effects of season on all aspects of the physiology of reproduction in tropical breeds of goats in their native environment. Such information will be useful in the applications of modern reproductive biotechnological techniques like artificial insemination (AI) and intracytoplasmic sperm injection (ICSI) in the tropics to augment the productivity of goats.

Due to the flexible integration of the WAD goat into the most diverse socio-economic conditions in the West African sub-region (Sumberg & Cassaday, 1985), its improvement not only in terms of meat production but also milk production as has been done in France (Leboeuf *et al.*, 1998), will be of immense benefits to farmers in the sub-region.

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Though season in our recent report (Bitto & Egbunike, 2006) had no effect on sperm production, the efficiency of spermatogenesis and the sperm storage capacity of pubertal WAD bucks in the same environment, there still remains a dearth of information on the effect of season on the histometric characteristics of the reproductive organs in these animals as they are constantly exposed to the prevalent ambient temperatures in the seasons as they scavenge. This situation becomes the more worrisome as whole body heating of animals is known to interfere with spermatocyte as well as spermatid maturation (Vandenmark & Free, 1970) and effects focal necrosis in the seminiferous tubules (Sod-Moriah *et al.*, 1974). We thus undertook to provide information on the effect of season on the histometric characteristics of the reproductive organs of pubertal WAD bucks in their native humid tropical environment.

MATERIAL AND METHOD

Location and Climate. The study took place at the Teaching and Research Farm of the University of Ibadan, Nigeria. Ibadan is located at latitude 07° 201 N and longitude 03° 501 E, with a hot humid equatorial climate divided into four three monthly seasons namely: The early rainy season (April – June), the late rainy season (July – September), the early dry season (October – December) and the late dry season (January – March) (Egbunike & Steinbach, 1979). The seasons in this study were limited to only two – the early rainy season (April – June) and the early dry season (October – December).

Animals and Management. Eight healthy kid bucks, 4 in each season were randomly selected for the study. They were all weaned between 35 and 40 days of age and were housed in a standard goat barn with concrete floor and adequate protection from prevalent ambient temperature and other climatic conditions. They were fed a maize – based concentrate ration supplemented with forage *ad libitum* and also supplied with salt lick and cool clean drinking water always.

Puberty. The preputial smear technique described by Vandenberg (1971) in male golden hamsters and Egbunike (1979) in boars was applied to the animals to determine the onset of puberty. The cotton buds used in the present study were the bel de luxe – Hartmann Ltd, brand. The bucks in the rainy season attained puberty at an age of 153.95±4.08 days and weighed between 8.86 and 11.00 kg while these in the dry season attained puberty at 154.62 ±5.04 days and weighed between 8.40 and 11.97 kg.

Histological preparations. Mid parenchymal portions of left and right organs were fixed in more than 20 times their volume of aqueous Bouin's fixative for 24 h. The samples were there after dehydrated in increasing concentrations of ethyl alcohol and cleared in two changes of chloroform, before they were embedded in molten paraffin wax. Histological sections of 7µ thick were obtained using a microtome and stained with haematoxylin-eosin for histometric evaluations.

Histometry. Histometric evaluations were done at 800x magnification using a Zeiss microscope after the eye piece had been dully calibrated with a stage micrometer.

Statistical analyses. Data were subjected to the student 't' test for a comparism of seasonal means, while quadratic regression analyses were used in the prediction of the histometric characteristics of the reproductive organs from body weight (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Though there were numerical differences between seasons in the histometric characteristics of the reproductive organs of these animals, season had no significant effect ($p>0.05$) on any parameter (Table I). Seminiferous tubular diameters and their mean in the present study were however higher than values reported for Saanen x Local and Jumnapari x Local bucks in the same age group (Bongso *et al.*) else where. This superiority of WAD bucks over their counterparts elsewhere in this regard may be an indication of a higher sperm production potential and a higher sperm storage capacity in the WAD breed as earlier reported (Bitto & Egbunike).

The stability of seminiferous tubular diameters, round spermatid nuclear diameters, epididymal luminal diameters and epithelial heights, as well as Leydig /Sertoli cell ratio and Sertoli cell index within the year, obtained in the present study is in agreement with the non effect of season on circulating testosterone level earlier reported in the breed by Bitto *et al.* (2000). These reports thus imply that inspite of the seasonal differences in ambient temperature in the tropics, the WAD buck would not have a restricted breeding season. Thimonier *et al.* (1986) actually considered high ambient temperature as a secondary factor affecting reproductive capacity in small ruminants. Roca *et al.* (1992) also did not find the magnitude of seasonal effects on the semen of Murciano-Granadian goats in the Mediterranean area sufficient to prevent bucks from being used for breeding through out the year. With photoperiodicity fairly static in tropical regions (Willis, 2001), the reproductive capacity of these animals in their native environment is therefore unlikely to change with season.

Table I. Seasonal variations in the histometric characteristics of the reproductive organs of the pubertal WAD buck.

Parameter/season	Early rainy season	Early dry season	Mean
Basement of membrane testes (μ)	5.79 \pm 0.04	5.64 \pm 0.05	5.72 \pm 0.056
Seminiferous tubular diameter (μ)	140.46 \pm 2.68	132.33 \pm 3.18	136.40 \pm 2.87
Round spermatid nuclear diameter (μ)	4.25 \pm 0.06	4.14 \pm 0.01	4.20 \pm 0.04
Epididymal luminal diameters (μ)	caput 16.38 \pm 0.05	15.98 \pm 0.05	16.18 \pm 0.14
	corpus 13.41 \pm 0.06	12.76 \pm 0.03	13.09 \pm 0.23
	cauda 27.47 \pm 0.90	23.92 \pm 0.95	25.69 \pm 1.25
Epididymal epithelial heights (μ)	caput 4.61 \pm 0.02	4.52 \pm 0.02	4.57 \pm 0.03
	corpus 5.40 \pm 0.02	5.27 \pm 0.06	5.34 \pm 0.04
	cauda 3.67 \pm 0.03	3.59 \pm 0.02	3.63 \pm 0.02
Leydig/Sertoli cell cell ratio	0.41 \pm 0.04	0.51 \pm 0.09	0.46 \pm 0.03
Sertoli cell index	11.26 \pm 1.47	16.69 \pm 3.04	13.98 \pm 1.91

(means + sem)*. sem = Standard error of mean * = (p>0.05).

Table II. Prediction equations for testicular and epididymal histometric characteristics from body weight based on quadratic regression analysis.

Dependent variable (Y)	Regression equations X = Body weight	r	R ²
Mean seminiferous tubular diameter	Y = 83.38 + 19.09 x - 1.19 x x ²	0.85***	0.72***
Caput epididymal luminal diameter	Y = 15.21 + 0.39 x - 0.02 x ²	0.51**	0.37*
Corpus epididymal luminal diameter	Y = 11.93 + 0.37 x - 0.01 x ²	0.66**	0.45*
Cauda epididymal luminal diameter	Y = 19.14 + 0.79 x + 0.30 x ²	0.78***	0.60**
Basement membrane of testes	Y = 5.35 + 0.12 x - 0.00 x ²	0.57**	0.32*
Epithelial height of caput epididymis	Y = 4.69 - 0.09 x - 0.02 x ²	0.62**	0.38*
Epithelial height of corpus epididymis	Y = 503 + 0.05 x + 0.01 x ²	0.72***	0.51**
Epithelial height of cauda epididymis	Y = 3.50 + 0.04 x + 0.00 x ²	0.55**	0.30*

* = (p < 0.05), ** = (p < 0.01), *** = (p < 0.001).

Table III. Prediction equations for testicular epididymal histometric characteristics from testicular weight based on quadratic regression analysis.

Dependent variable (Y)	Regression equations X = Paired testes weight	r	R ²
Mean seminiferous tubular diameter	Y = 110.05 + 1.17 x - 0.01 x ²	0.88***	0.77***
Caput epididymal luminal diameter	Y = 15.51 + 0.03 x - 0.00 x ²	0.75***	0.56**
Corpus epididymal luminal diameter	Y = 12.07 + 0.05 x - 0.00 x ²	0.79***	0.62**
Cauda epididymal luminal diameter	Y = 17.98 + 0.32 x - 0.00 x ²	0.87***	0.75***
Basement membrane of testes	Y = 5.44 + 0.01 x - 0.00 x ²	0.65**	0.42**
Epithelial height of caput epididymis	Y = 4.49 + 0.00 x + 8.93 x ²	0.76***	0.57**
Epithelial height of corpus epididymis	Y = 5.11 + 0.01 x - 0.00 x ²	0.79***	0.62**
Epithelial height of cauda epididymis	Y = 3.49 + 0.01 x - 0.00 x ²	0.71***	0.50**

** = (p < 0.01), *** = (p < 0.001).

The regression model showed (Tables II and III) that the histometric characteristics of the reproductive organs of these animals are predictable from changes in body weight and may thus enhance the early selection of good sires, based on body weight and testicular measurements.

The results of this work imply that the WAD buck would not require a restricted breeding season in its native environment.

The predictability of the histometric characteristics of the reproductive organs from body weight in this breed lends ground for the early selection of good sires based on the prediction of sperm production rates as testicular measurements are related to sperm production. Goat farmers could thus have quicker payoffs by selling young bucks to research institutions and government owned breeding centers for planned breeding programmers all year round.

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RESUMEN: Como la temperatura ambiental y la humedad son altas durante todo el año dentro de estaciones secas y lluviosas claramente definidas en nuestro ambiente húmedo tropical, se evaluaron los efectos de las estaciones en la características histométricas de los órganos reproductivos de cabras enanas machos púber del África Occidental, usando 8 animales sanos. No hubo diferencias significativas ($p > 0,05$) entre las estaciones de lluvia y secas, en la membrana basal de los testículos, diámetro de los túbulos seminíferos, y el diámetro de la envoltura nuclear espermática. Sin embargo, hubo similitudes ($p > 0,05$) entre las diferentes estaciones en el diámetro luminal del epidídimo, altura del epitelio del epidídimo, así como en la proporción de células Leydig/Sertoli e índice de células de Sertoli. El análisis de regresión cuadrática mostró que todas las características histométricas de los testículos son altamente predecibles desde el peso de los animales vivos. Se concluye de estos resultados, que las cabras enanas del África Occidental no tendrían una restricción estacional para tener crías en el ambiente tropical nativo. Padres jóvenes por lo tanto, podrían ser seleccionados tempranamente en la vida para programas de mejora planeados en instituciones de investigación y centros criadores los que provean a granjeros de rápidos retornos por sus inversiones.

PALABRAS CLAVE: Caprinos; Testículos; Histométrico; Estaciones; Trópico; Granjeros.

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Received: 24-04-2007

Accepted: 12-02-2008

