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Studies on the semen characteristics of kambing Katcang crossbred bucks

(Kajian terhadap perbezaan dalam ciri semen kambing Katcang jantan kacukan)

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Key words: semen characteristics, frequent ejaculation, temperature, grazed, housed, crossbred bucks

Abstrak

Ciri semen yang dipancut kerap kali setelah kambing Katcang jantan kacukan didedahkan pada suhu persekitaran yang tinggi telah dikaji. Dua belas ekor kambing jantan telah dipelihara secara rawak dalam sistem pengurusan di bawah teduhan (kumpulan I) dan dalam sistem pengurusan tanpa teduhan (kumpulan II) selama 7 hari. Keputusan analisis varians menunjukkan bahawa terdapat penurunan dalam isipadu, kepekatan setiap mililiter dan ketumpatan setiap pancutan semen dengan pancutan yang berturutan untuk kedua-dua kumpulan tersebut. Walau bagaimanapun, hanya kambing yang terdedah pada suhu yang tinggi sahaja yang mengeluarkan semen yang sedikit dan bermutu rendah dibandingkan dengan kambing jantan yang diberi teduhan. Purata suhu yang tinggi iaitu 30.9 °C tidak memberi apa-apa kesan terhadap pergerakan massa semen dan peratus spermatozoon yang abnormal. Hasil daripada kajian ini juga menunjukkan bahawa pancutan yang kerap menyebabkan pengurangan yang nyata pada ciri-ciri utama semen bagi kambing jantan yang telah didedahkan pada suhu persekitaran yang tinggi.

Abstract

The characteristics of frequently ejaculated semen of kambing Katcang crossbred bucks exposed to short periods of high environmental heat (i.e. environmental temperature and solar radiation) were studied. Twelve bucks were randomly maintained either in shade (group I) or without shade (group II) for 7 days. The analysis of variance showed that there was a decrease in the volume of semen, concentration per millilitre and density per ejaculation with successive ejaculations for both the groups. However, only the grazed heat-exposed bucks' percentage individual motility was affected with the frequent ejaculation. Generally, the bucks without any form of shade produced less semen and poorer quality compared with those in shade. The mean high environmental temperature of 30.9 °C did not have any effect on the mass motility and percentage of abnormal spermatozoa. Results of this study showed that a high mating frequency in the bucks was accompanied by a significant decline in the main semen characteristics with successive ejaculations, especially when the bucks were exposed to high environmental heat.

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Introduction

The genetic impact of a superior buck in artificial insemination is determined by the number of does inseminated or mated and this is limited by the number of spermatozoa collected or deposited in the females. Frequency of ejaculation and libido are the major factors influencing the total spermatozoa collected per buck per year. The quality and quantity of the ejaculates depend not only on the producing ability of the bucks but also on other factors such as temperature, nutrition and breed. It is common knowledge that hot climate is the principal cause of testicular degeneration. It is therefore important to understand the nature and significance of the seminal changes that occur during conditions of high mating frequency under high environmental temperatures. However, local information is lacking on this aspect of the male reproductive efficiency. This study therefore reports on the effect of repeated ejaculation on semen characteristics and spermatozoa output in bucks under different environmental conditions.

Materials and methods

Before the start of the experiment, ten kambing Katcang crossbred does of about 2 years old were induced for oestrus with prostaglandin (PGF2α). The does came to heat about 30–40 h after injection of prostaglandin.

Twelve kambing Katcang crossbred bucks, about 2 years old and trained to serve an artificial vagina (AV), were randomly allocated to either in shade (Group I) or grazing without shade (Group II). The bucks were maintained in the treatment sites for 7 days. During the study, the bucks were fed on Napier grass *(Pennisetum purpureum).* Water and mineral licks were available at all times. A formulated feed concentrate containing 150 g crude protein/kg DM and 11 M J/kg DM was fed at 0.25 kg/animal as a standard feeding practice. Semen sample from each buck was collected with the AV at the beginning of the experiment. Three bucks from each group were tested each day for 8 h (0800 to 1600h) to study the frequency of ejaculation under the two treatments. The bucks were then returned to the pens with three oestrus does and allowed to mate naturally twice while in the pens. After the natural matings, a semen sample was collected with the AV. The bucks were again returned to different oestrus females and the process was repeated throughout the duration of the experiment for the day. All the bucks had access to all the oestrus females during the 8-h test. Semen samples were collected in graduated centrifuge tubes and measured to the nearest 0.1 mL. A drop of semen was examined for mass motility (scale 0–5), and percentage of individual motility of spermatozoa was estimated using a warmed microscopic stage. The percentages of live and morphologically abnormal spermatozoa were determined from smears stained with eosin nigrosin stain and examined under phase contrast microscope. Spermatozoa concentration was calculated by using improved Neubauer haemocytometer. Abnormal spermatozoa count included the various abnormalities of the head, mid-piece and tail. Analysis of variance was used to determine the significance between the group means (Steel and Torrie 1980) for data recorded up to the 18th ejaculation only because very few bucks gave more than 18 ejaculations. The semen characteristics were fitted in the function $y = a^{\exp -bx}$

where y = semen variable
a = intercept
b = rate of decrease of the semen variable to the order of ejaculation
x = order of ejaculation

During the treatment period, environmental temperature was measured with a maximum and minimum thermometer, and rectal temperatures with a clinical thermometer at 8300, 1330 and 1630 h respectively.

Results

Number of matings

The number of matings for bucks ranged from 9 to 24 with a mean of 17.6 ± 1.02 for group I while in group II the range was from 10 to 22 with a mean of 17.2 ± 1.04 *(Table 1)*.

Volume of semen

The mean semen volume declined significantly (p <0.01) from 1.15 ± 0.17 mL for the first ejaculation to 0.48 ± 0.07 mL for the 18th ejaculation *(Figure 1)* for group I and the decline followed an exponential decay with a relationship of

Table 1. Characteristics of semen collected from bucks under two different environments (± S.E.)

	Group I (in shade)			Group II (no shade)		
Variable	Min.	Max.	Mean	Min.	Max.	Mean
Total no. of ejaculations	9	24	17.60 ±1.02	10	22	17.20 ±1.04
Total semen vol. (mL)	2.1 (5)	5.9 (7)	4.70 ±0.50	1.97 (4)	4.68 (7)	3.89 ±0.79
Total no. of sperm ejaculated(x 10^8)	41.67 (4)	121.56 (7)	104.72 ±6.59	39.89 (4)	101.67 (7)	75.32 ±4.51

Note: Values in brackets indicate no. of ejaculations collected and examined
Semen was collected by artificial vagina.

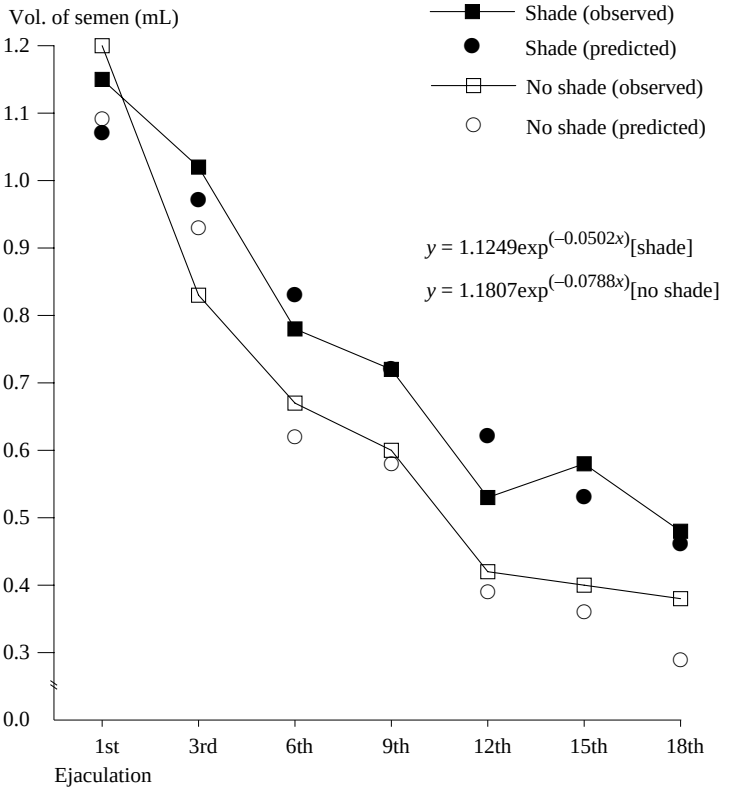

Figure 1. Mean semen volume of bucks given shade and no shade, in various ejaculations

Table 2. Exponential decay of main semen characteristics of bucks under two different environments

Characteristic	In shade	No shade
Semen volume (mL)	$y = 1.1249\exp^{(-0.0502x)}$ $r = 0.8611$	$y = 1.1807\exp^{(-0.0788x)}$ $r = 0.8712$
Sperm concentration ($x10^8$/mL)	$y = 34.8760\exp^{(-0.0850x)}$ $r = 0.8563$	$y = 33.2400\exp^{(-0.1001x)}$ $r = 0.8407$
No. of sperm/ejaculation ($x10^8$)	$y = 37.9094\exp^{(-0.1503x)}$ $r = 0.9466$	$y = 38.6907\exp^{(-0.1793x)}$ $r = 0.9598$

r = correlation coefficient

Table 3. Main semen characteristics for successfully collected ejaculates for bucks under two different environments (± S.E.)

Ejaculate no.	1st	3rd	6th	9th	12th	15th	18th
Volume(mL)							
Group I	1.15	1.02	0.78	0.72	0.53	0.58	0.48
	±0.17	±0.13	±0.11	±0.12	±0.09	±0.07	±0.07
Group II	1.20	1.00	0.67	0.60	0.42	0.40	0.33*
	±0.10	±0.32	±0.12	±0.08	±0.11	±0.10	±0.09
Sperm concentration (x 10^8/mL)							
Group I	35.63	26.58	21.63	16.43	1.23	12.05	8.05
	±8.05	±7.19	±1.87	±4.17	±3.64	±3.36	±2.49
Group II	33.45	22.46	18.51	13.47	11.31	9.13	5.67*
	±5.71	±5.20	±5.51	±4.49	±2.71	±2.21	±3.09
Sperm/ejaculation (x 10^8)							
Group I	38.50	24.27	13.73	9.06	6.05	5.25	2.47
	±2.01	±3.90	±3.74	±1.52	±2.46	±0.77	±0.53
Group II	36.50	22.43	11.93	7.26	4.23	3.46	1.67**
	±2.77	±1.42	±1.38	±0.99	±1.37	±0.94	±0.81
Motility (%)							
Group I	76.05	76.10	77.08	74.20	73.50	74.50	73.40
	±1.45	±1.10	±0.35	±1.22	±1.58	±1.35	±1.49
Group II	73.43	70.50	67.08	63.67	59.70	55.45	52.12*
	±1.05	±0.90	±1.28	±0.67	±1.38	±2.02	±2.19

	In shade	No shade
Rectal temp. (°C)	37.8 ± 0.92	39.7 ± 1.24*
Environmental temp. (°C)	28.2 ± 1.12	30.9 ± 1.76*

*p <0.05 **p <0.001

$y = 1.1249\exp^{(-0.0502x)}$ *(Table 2)* and the correlation coefficient was $r = 0.8611$ (p <0.01). The bucks in group II also showed a similar trend with the semen volume declining significantly (p <0.01) from 1.20 ± 0.10 mL for the first ejaculation to 0.33 ± 0.09 mL for the 18th ejaculation with non-linear function $y = 1.1807\exp^{(-0.0788x)}$ and the coefficient regression was r = 0.8712 *(Table 2)*. There was a significant difference (p <0.01) between the two groups *(Table 3)*. There were significant differences in the rate of decline between the 1st and the 3rd ejaculation, and the 6th ejaculation.

No significant difference (p >0.05) was observed after the 6th ejaculation. Similarly, there was no significant difference after the 6th ejaculation for group I bucks except between the 12th and 15th ejaculation (p <0.05).

Concentration of semen

There was a highly significant difference (p <0.01) between the two groups in the reduction of sperm concentration. In the group I bucks, the mean spermatozoa concentration reduced significantly (p <0.01) from 35.63 ± 8.05 x 10^8/mL to 8.05 ± 2.49 x 10^8/mL, a mean reduction of more than fourfold *(Figure 2).* However, a decline of more than 10-fold, from 33.4 ± 5.71 x 10^8/ mL to 3.09 ± 1.23 x 10^8/mL was observed in group II. The decline in concentration between successive ejaculations was significant (p <0.01) up to the 9th ejaculation in group I and thereafter the decline was not significant *(Table 3).* In group II however, there were significant differences (p <0.01) between all the ejaculations. Total spermatozoa per ejaculation declined significantly (p <0.01) in both the groups *(Table 3)* and the decline was significant between groups (p <0.01). In group I, the decrease was from 38.50 ± 2.01 x 10^8 to 2.47 ± 0.53 x 10^8 spermatozoa/ ejaculation while in bucks without shade, it was from 36.50 ± 2.77 x 10^8 to 1.67 ± 0.81 x 10^8 spermatozoa/ejaculation *(Figure 3).* The decline between successive ejaculation was significant (p <0.01) up to the 12th ejaculation for both the groups. Similar observations were recorded between the groups for the difference between bucks in rate of decline which were only significant (p <0.01) between ejaculates 3 and 6 and between 9 and 12.

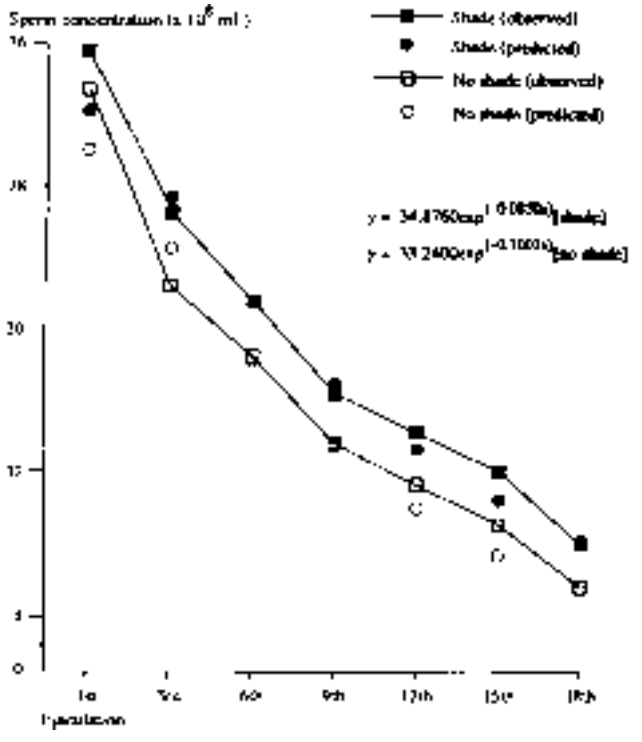

Figure 2. Decline in sperm concentration of bucks given shade and no shade, in various ejaculations

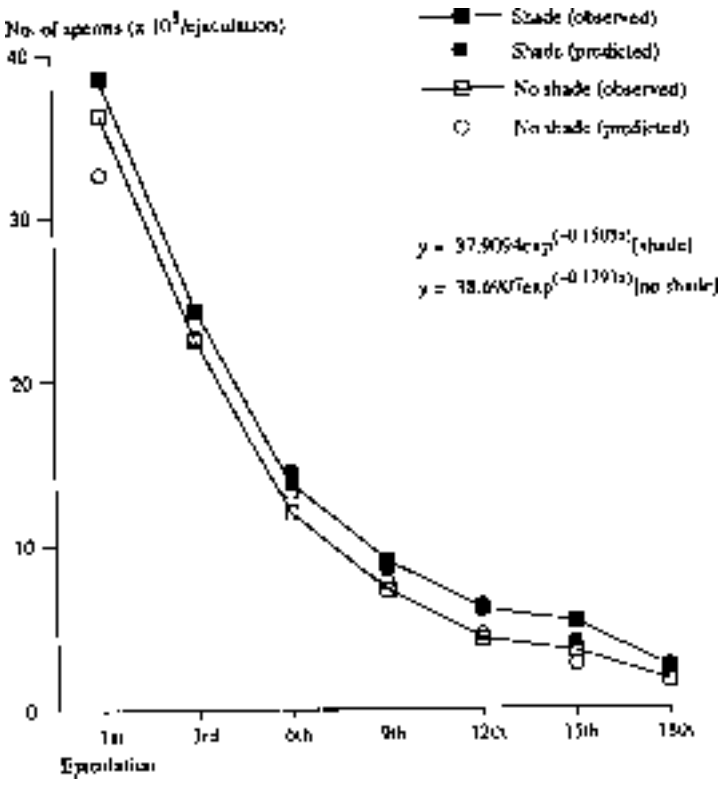

Figure 3. Decline in number of sperms of buck given shade and no shade, in various ejaculations

Individual motility

The percentage of individual motility in the group I bucks was not affected as a result of successive ejaculations but there was a significant decline in the heat-stressed bucks *(Table 3)*. There was no significant difference in the gross motility and percentage of abnormal spermatozoa due to frequent ejaculations for both the groups.

Rectal and environmental temperatures

It was observed that bucks in the open had a significantly (p <0.01) higher mean rectal temperature of 39.7 ± 1.24 °C compared with those in the shade (37.8 ± 0.92 °C). Mean environmental temperature was 28.2 ± 1.12 °C in the shade, while in the open it was 30.9 ± 1.76 °C *(Table 3)*, and the difference was significant (p <0.01).

Discussion

Several reports have been published concerning buck semen characteristics but the majority of them dealt with bucks subjected to low rates of ejaculation (Hatija 1982; Kalaimathee 1984; Abdul Wahid and Jaafar 1989). Measurements of spermatozoa reserves in goats have also received very little attention in Malaysia (Razak 1980; Bongso etal. 1981). However, no information is available concerning the effects of frequent ejaculations and high environmental temperatures in Malaysia. In this study, although complete depletion of semen was observed in some of the group I bucks after the 18th ejaculation, their libido was still good and they continued to ejaculation up to 24 times. In comparison, only two heat-exposed bucks could ejaculate up to 22 times. This difference could be attributed to the high environmental

temperatures to which the group II bucks were exposed. The observation of a decrease in semen volume from these bucks is in agreement with previous reports (Colas et al. 1975; Bagley 1980). Further, Mittal (1983) and Akusu et al. (1984) have also reported that the rate of decrease in the semen volume is dependent on breed and size of the animal. Some of the studies conducted without subjection to any form of heat stress have also reported a decrease in the volume, concentration and spermatozoa number in successively collected ejaculates in goats (Tewari et al. 1968; El-Sayed et al. 1983). These findings should be so because the bucks ejaculated frequently during the test period thus reducing the semen reserve. The present results also indicated that there was a significant decrease in the semen volume for the heat-exposed bucks as compared with those under the shed and hyperthermia appears to be an important factor. This finding supports that of Reddy et al. (1989) about the effects of high temperatures on semen characteristics. These authors concluded that high temperatures caused a decrease in the volume of ejaculation, spermatozoa concentration, motility and percentage of live and normal cells. The reduction in the number of spermatozoa was significant between successive ejaculates up to the 15th ejaculation and thereafter it was not significant. The fall in total spermatozoa number per ejaculation agrees very closely with the results reported by Lightfoot (1968) on the effect of semen and frequent matings in rams.

The ability of the bucks to supply does with adequate number of spermatozoa under natural matings depends on the frequency at which does are served. Further, the number of spermatozoa for different bucks varies, the concentration being dependent on their testicular weights and the frequency of ejaculation (Bongso et al. 1981; Corteel et al. 1981). Tewari et al. (1968) reported that there was no deterioration in semen quality with once a day collection over a period of 21 days. However when it was extended to 40 days, there was a significant reduction in the volume and spermatozoa number per ejaculation.

It has been reported that frequent matings may be accompanied by seminal degeneration with a high incidence of morphologically abnormal spermatozoa in the ejaculation, the effect being most severe in hot environments (Reddy et al. 1989). In this study, the incidence of abnormalities was not significant.

Elevation of testis temperature beyond 36 °C is harmful to spermatogenesis and usually results in damage at the spermatid and spermatocyte stages. Raising body temperature by only 1.7 °C may also result in the depression of semen quality.

Conclusion

Results of this experiment showed that a high mating frequency in bucks grazed in the open was accompanied by a significant decline in the main semen characteristics with successive ejaculations. High ambient temperatures experienced by these bucks were possibly the main factor responsible for the sporadic seminal degeneration observed in this study. It is suggested that the number of spermatozoa per ejaculation after the sixth ejaculation could fall below that required for fertilization to occur, especially in hormone synchronized does, where large spermatozoa numbers are needed to overcome the reduced spermatozoa transport in these treated does (Memon and Ott 1981). The conclusions arising from the present investigations may not necessarily apply to the effect of high air temperature for longer durations. Further investigations need to be carried out to determine the long-term effects.

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