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The Semen Characteristics of Pubertal West African Dwarf Bucks

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ABSTRACT

Semen was collected twice weekly between 0800 and 0900 hours from 6 healthy pubertal West African Dwarf (WAD) bucks for three months by electrical stimulation, and later evaluated and compared with values from healthy adult bucks of the same breed. Apart from semen colour, which was similar between pubertal and adult bucks, adult bucks were significantly superior ($p < 0.05$) to pubertal bucks in semen volume, mass activity, sperm progressive motility, sperm concentration, live sperm, total sperm/ejaculate and normal sperm morphology. In addition, pubertal buck semen also had significantly higher ($p < 0.05$) incidences of abnormal and dead spermatozoa. The incidence of coiled tails was however similar ($p > 0.05$) between the two age groups. The sperm concentration in the pubertal buck was highly significantly and positively correlated with total sperm/ejaculate ($r = 0.72$; $p < 0.001$), while semen volume was significantly but negatively related to the total sperm/ejaculate ($r = -0.37$; $p < 0.05$). Based on the findings of this study, it is concluded that pubertal buck semen, though inferior in quantity and quality to that of the adult, may be sparingly used for AI, and that good sires may be selected at puberty on the basis of the physical characteristics of their semen.

Keywords: Pubertal, bucks, semen characteristics, humid, tropical environment

INTRODUCTION

Goats are better adapted to hot environments than sheep and cattle (Coop, 1982; Valez-Nauer *et al.*, 1982), but are more susceptible to heat stress than sheep and cattle, as reflected by a rise in body temperature, outward signs of stress and a reduction in performance (Bianca & Kunz, 1978). Their importance in the livestock economy of people living in subsistence agriculture in the humid zone of West Africa has made them the species of choice for peasant farmers and for the supply of animal protein and other products in the sub-region. In Nigeria, the most popular genotype, i.e. the West African Dwarf (WAD) goat which supplies excellent quality meat, milk, skin and other products, has been adjudged as one of the most prolific in the world, with a remarkably high reproductive potential (Wilson, 1989; Gall *et al*., 1992). The WAD goat, however, is still largely unimproved. The improvement of the tropical breeds of goats generally and the WAD goat in particular for higher productivity as has been successfully done with goats in France (Leboeuf *et al*., 1998) will require information on the seminal characteristics of bucks. Earlier reports in the WAD buck concentrated on the adult bucks of the breed (Akusu *et al*., 1984; Ugwu

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& Orji, 1984; Bitto *et al*., 1988, 2000a, 2000b; Bitto *et al*., 2000c) and neglected pubertal bucks. However, the use of younger bucks for breeding purposes may save time and cost of management in raising bucks to adulthood. It is also a common occurrence in developing countries where goats are often mostly managed extensively to have pubertal bucks serve does successfully. Moreover, it has been reported that bucks exhibit sexual aggressiveness, penile development and permit intromission with good *libido* under tropical conditions at a very young age (Bongso *et al*., 1982). Thus, knowledge of the seminal characteristics of pubertal bucks is very useful in the early selection of sires for planned breeding programmes. In addition, older bucks constitute a problem as their *libido* and reaction time decline with increasing age (Butswat & Zaharaddeen, 1998). Inspite of our recent reports in pubertal bucks of the breed on sperm production rates and sperm storage capacity (Bitto & Egbunike, 2006a), testicular morphometry (Bitto & Egbunike, 2006b), some biochemical characteristics of spermatozoa and seminal plasma (Bitto *et al*., 2007) as well as the histometry of the testes (Bitto & Egbunike, 2008), information on the ejaculate characteristics of the pubertal West African Dwarf buck is still lacking. This study was therefore designed to characterize the seminal characteristics of the pubertal WAD buck in its native humid tropical environment, preparatory to the improvement of this particular breed.

MATERIALS AND METHODS

Animals and Management

Six healthy pubertal WAD bucks between 148-156 days in age and weighing between 9.10 and 12.00kg were used in this study. The pubertal bucks were obtained as kids bucks born to does at the Physiology unit of the Teaching and Research Farm of the University of Ibadan, where the experiment was conducted. They were weaned between 35 and 40 days of age and housed together in a group in a standard goat pen with concrete floor. The animals were fed a maize based concentrate ration supplemented with forage *ad libitum* and had access to cool clean drinking water at all time. They were allowed out for exercise early in the mornings on days with favourable weather.

Puberty

The preputial smear technique (Vandenberg, 1971; Egbunike, 1979) was used to determine the onset of puberty. Smears were taken every other day from each animal by gently and carefully rotating moistened cotton in the preputial pouch between the orifice and the glans penis. In each case, the adherent material was smeared on a clean dry glass slide and screened under a microscope for spermatozoa. This was continued until three consecutive positive readings from an animal were obtained. The cotton buds used were of the Bel de luxe-Hartman Ltd. brand.

Adult bucks which were meant for comparison had been previously used for breeding with satisfactory results. They were likewise housed in a standard goat pen in the same unit with adequate protection from prevalent ambient temperatures and other climatic conditions, apart from being maintained on a good plane of nutrition which had earlier been certified free from clinical abnormalities.

Semen Collection

As soon as the bucks had attained puberty, they were ejaculated twice weekly (on Tuesdays and Saturdays) between 0800 and 0900 hours, by the electro ejaculation technique for three months (January to March) as reported earlier by Bitto *et al*. (1988), Bitto *et al*. (2000a, 2000b), and Bitto *et al*. (2007). An electro-ejaculator probe was specially constructed to fit the relatively smaller rectum of the pubertal bucks. Semen was collected from 2 healthy adult WAD bucks, 22 and 28 months old with body weight ranging from 18.40 and 21.10kg for comparison (Bitto *et al*., 2007).

Semen Evaluation

Freshly collected semen samples were evaluated for colour, volume, mass activity, sperm progressive motility, sperm concentration, live/dead sperm, total sperm per ejaculate and abnormal sperm morphology by standard laboratory methods (Bitto *et al*., 2000a).

Statistical Analysis

Data obtained were subjected to the student's *t*-test (Steel & Torrie, 1980) for a comparison between pubertal and adult bucks. The linear relationships between the seminal characteristics in both pubertal and adult bucks were also assessed.

RESULTS

The physical characteristics of the semen of the pubertal buck, in comparison to those of the adult, are summarized in Table 1. Table 2 shows a summary of the comparison of sperm abnormalities between the age groups. Even though colour of the semen was consistently similar between the pubertal and adult bucks, the latter bucks were significantly superior ($p < 0.001$) to pubertal bucks in terms of their semen volume, mass activity, sperm progressive motility, sperm concentration, total sperm/ejaculate and normal sperm morphology. There was also a significant difference ($p < 0.01$) between the groups in the proportion of live sperm. Pubertal buck semen also had a significantly higher ($p < 0.01$) proportion of dead sperm than adult buck semen. In relation to abnormal sperm morphology, the semen of pubertal bucks had significantly higher proportions of detached normal heads ($p < 0.01$), bent tails ($p < 0.05$), double tails ($p < 0.001$), proximal cytoplasmic droplets ($p < 0.001$), distal cytoplasmic droplets ($p < 0.001$) and total abnormal sperm morphology ($p < 0.001$). There was however a similarity between pubertal and adult bucks in the incidence of coiled tails ($p > 0.05$).

The relationships between seminal characteristics in pubertal and adult bucks are presented in Tables 3 and 4, respectively. The sperm concentration in the pubertal bucks was highly, significantly and positively correlated with the total sperm per ejaculate ($r = 0.72$; $p < 0.001$). In the adult buck, however, the concentration of sperms was significantly and positively correlated to semen volume ($r = 0.66$; $p < 0.01$) and mass activity ($r = 0.53$; $p < 0.05$); highly, significantly and positively correlated to sperm motility ($r = 0.80$; $p < 0.001$) and total sperm/ejaculate ($r = 0.97$; $p < 0.001$). However, the concentration of sperm in the adult buck was found to be highly and significantly but negatively related to live sperm ($r = - 0.94$; $p < 0.001$) and normal morphology ($r = -0.72$; $p < 0.001$). Meanwhile, semen volume was highly, significantly and positively related to sperm motility ($r = 0.95$; $p < 0.001$) and total sperm/ejaculate ($r = 0.80$, $p < 0,001$). Mass activity was negatively and significantly correlated to live sperm ($r = -0.80$; $p < 0.001$). Sperm motility was highly positively significantly related to total sperm/ejaculate ($r = 0.88$; $p < 0.001$) and live sperm ($r = 0.87$; $p < 0.001$), but significantly and negatively related to dead sperm ($r = -0.43$; $p < 0.05$). Total sperm per ejaculation was also highly but negatively related to live sperm ($r = -0.92$; $p < 0.001$) and normal morphology ($r = -0.61$; $p < 0.01$). Moreover, live sperm was significantly related to normal morphology ($r = 0.50$; $p < 0.05$), and dead sperm was similarly highly significantly positively related to normal morphology ($r = 0.72$; $p < 0.001$).

DISCUSSION

The colour of pubertal bucks' semen obtained in this study, being similar to the adult buck, is consistent with the earlier observation and report in the adult WAD buck (Bitto *et al*., 1988); therefore, this is noted to be the characteristic of this particular genotype in its native environment.

The volume of pubertal bucks' semen in the present study was also lower than the values reported for the pubertal Damascus male goat (Elwishy & Elsawaf, 1971), but comparable with that reported at the onset of puberty in

Boer goats (Corteel, 1977). Pubertal buck semen volume obtained in the present study was also much lower than the values (much earlier) reported for the three breeds of pubertal rams (Skinner & Rowson, 1968). Semen volume, sperm motility and sperm concentration values obtained in both the pubertal and adult bucks in the present study were respectively lower than the corresponding values reported by Noran *et al*. (1998) for adult Katjang and Katjang x German Fawn goats. These differences are obviously due to genotype (breed) and species (in the case of sheep) differences in seminal characteristics. Semen volume, sperm concentration, total sperm/ejaculation and sperm motility obtained in the present study were lower in comparison to 13 month old Murciano-Granadina male goats in all four seasons of the year (Roca *et al*., 1992). These differences might be due to breed, age and environmental factors.

Sperm concentration in the pubertal WAD bucks in this study was much higher than the values reported for pubertal Damascus (Elwishy & Elsawaf, 1971) and Boer goats (Corteel, 1981). Meanwhile, the values of live sperm in both the pubertal and adult bucks were also higher than the corresponding values for adult Katjang and Katjang x German Fawn goats (Noran *et al*., 1998). Live sperm in the pubertal WAD bucks was also higher than that of Suffolk

TABLE 1
The semen characteristics of pubertal and Adult WAD bucks (means ± sem)

	Parameter	Pubertal buck (n=6)	Adult buck (n=2)	Level of significance
a.	Colour	Milky white	Milky white	$p < 0.001$
b.	Volume (ml)	0.20 ± 0.02	0.47 ± 0.02	$p < 0.001$
c.	Mass activity (1-5)	3.60 ± 0.08	4.25 ± 0.05	$p < 0.001$
d.	Progressive motility (%)	60.37 ± 1.00	74.66 ± 0.85	$p < 0.001$
e.	Sperm concentration ($x10^9$/ml)	0.53 ± 0.04	1.65 ± 0.07	$p < 0.001$
f.	Live sperm (%)	88.91 ± 0.61	91.88 ± 0.60	$p < 0.01$
g.	Dead sperm (%)	11.09 ± 0.61	8.12 ± 0.60	$p < 0.01$
h.	Total sperm /ejaculation ($x10^9$)	0.12 ± 0.01	0.79 ± 0.06	$p < 0.001$
i.	Normal morphology (%)	85.90 ± 0.72	94.15 ± 0.60	$p < 0.001$

sem = standard error of mean; ns = not significant ($p > 0.05$)

TABLE 2
The sperm abnormalities of pubertal and Adult WAD bucks (means ± sem)

	Parameter	Pubertal buck (n=6)	Adult buck (n=2)	Level of significance
a.	Detached normal heads (%)	3.01 ± 0.29	1.78 ± 0.26	$p < 0.01$
b.	Ben tails (%)	2.58 ± 0.30	1.36 ± 0.30	$p < 0.05$
c.	Coiled tails (%)	1.45 ± 0.23	1.66 ± 0.28	ns
d.	Double tails (%)	0.50 ± 0.00	0.00 ± 0.00	$p < 0.001$
e.	Proximal Cytoplasmic droplet (%)	3.58 ± 0.41	0.50 ± 0.00	$p < 0.001$
f.	Distal Cytoplasmic droplet (%)	2.98 ± 0.42	0.55 ± 0.04	$p< 0.001$
g.	Total abnormalities (%)	14.10 ± 0.72	5.85 ± 0.60	$p < 0.001$

sem = standard error of mean; ns = not significant ($p > 0.05$)

TABLE 3
The relationships between semen characteristics in the pubertal WAD buck

		8	7	6	5	4	3	2	1
1.	Sperm concentration	-0.27	0.72**	-0.19	-0.19	-0.21	0.01	-	-
2.	Volume	-0.37	0.20	-0.16	-0.16	0.09	0.23	0.23	
3.	Mass Activity	-0.16	0.11	0.33	0.33	0.06	-		
4.	Motility	0.06	0.06	-0.02	-0.02	-			
5.	Live (%)	0.18	-0.12	-1.00	-				
6.	Dead (%)	0.18	-0.12	-					
7.	Total sperm/Ejaculation	0.10				-			
8.	Normal Morphology	-							

*= p< 0.05; **= p < 0.01

TABLE 4
The relationships between semen characteristics in the pubertal WAD buck

		8	7	6	5	4	3	2	1
1.	Sperm concentration	-0.72***	0.09	-0.94***	0.94***	0.80***	0.53*	0.66**	-
2.	Volume	-0.04	0.40	-0.70**	0.80***	0.95***	-0.26	-	
3.	Mass Activity	0.80***	-0.42	-0.47*	0.33	0.01	-		
4.	Motility	-0.16	-0.43*	0.87***	-0.88***	-			
5.	Total Sperm/Ejaculate	-0.61**	-0.02	-0.92***					
6.	Live Sperm	0.50*	-0.22	-					
7.	Dead Sperm	0.72***	-						
8.	Normal Morphology	-							

*= p< 0.05, **= p < 0.01, ***= p < 0.001

rams in a similar age group (Skinner & Rowson, 1968). The differences may be due to factors like breed, method of semen collection, frequency of collection and probably the environment (Evans & Maxwell, 1987).

Likewise, the total sperm/ejaculation of the pubertal WAD buck in this study was found to be comparable to the lower limit but much higher than the upper limit ($0.123x10^9$/ml and $0.98x10^9$/ml respectively) reported for the pubertal Damascus goats (Elwishy & Elsawaf, 1971). However, the total abnormal sperm in the present study was highly comparable with that of pubertal Damascus goats (Elwishy & Elsawaf, 1971).

The differences between the pubertal WAD buck and other breeds of goats and rams in the seminal characteristics could be an expression of species, breed, nutritional status and environmental differences, as well as the differences in the methods used for semen collection and the frequency of the use of the animals. The highly significant differences between the pubertal and adult bucks in both semen quantity and quality are probably due to the differences in the development of the reproductive organs. These might have led to the obvious differences in the weights, sizes and capacities of the respective regions of the reproductive tract. Therefore, the two age groups would be expected to differ in some physiological processes, like sperm production, sperm maturation and sperm storage capacity, as well as the relative secretions of the various

accessory sex organs/glands which are all age dependent. However, it is worthy to observe that the total abnormal sperm morphology in the pubertal WAD buck obtained in this study (as in the adult buck) is within the acceptable range of not more than 20% of the semen acceptable for use in Artificial Insemination (AI).

The linear relationships between seminal characteristics, as well as the highly significant positive relationship between sperm concentration and the total sperm per ejaculation in the pubertal buck, are a normal trend. These indicate normal spermatogenic activities as well as other gonadal and extragonadal functions. The significant and positive relationships between sperm concentration, total sperm per ejaculate, sperm motility, semen volume and density in the adult buck are indications of the superiority of the adult bucks over the pubertal buck in terms of spermatogenesis, and other testicular and accessory organ functions. Meanwhile, the negative relationships between sperm concentration and live sperm and normal morphology probably express the differences between the quantitative and qualitative evaluations of the freshly collected semen, with sperm concentration being the actual number of spermatozoa per milliliter (ml), including dead and abnormal spermatozoa. In addition, the relationships between semen volume and motility, as well as the total sperm per ejaculation suggest high subjective fertility estimates, based on the semen volume in both the natural service and probably AI when semen is extended. The significant negative relationships between mass activity and live sperm, as well as the normal morphology in the pubertal buck, are explainable from the understanding of this particular criterion of semen evaluation. This being rather subjective, the wave motion of a semen sample is therefore dependent on a number of factors, but not limited to live and morphologically normal spermatozoa. The highly significant positive relationships between sperm motility and total sperm per ejaculation, live sperm and the significant negative relationship with dead sperm and the relationships of total sperm per ejaculate to live sperm are consistent with good quality semen in the adult buck. This status is where the pubertal buck would be expected to attain with age and good management.

CONCLUSIONS AND APPLICATIONS

In conclusion, the semen from the pubertal WAD bucks may be used sparingly in both natural mating and AI programmes and on the basis of their semen characteristics, good sires may be selected at puberty.

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