Semen Traits and Quality in Hemiorchidectomized Puberal West African Dwarf Goat and Coital Cues of Intact Sexually Mature Counterparts[1]

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ABSTRACT

In the first of two trials, 15 puberal West African dwarf goats aged between 12-18 months, were assigned randomly to three treatments: a) left testis orchedectomy: castration of the left testis; b) intact testis: zero castration; and c) right testis orchidectomy: castration of the right testis. Semen was collected in this trial by artificial vagina using restrained non-estrous does. In a second trial which consisted of four sexually-matured bucks, semen was also collected by artificial vagina using restrained non-estrous does. In this trial estrous does were also used to determine coital cues of the sexually-matured bucks. Semen characteristics were measured in each of the two trials. Results indicated that younger puberal bucks should be preferred in a breeding programme because of their high libido (quick reaction time), rather than the older, sexually-matured bucks with slow reaction time and low libido.

COMPENDIO

En esta investigación se realizaron dos pruebas. En la primera de ellas, 15 cabros enanos de Africa Occidental al inicio de la pubertad (entre 12 y 18 meses de edad) fueron sometidos a tres tratamientos: a) gonadectomía (castración) del testículo izquierdo (LC); b) testículos intactos (sin castrar) (IN), y c) gonadectomía (castración) del testículo derecho (RL); se recolectó el semen por medio de vaginas artificiales utilizando hembras sujetas que no estaban en celo. En la segunda prueba se recolectó el semen de cuatro cabros sexualmente maduros por medio de vaginas artificiales utilizando hembras sujetas que no estaban en celo, y con el fin de determinar las señales de coito de los cabros sexualmente maduros, también se utilizaron cabras en celo. En cada una de las dos pruebas se analizaron las características del semen. Los resultados indicaron que para programas de cría es preferible utilizar machos jóvenes en pubertad, debido a su alto libido (corto tiempo de reacción), en vez de machos más viejos y sexualmente maduros, que tienen un tiempo de reacción más largo y bajo libido.

INTRODUCTION

Chiboka *et al.* (4) found significant increase in sperm output by unilaterally castrated rams over intact rams. In bulls, Boockfor (6) found increase in testis weight, seminiferous tabular diameter, epithelial cell height and the ratio of testis to body weight were greater in the unilaterally castrated bulls than those of intact bulls or bulls surgically rendered unilaterally cryptorchid. Boockfor (6) also found that unilateral castration at three months of age caused greater compensatory growth and associated changes as opposed to unilateral castration later in the life of those bulls. There is a paucity of information on reproduction work of West African dwarf goats in the humid tropics. The objective of this work was to find the effect of unilateral gonadectomy on sperm production in puberal West African dwarf goat (WADG) bucks and semen traits and coital cues in their intact sexually-matured counterparts.

MATERIALS AND METHODS

In the first of two trials, 15 WADG bucks between 12-18 months old were assigned randomly in five successive replicates to three treatments: a) left testis orchidectomy: castration of the left testis (LC); b) intact testis: zero castration (IN); and c) right testis orchidectomy: castration of the right testis (RC). Castration was carried out at four weeks *post partum* by crushing the spermatic cord with a burdizzo and sterilizing the area of the skin overlying the cord with penicillin antibiotic spray to prevent infection. The goats used in the two trials were zero grazed and housed in a barn with slatted floor. They were in good health with low flock mortality. They were fed twice daily (morning and evening) on forage consisting of *Panicum maximum*, *Leucaena leucocephala* and *Gliricidia sepium*; and each received 250 g/day of concentrate supplement in the afternoon. They were routinely treated once every three weeks against ectoparasites such as ticks and lice, and vaccinated against brucellosis once in their lifetime and vaccinated annually against "peste des petits ruminant." Prompt veterinary care was given to the animals when necessary. Details of the management procedure are given by Chiboka *et al.* (5).

In the first trial, semen was harvested by artificial vagina from five bucks every Saturday using restrained non-estrous does. In a second trial semen was collected

1. Received for publication 25 July 1989.

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from four sexually-matured bucks (numbers 207, 1000, 996 and 999) also by artificial vagina. At the beginning of the experiment bucks 207 and 1000 were three years old, and bucks 996 and 999 were five years old. Restrained non-estrous does were also used in the trial for semen harvest. Five estrous does per buck were used in this second trial to measure coital cues and sex drive (libido).

Semen characteristics measured in each of the two trials were colour, volume, raw motility, pH, progressive motility, total percentage abnormal sperm, live sperm and total sperm concentration. The method of semen harvest and determination of semen characteristics are described by Chiboka (2, 3) and Okere *et al.* (10). All matings were carried out early in the morning between 8.00 and 10.00 am and late afternoon, 4.00 pm. The procedure for testing the rams for coital cues consisted of exposing an estrous doe to a buck for a maximum time of ten minutes. The test was terminated after effective ejaculation, usually marked by foreward pelvis thrusts, or at the end of ten minutes, whichever came first.

Throughout the test, each estrous doe was taken to the buck occupying a single pen. A combination of stop watch and digital wrist watches were used to record time changes for the following coital events by the buck: time to Flehmen lip curl; time to sniff the perineum of the estrous does; time for abortive mounts of estrous doe; time to mount estrous doe; time for intromission; and time to ejaculation. The totality of time spent from the first to last event (one sexual congress) is the reaction time of a given buck.

Semen for characterization was collected from a given buck on a separate day from the day of the coital cues test; this procedure being slightly modified from that described by Chiboka (1). Each of the two trials was considered as a one-way experimental design and analysed as such by analysis of variance and means compared by Duncan's new multiple range test as described by Steel and Torrie (11).

RESULTS

Table 1 shows comparison of means by Duncan's new multiple range test of the semen characteristics from intact and unilaterally castrated West African dwarf goat bucks in the first trial. There was a significant ($P < 0.05$) difference in sperm cell concentration/ml ($x \cdot 10^9$ spc/ml) between intact and unilateral castrates which produced significantly ($P < 0.01$) more sperm cells than the intact. There were no significant differences for other variables including semen colour which was like lemon juice. Table 2 shows the analysis of variance of the first trial indicating a significant ($P < 0.01$) treatment effect on spc/ml and total sperm count. Other treatment effects were not significantly different.

In trial two, Table 3 shows mean semen characteristics of sexually matured WADG bucks. There were no significant differences for the variables of all the coital cues measured. Buck numbers 207 and 1000 did not differ significantly ($P > 0.05$) in Flehmen lip curl but they differed ($P < 0.05$) significantly from buck numbers 996 and 999 with regard to that same variable. The same pattern of variation was observed for time spent on abortive mounts, number of abortive mounts, and in total reaction time. Semen colour in the second trial was creamy-white.

Table 4 shows the mean values of coital cues of sexually matured WADG backs, and Table 5 shows mean squares of the analysis of variance of coital cues of sexually matured WADG bucks. The latter table shows significant ($P < 0.01$) treatment effects on Flehmen lip curl, time and number of abortive mounts, and total reaction time.

DISCUSSION

The results in Tables 1 and 2 show that compensatory growth and testicular activity of the remaining testis following unilateral castration in the goat buck occur, leading to greater sperm cell production than in the intact goat bucks. This finding is in keeping with findings in sheep (4, 8), bulls (6), and rats (9). There was an increase in sperm cells of about 67 percentage points in the hemiorchidectomized goat bucks over the intact bucks, as compared to that found in sexually-matured rams (4) in which the sperm concentration in the hemiorchidectomized rams appeared to be more than double that of the intact rams. This might be due to species and/or age differences.

The increase in sperm concentration in the goat bucks is of great significance for artificial insemination programmes in which such goat bucks could be unilaterally orchidetomized for increase in sperm output during sperm harvest. On the other hand, sperm output in intact puberal and sexually- matured goat bucks failed to show any noticeable differences. This indicates that once sperm production begins in normal bucks, normal production appears to continue. Perhaps the effect of compensatory growth takes longer. In the work of Chiboka *et al.* (4) semen was harvested when the rams (both the intact and unilaterally orchidectomized groups) were over two years old. Since compensatory hypertrophy is a growth process it is not surprising that it should be a function of time.

Table 1. Mean semen characteristics of intact and unilaterally castrated West African dwarf goat bucks (Trial 1).

Semen characteristics	LC		IN		RC	
	$\bar{x}$	s d	$\bar{x}$	s d	$\bar{x}$	s d
Volume (ml)	0.46[a]	0.05	0.46[a]	0.05	0.48[a]	0.084
Raw motility (1–5)	4[a]	0.71	4[a]	0.71	4[a]	0.71
Sperm concentration (x 10^9/ml)	5.92[a]	0.44	3.54[b]	0.51	5.70[a]	0.29
pH	7[a]	0	7[a]	0	7[a]	0
Progressive motility percentage	78.9[a]	1.50	79.7[a]	1.42	79.6[a]	0.91
Live sperm percentage	86.7[a]	1.5	86.3[a]	1.0	87.0[a]	1.1
Abnormal sperm percentage	9.2[a]	1.3	9.4[a]	1.1	9.8[a]	1.3
Total sperm count (x 10^9/ml)	2.71[a]	0.53	1.63[b]	0.32	2.72[a]	0.39

Within each row variable means with same letters are not significantly different ($P > 0.05$)

LC = left testis orchedectomy (castration of the left testis)
IN = intact testis (zero castration)
RC = right testis orchidectomy (castration of the right testis)
SPC = sperm cell concentration

Table 2. Analysis of variance of semen characteristics of intact and unilaterally castrated West African dwarf goat bucks (Trial 1).

Source of variation	d.f	Mean squares						
		Volume ml	Raw motility	Sperm concentration (x 10^9 spc/ml)	Total sperm count (x 10^9 spc/ml)	Progressive motility	Live sperm	Abnormal sperm
Treatments	2	1.25×10^{-4}	0	5.20**	1.949**	0.56	0.55	0.47
Error	12	4.33×10^{-4}	0.5	0.18	0.11	2.37	1.44	1.56

** = ($P < 0.01$)

Table 3. Mean semen characteristics of sexually matured West African dwarf goat bucks variables compared by Duncan's new multiple range test (Trial 2).

Volume	996 0.74 ± 0.13	207 0.74 ± 0.14	999 0.82 ± 0.06	1000 0.87 ± 0.08
Raw motility	3.8 ± 0.27	4.0 ± 0.35	3.9 ± 0.22	3.9 ± 0.30
Sperm concentration (x 10^9/ml)	3.2 ± 0.3	3.3 ± 0.2	3.3 ± 0.4	3.2 ± 0.3
Total sperm count (x 10^9/ml)	2.4 ± 0.3	2.4 ± 0.4	2.8 ± 0.1	2.8 ± 0.2
pH	7.0	7.0	7.0	7.0
Progressive motility %	79.2 ± 1.3	78.9 ± 0.9	79.3 ± 0.8	78.4 ± 1.9
Live sperm	86.06 ± 1.01	87.44	87.2 ± 1.8	86.9 ± 1.4
Total abnormality %	9.2 ± 1.5	8.7 ± 0.8	9.2 ± 0.7	9.00 ± 1.0

In a given row, means without any superscript are not ($P > 0.05$) significantly different

Land and Carr (8) showed that there is increased production of luteinizing hormone (LH) following unilateral orchidectomy, and Chiboka *et al.* (4) also showed increases in follicle stimulating hormone (FSH), LH and prolactin following unilateral orchidectomy. According to Williams (13) and Frieden and Lipner (7), FSH in the male is involved in initiation of gametogenesis and testosterone production, and is also necessary for completion of spermatogenesis while LH or interstitial cell stimulating hormone (ICSH) promotes Leydig cell production of testosterone, an anabolic steroid. Synergism exists in the interaction of FSH an LH (13) and can lead to increased growth of the testis with a concomitant increase in sperm output. Prolactin, a lactogenic hormone, can, under certain laboratory conditions (13), also lead to increased growth of the testis. Prolactin, though a lactogenic hormone, has, under certain laboratory conditions (13), been shown to have general metabolic actions in males which are unrelated to reproduction and are similar to those of somatotropin. Chiboka (3) indicates that African dwarf sheep and tropical livestock breeds reproduce all year round because the hypothalamic hypophysial adreno gonadal axis has become photo and thermo-neutral over centuries, irrespective of environmental variations.

Tables 4 and 5 contain the coital cues in sexually matured WADG bucks. The objective of this work is to document normal coital cues so that any deviations could be used in selecting good stud bucks. Table 4 indicates that bucks 996 and 999 (which were five years old at the start of the experiment) spent more time on Flehmen lip curl, sniffing, abortive mounts, number of abortive mounts, and total reaction time than bucks 207 and 1000 (which were three years old at the start of the experiment). This observation, among others, indicates that the older goat bucks become, the lower their libido because more time is spent sluggishly performing the coital cues preceding ejaculation. This observation also shows that between the ages of three and five years the time spent on Flehmen lip curl, sniffing, intromission and ejaculation differs. This experiment favours the practice of replacing older bucks with younger ones for higher libido in a breeding programme. With low libido, it may become difficult to ensure that the sperm cells are at the site of fertilization (fallopian tube) when the ovum/ova are ready to be fertilized. A slow breeding process or low libido will inhibit the timely meeting of the ova and sperm cells. This scenario could undermine profitable livestock programmes unless the presence of virile bucks is assured at all times.

Table 4. Mean values of coital cues of sexually matured West African dwarf goat bucks. Means compared by Duncan's new multiple range test bucks (Trial 2).

		Ram number			
	Variable	996	207	999	1000
1	Flehmen lip curl (sec)	22^{b}	14^{a}	24^{b}	14.6^{a}
2	Sniffing (sec)	4.8^{a}	4.2^{a}	4.8^{a}	4.6^{a}
3	Abortive mounts (min)	3.6^{b}	1.4^{a}	3.8^{b}	1.2^{a}
4	Number of abortive mounts	5.6^{b}	1.8^{a}	6.4^{b}	1.4^{a}
5	Intromission (sec)	4.0^{a}	3.8^{a}	3.6^{a}	3.6^{a}
6	Ejaculation (sec)	3.2^{a}	2.4^{a}	2.6^{a}	2.8^{a}
7	Total reaction time (min)	4.6^{a}	1.81^{b}	4.79^{a}	1.64^{b}

Within a given row, variable means with the same letter are not significantly ($P > 0.05$) different.

Table 5. Mean squares of analysis of variance of coital cues in sexually matured West African dwarf goat bucks (Trial 2).

Source	d.f	Flehmen lip curl (sec)	Sniffing (sec)	Abortive mounts (min)	Intromission (sec)	Ejaculation (sec)	No. abortive mounts	Reaction time (sec)	Corpula inter (min)
Treatment	3	129.78**	0.4ns	9.67**	0.18ns	0.73ns	32.93**	12.96**	1.13
Error	16	14.45	0.6	1.00	0.33	0.50	5.28	0.76	0.68
SEM									

* = $P < 0.05$ ** = $P < 0.01$ ns = $P < 0.05$

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