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EFFECTS OF VASECTOMY ON TESTOSTERONE LEVEL IN PLASMA, SEMEN CHARACTERISTIC AND TESTICULAR PARAMETERS OF BLACK BENGAL BUCKS (*Capra hircus*)

B Paul, S Sarkar, A Paul, MM Parvej and GN Adhikary*

Department of Anatomy and Histology, Sylhet Agricultural University, Sylhet, Bangladesh

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Abstract

The effects of unilateral and bilateral vasectomy on the seminal characteristics, testosterone concentrations, and testicular parameters following castration were assessed. Immediately after vasectomy, the ejaculate volume declined in all vasectomized bucks, which was also found to increase afterward, irrespective of the groups. Concerning the color, the ejaculate was very light yellow in each vasectomized buck, while the typical milky appearance of the ejaculate was found in the control animals. The individual sperm motility was found to vary from 70.33% to 76.67% in the studied bucks, irrespective of the group before vasectomy. Following seven days of vasectomy, the sperm motility in unilaterally vasectomized bucks reduced to around 50%, whereas no individual sperm motility in all bilaterally vasectomized groups. In the plasmatic concentrations of testosterone, a marked decrease ($p < 0.01$) was observed in all the males from 2 to 6 weeks after the vasectomy. However, a gradual rise in the plasma levels of testosterone was also observed from 8 to 12 weeks after surgery. Before vasectomy, all bucks showed attraction to the goats ejaculating in the artificial vagina in a short time (<15–20 s) after contact with the goat in heat. From 10 weeks after vasectomy until the end of the experiment, the same bucks (four of the vasectomized and the control ones) that showed a recovery of the plasma levels of testosterone demonstrated normal libido and manifested attraction to the goats in heat. After 16 weeks of rearing, the bucks were subjected to castration to evaluate the testes and the epididymis. In the unilaterally vasectomized bucks, the vasectomized side was larger than the contra-lateral part and showed a nodule containing creamy material. The bilaterally vasectomized testis and epididymis were noticed to have more extensive morphology. These results demonstrate that vasectomy has little effect on the morphologic characteristics of the testis and epididymis. Though vasectomy did not affect the plasmatic concentrations of testosterone, it considerably affected the seminal parameters. Thereby, vasectomy can be used to develop teaser buck in the breed development program.

Keywords: Vasectomy, seminal characteristics, testosterone concentrations, testicular parameters teaser buck.

Introduction

The Black Bengal goat (BBG) is a famous goat breed found throughout Bangladesh that comprises more than 90% of the national goat population having variations in color, size, and body weight (Hossain, 2004). They are well-known for their adaptability and resistance to some common diseases. Early sexual maturity and high prolificacy, larger litter size, low kidding interval, the delicacy of meat, and best-quality skin are the notable characteristics of the breed (Islam et al.,1991). The ability to walk long distances, graze and utilize a wide range of poor-quality forages, and efficiently use marginal lands make them popular in the poor rural community (Acharya, 1987). However, BBGs have a comparatively low dressing percentage in comparison to the meat-type breed of goats (Malan, 2000) and low milk production than dairy goats (Knights and Garcia, 1997). A partial explanation of this situation may be the poor genetic build-up of BBGs, and improper feeding and management practices (Haque et al., 2012).

The ultimate goal of livestock production, including goats, is to ensure the nutritional requirement for the population through the production of quality products, mainly meat, and milk. An essential component in attaining this goal is to develop goats genetically through genetic improvement schemes. Production of superior bucks through genetic

***Corresponding author: GN Adhikary,** *Department of Anatomy and Histology, Sylhet Agricultural University, Sylhet-3100, Bangladesh. Email: adhikarygn.dah@sau.ac.bd*

improvement achieved by selection has been found to play a significant role in upgrading native goats in different areas of Bangladesh (Faruque et al., 2010). Besides, age at puberty is an important economic indicator for the reproductive nature of the doe (Horst and Husain, 1991), and nearly 93% of BBGs have been reported to show their first estrus within one year of their life (Amin et al., 2000). The efficiency of a successful breeding practice greatly depends on the timely detection of estrus and the knowledge of the changes that occur during estrus. Failure to know the exact time of estrus misguides in predicting the time of ovulation, i.e., the correct mating time. If fertile males are kept continuously with the fertile female, the males will detect the occurrence of estrus and will mate with the female, but may also interfere with the breed improvement program. In a large flock of the breed improvement program, a selected buck may be engaged to mate with some particular does, but it may take much work for farmers to identify each doe in estrus. In this circumstance, having a teaser buck that can run with the flock continuously and detect the estrus may be helpful. Therefore, the principal objectives of a teaser male preparation might include rendering the animal completely sterile, resulting in no chance of fertilization, and maintaining the libido for a more extended period (Gill, 1995). Several surgical and non-surgical procedures are described in the literature for preparing teaser males. Vasectomy is the most widely used surgical intervention in the case of preparing teaser bulls, bucks, and rams (Batista et al., 2002; Boundy, 1996; Gill, 1995). In this procedure, the vas deference of both sides is surgically ligated to render permanent contraception. However, this procedure has reported numerous short- and long-term effects on the testes and associated structures in various animal species. Several studies, for example (Shiraishi et al., 2001; Alexander and Tung, 1977; Lohiya et al., 1987 and Vare and Bansal, 1973) have been performed on mice, rats, rabbits, guinea pigs, monkeys, and dogs where the histoarchitecture of testes were markedly altered following, others reported little or no alteration in the testes of rats, hamsters, rabbits, monkeys, and bucks (McDonald and Scothorne, 1988; Lue et al., 1997; Paufler and Foote, 1969; Peng et al., 2002 and Batista et al., 2002).

There is a paucity of information regarding the effects of vasectomy on testicular organization and function and semen quality in Black Bengal Buck (BBB). This experiment was conducted to evaluate the impact of unilateral and bilateral vasectomy on testicular structure, plasma level testosterone, and seminal parameters of BBB will help establish teaser buck in a successful breed improvement program.

Materials and Methods

The experiment was conducted under the Department of Anatomy and Histology, Sylhet Agricultural University, Sylhet 3100, Bangladesh. Nine healthy adult BBBs aged between "1.0 -1.5" years old and weighing between 8.0-10 kg were purchased from marginal farmers near the university premises and housed in the animal house in the university premises for 16 weeks.

Before the start of the experiment, the bucks were divided randomly into three groups (3 in each one); the bucks in group A were left as control, animals in group B were unilaterally vasectomized (vas deferens in the left spermatic cord), and animals in group C were bilaterally (both the left and right vas deferens) vasectomized.

The vasectomy was performed by restraining the animals in dorsal recumbence under deep sedation and analgesia, as described by Batista et al. (2002). Shortly, the spermatic cord and the vas deferens were isolated from the surrounding testicular tissue. After gently opening the vaginal tunic, the vas deferens were isolated and held firmly. A segment of vas deferens was externalized, approximately 3 cm of vas deferens was cut out, and both ends were ligated. Subsequently, the vaginal tunic of the testes and the skin of the scrotum were sutured, and an antibiotic was maintained for seven days. All the experimental animals were clinically examined daily, starting two weeks before the vasectomy and up to 12 weeks post-vasectomy, as Gouletsou et al. (2004) described. Testicular circumference was measured using a graduated tap. Blood samples were collected into heparinized tubes two weeks before vasectomy and every four weeks after a vasectomy for up to 12 weeks to check the plasma concentrations of testosterone.

Before the surgical intervention, all the BBBs were skilled to mount on a restrained doe medicated with estrogen. From each of the BBBs, semen samples were obtained by artificial vagina (AV) 2 weeks prior and every two weeks for 12 weeks following vasectomy. The ejaculate volume, color, concentration of sperm cells, motility, and percentage of live spermatozoa were assessed.

Figure 1: AV set used for semen collection.

After 16 weeks of rearing, the bucks were subjected to castration to collect the testes and the epididymis. Morphometric measurements of the testis and the epididymis were recorded to evaluate the effect of vasectomy. The data on testosterone, seminal characteristics, and testicular parameters was presented as mean±SE. Data were analyzed using SPSS, and analysis of variance (ANOVA) was used to determine the differences between groups.

Results & Discussion

There have only been a few attempts, but somewhat contradictory, to study the effects of vasectomy on small ruminants. Either it was performed on ram lambs (Osman, 1980) or on rams that were euthanatized shortly after vasectomy (Ball and Setchell, 1983) or done on a few (two animals) animals (Ahmad and Noakes, 1995). This assay was attempted to see the effect of vasectomy on the seminal characteristics, the plasmatic testosterone level, and the morphological features of testes in Black Bengal Bucks. No abnormal clinical findings were recorded in the genitalia before vasectomy. The postoperative recovery was good in all bucks. The animals did not show any inflammation or symptoms of infection at the testicular level. Healing of the surgical injuries was completed seven days after vasectomy. Following castration, the different parameters of the vasectomized and contra-lateral testes were recorded to evaluate the gross and pathological findings in the testes.

Seminal parameters

The seminal characteristics (i.e., the volume, the concentration of sperm, motility, and percentage of live spermatozoa) were studied in the three experimental groups starting two weeks before vasectomy till twelve weeks post-vasectomy to check the effect of vasectomy on seminal parameters. Figure 2 shows the mean ± SEM of the ejaculate volume before and after vasectomy. Before vasectomy, the ejaculate volume (mean±SEM) in the control group was slightly higher than in the vasectomized groups (unilateral and bilateral). Following vasectomy till the second-week post-vasectomy, the ejaculate volume decreased in the vasectomized groups in this present experiment. It then gradually reached the same level before the start of the investigation—the drop in seminal volume results from the vasectomy procedure (Janett et al., 2001). Regarding the color, the ejaculate was very light yellow in each vasectomized buck, while the typical milky appearance of the ejaculate remained unchanged in the control animals.

Vasectomy affects the result of semen analysis. The mean volume of the artificially collected ejaculate declined in the bucks vasectomized; this decline in volume may be due to the reduced number of sperm in the ejaculate. As expected, vasectomy consequences in the blockage of the passage of the male gland system secretions may result in less volume of ejaculation than the normal range. However, a seasonal influence on the seminal volume must be noticed. The ejaculates were obtained between March and June, and a decline in the ejaculation in the control bucks was also found. Our results concur with Ahmad and Noakes (1995) findings in bucks subjecting to unilateral vasectomy and Janett et al. (2001) findings in rams following a bilateral vasectomy, where the ejaculatory volume declined. In a study on ram, Janet and co-workers (2001) found a significant ($P<0.05$) drop in mean ejaculate volume (from 1.2 to 0.5mL) in the first ejaculate collected two weeks post-vasectomy.

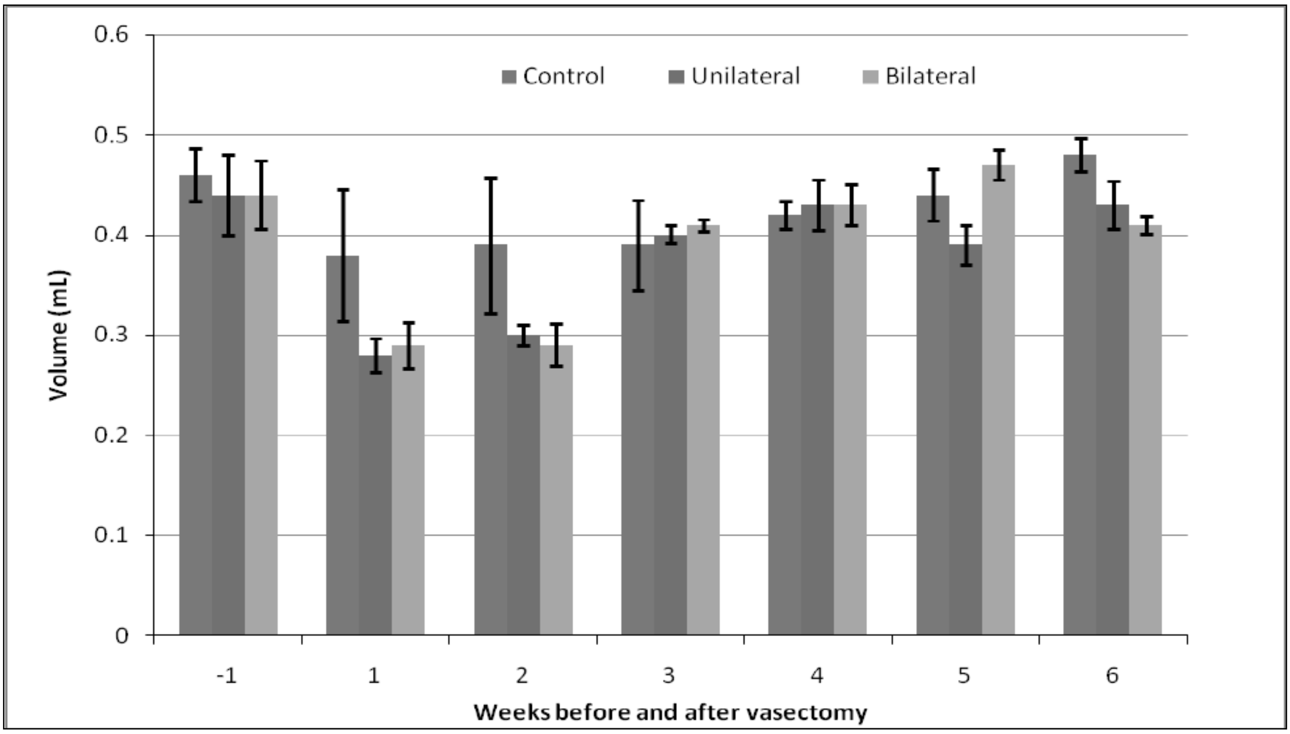

Figure 2. Mean±SEM of the volume of ejaculate in control, unilateral, and bilateral vasectomized Black Bengal bucks. -1, 1, 2, 3, 4, 5, and 6 indicate two weeks prior and two, four, six, eight, ten, and twelve weeks post-vasectomy, respectively.

Before vasectomy, the individual sperm motility ranged from 70.33% to 76.67% in the studied buck. One week after vasectomy, the unilaterally vasectomized bucks showed reduced sperm motility. In contrast, there was no individual sperm motility in all bilaterally vasectomized bucks, while in the control males, the percentage of sperm motility varied between 70.67% and 75.67%. On the other hand, the rate of live spermatozoa was below 5% in all bilaterally vasectomized males two days after vasectomy. Three weeks after the vasectomy, no live spermatozoa could be found in the ejaculates of any of the bilaterally vasectomized bucks (Table. 1). Concerning the sperm concentration, a remarkable decline in spermatozoa/ ejaculate was observed in all bilaterally vasectomized bucks starting from the first week after vasectomy (Table 1). In unilaterally vasectomized bucks, the concentration declines though a remarkable number of spermatozoa persist in the ejaculate.

Table 1. Characteristics of Black Bengal goat semen

Parameters	**Groups**	**Weeks before and after vasectomy**						
		-1	**1**	**2**	**3**	**4**	**5**	**6**
Sperm concentration (10^9/ml)	Control	4.84±0.09	4.9±0.11	3.93±0.15	4.4±0.18	3.86±0.05	4.75±0.32	4.44±0.92
	Unilateral	4.04±0.67	1.58±0.31	1.19±0.11	1.82±0.17	1.73±0.13	1.59±0.16	1.62±0.25
	Bilateral	3.76±0.45	0.022±0.01	0.013±0.01	0±00	0±00	0±00	0± 00
Sperm motility (%)	Control	74.33±3.52	70.67±1.67	75.67±2.72	75±3.00	73.33±3.38	74.67±2.96	74.33±3.17
	Unilateral	70.33±1.33	59±2.52	54.33±3.53	52.67±3.67	52.33±2.91	52.33±2.40	51±3.06
	Bilateral	76.67±1.76	20±1.73	0±00	0±00	0±00	0±00	0± 00
live spermatozoa (%)	Control	74.33±3.52	70.67±1.67	75.67±2.72	75±3.00	73.33±3.38	74.67±2.96	74.33±3.17
	Unilateral	70.33±1.33	59±2.52	54.33±3.53	52.67±3.67	52.33±2.91	52.33±2.40	51±3.06
	Bilateral	76.67±1.76	20±1.73	0±00	0±00	0±00	0±00	0± 00

The most significant observation of our study is that vasectomy affects sperm concentration, sperm mass motility, and individual motility, which dropped gradually due to blockage of sperm passage; the remaining amounts of sperm in another male genital system in the path may be seen initially after vasectomy. The concentration of the sperm started to decline dramatically in all the bilaterally vasectomized bucks following vasectomy. However, in the bucks unilaterally vasectomized, spermatozoa were observed in the ejaculate up to 16 weeks after vasectomy, but their number decreased throughout this period. There is ample evidence supporting the findings that the spermatic concentration intensely reduced in the ejaculates obtained from the ram in the first week following vasectomy (Ahmad and Noakes, 1995; Janett et al., 2001). Evidence shows that the spermatozoa could retain in the ductus deferens and the accessory genital glands and undergo a gradual decline in repetitive seminal extractions (Osman, 1980; Janett et al., 2001). Analyzing semen specimens of 436 patients two and three months after surgical vasectomy. Dhar et al. (2006) discovered that 75% were reported as azoospermic, while 25% of the sample contained sperm.

Numerous studies have documented a strong and consistent association between vasectomy and sterility. Villegas et al. (1992) demonstrated low fertility in rams' seminal ejaculation collected four days after surgery. Complete sterility was reported in the vasectomized animals seven days after the intervention (Villegas et al., 1992; Janett et al., 2001). Moreover, the spermatozoa from the vasectomized bucks showed no progressive motility after seven days of vasectomy.

Plasmatic concentrations of testosterone

The concentrations of plasma testosterone before and after vasectomy in both the unilaterally and bilaterally vasectomized bucks and in the control group are shown in Figure 3. Before vasectomy, the plasma testosterone concentrations (mean ± SEM) were 5.53±0.375, 5.27±0.698 and 5.17±0.352 ng/ml, in the unilateral and bilateral vasectomized and control bucks, respectively, with no significant difference between the experimental groups.

A marked decrease in testosterone concentration was observed in all the males from 2 to 6 weeks after vasectomy. Again, a gradual rise in the plasma levels of testosterone was observed from 8 to 12 weeks after surgery. Before vasectomy, all bucks showed attraction to the goats ejaculating in the artificial vagina in a short time (<15–20 s) after contact with the goat in heat. From 4 to 10 weeks after vasectomy, the attraction to the goats decreased in all males (groups B and C); only two vasectomized males and one of the intact bucks in group A manifested attraction to the goats. From 10 weeks after vasectomy until the end of the experiment, the same bucks (four of the vasectomized and the control ones) that had shown a recovery of the plasma levels of testosterone showed normal libido and manifested attraction to the goats in heat.

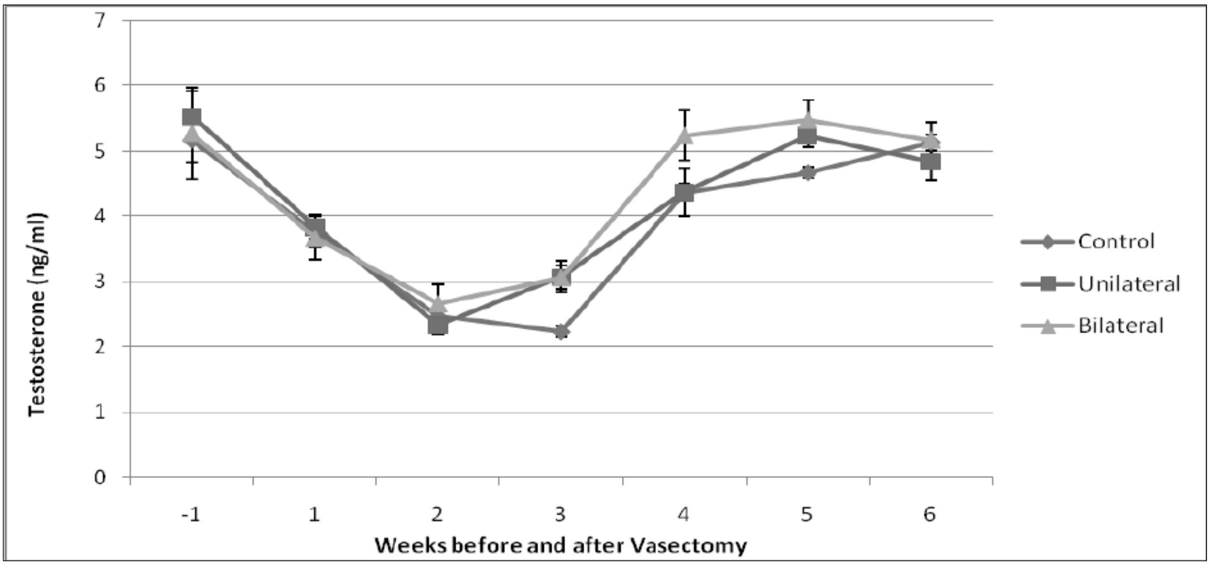

Figure 3. Plasmatic testosterone concentrations (mean ± SEM) in Control Unilaterally vasectomized and Bilaterally vasectomized bucks. -1, 1, 2, 3, 4, 5, and 6 two weeks prior and two, four, six, eight, ten, and twelve weeks post-vasectomy, respectively.

Before vasectomy, the plasma testosterone levels in different experimental bucks were estimated and similar to other caprine breeds (Walkden-Brown et al., 1994; Janett et al., 2001). Vasectomy does not affect the testosterone level, despite the consequences of unilateral (Ahmad and Noakes, 1995) or bilateral (Sargison et al., 1995) vasectomy.

In our study, a general decline was observed in the plasma testosterone concentrations in all the males after vasectomy; this fact does not seem to be a direct consequence of the surgical procedure because this decrease in the plasma concentration of testosterone was also observed in the control males. A possible explanation could be that the plasma testosterone concentrations were subjected to the effects of the photoperiod, as has been established by different experiments (Walkden-Brown et al., 1994). Recovery of the plasma levels of testosterone was confirmed in six of the males (four vasectomized and two control males) from May onwards.

Therefore, we consider that the males could have been used as estrous detectors, without risk of accidental fecundation, after only one week following vasectomy. The vasectomized males should rest for two or three weeks before being used as estrous detectors to allow total healing of the surgical injuries.

Morphometric findings in the testis and epididymis

In the unilaterally vasectomized bucks, the vasectomized side was larger than the contralateral part. It showed a nodule containing creamy material attached to a cyst containing yellowish watery fluid and a semi-solid creamy material. The bilaterally vasectomized testis and epididymis were noticed to have larger morphology (Figure 4).

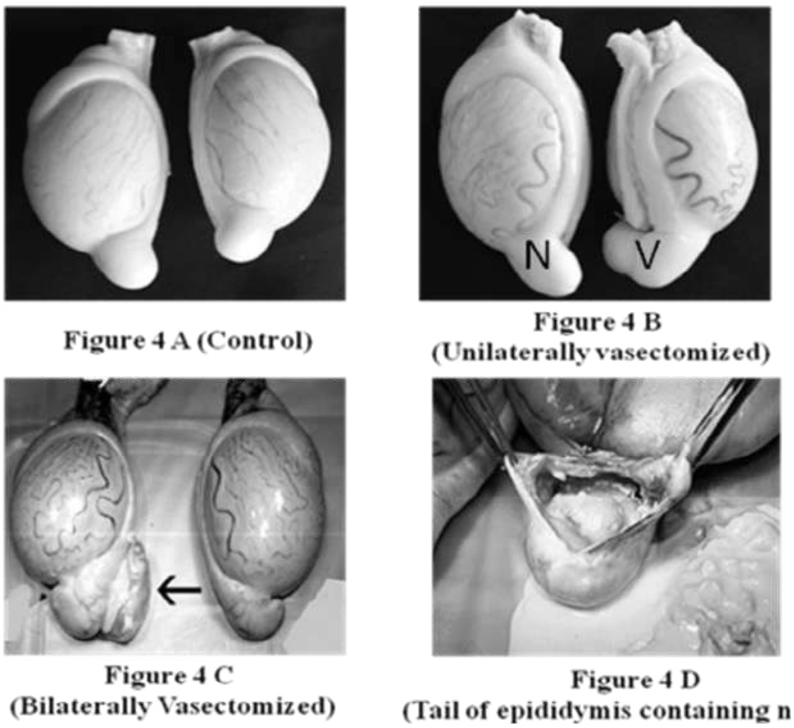

Figure 4. The testes from the control group (Figure 4A). The unilaterally vasectomized side (V) showed being larger than the contra-lateral part (N) (Figure 4B) and nodule containing creamy material (Figure 4D). The bilaterally vasectomized testis and epididymis were noticed to have larger morphology (Figure 4C).

The vas deferens suffered from enlargement and swelling lesions like a terminal end sac containing yellowish milky fluid. The dimensions of the testes and epididymis of all bucks are shown in Table 2. Four vasectomized males showed a slight reduction of testicular mobility during the experimental period. In addition, two of these males presented a remarkable increase in the size of the testes (orchitis) about eight weeks after vasectomy. Spermatic granulomata were observed at the epididymal tail in five of the six vasectomized males.

Table 3. Relationship between selected characteristics of the growers and their knowledge about pineapple cultivation.

Groups	Side	Testis			Epididymis				
					Head	Body	Tail		
		Dorso ventral	Medio Lateral	Cranio Caudal	Cranio caudal	Diameter	Medio Lateral	Dorso ventrral	Cranio caudal
Control	Right	73.6±1.3	59.3±0.7	43.2±0.8	25.4±1.1	9.7±0.8	29.4±1.4	24.3±1.2	19.8±1.3
	Left	76.2±1.8	61.2±1.1	43.1±0.6	24.9±0.7	9.3±0.6	27.3±1.2	23.7±0.8	19.3±0.7
Unilateral	Right	70.5±2.3	56.3±0.5	42.6±2.1	21.4±0.9	9.8±2.1	30.5±2.3	25.2±0.8	20.3±0.7
	Left	79.4±3.0	67.4±0.9	48.4±2.3	25.3±2.1	9.7±0.8	31.4±2.1	26.4±0.9	23.1±2.1
Bilateral	Right	82.5±3.2	67.3±0.7	49.5±1.7	26.7±0.9	9.9±1.5	32.5±1.6	27.5±1.2	26.3±0.9
	Left	84.6±2.1	66.5±2.1	49.3±2.2	27.3±1.2	9.7±2.3	33.5±2.1	27.2±0.7	25.5±1.3

Different studies confirmed that vasectomy is associated with generating sperm granulomata in a variable period after vasectomy (Ahmad and Noakes, 1995; Sargison et al., 1995 and Janett et al., 2001). Sometimes, this pathology develops due to processes of infectious etiology (Sargison et al., 1995) or as a consequence of poorly performed surgical techniques (Mayenco et al., 1996), but in most cases, complications occur regardless of the surgical procedure (Ahmad and Noakes, 1995; Janett et al., 2001). In our experience, granuloma was observed in vasectomized males at the level of the epididymal tail. In addition, the intense orchitis observed in two vasectomized males was probably caused by an immune-mediated inflammatory reaction consecutive to granulomas. These sperm granulomata did not appear to affect the characteristics of the ejaculates (volume, color) or the plasmatic levels of testosterone. However, we cannot rule out a possible influence of the granulomas (and other clinical signs) over the libido of the bucks.

Our results showed that the vasectomized bucks could be used as estrus detectors starting from 1 week after vasectomy because there was no sperm motility. In addition, the plasma levels of testosterone did not alter after vasectomy. Although it is not easy to establish a connection between the plasma level of testosterone and the libido of the animals, it could be asserted that the libido of an essential proportion of bucks (and therefore their capacity as teasers) may decline as a consequence of the clinical signs resulting from the complications that occur after vasectomy.

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