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Comparative Study of Scrotal Circumference and Semen Characteristics of Mountain Black Goat and Its Crossbred with Damascus Goat as Affected by Different Factors

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ABSTRACT

This study was designed to examine semen profiles of Mountain Black Goat bucks (BG) and its Crossbred with Damascus goat (CB) prior to the breeding season under arid conditions of Jordan. Semen was collected via electro-ejaculation. Scrotal circumference was significantly influenced by breed ($P < 0.01$) and buck age ($P < 0.05$). The difference in scrotal circumference between yearlings and matures was reflected upon Ejaculate Volume (EV) as matures had significantly greater EV ($P < 0.05$) than yearlings. With respect to breed, there was a strong tendency ($P < 0.10$) for BG bucks to have greater EV than CB bucks. Horned bucks tended to be heavier than polled bucks ($P < 0.10$) without having any effects on semen characteristics. Results of the present study indicate that breed of buck did not influence any of the measured variables. Buck age and the presence of horns affected body weight and scrotal circumference without influencing semen characteristics.

KEYWORDS: Buck semen, Reproduction, Mountain Black goat, Damascus goat

INTRODUCTION

Mountain Black Goat (BG) is the predominant goat breed in Jordan comprising more than 95% of the 426 thousand head population (Ministry of Agriculture, 2001). It is also the main breed in Syria, Egypt and other Middle Eastern countries (Hassan, 1993). Mountain Black goats are mostly raised extensively. Very little research has been done to explore BG performance because of its low productivity under extreme desert conditions. However, high milk production and growth rate were reported in BG under semi-intensive management systems (Awad et al., 1997).

Reproductive performance is a function of both doe and buck fertility. Therefore, all aspects related to semen evaluation are important in management practices, especially for AI in a breeding program. Scrotal circumference and semen characteristics were found to be different among different breeds and among individuals of the same breed (Langford et al., 1998; Noran et al., 1998). Bucks show lower reproductive activity during high ambient temperatures (Roca et al., 1992). Farmers in Jordan breed their does during the warm summer and early autumn to obtain kids during the range-growing seasons (winter and spring). This study was designed to examine semen profiles of Mountain Black goat bucks and its crossbred with Damascus goat (yearling and matures) prior to the breeding season under arid conditions of Jordan.

MATERIALS AND METHODS

General

The study was conducted at the Khanasry Research Station for Small Ruminant Improvement (National Center for Agricultural Research and Technology Transfer) located in the northern part of Jordan, at 32°30'

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N, 35°59' and an altitude of 860 m. Data were collected over two seasons during the month of May in the years 1999 and 2000 during which the minimum and maximum temperatures were 14.15 °C and 29.94 °C, respectively.

Animals

Nineteen Mountain Black Goat bucks (BG) and 15 first Cross Black x Damascus goat bucks (CB) were used in the study over a 2-year period (1999 and 2000). Eighteen of the bucks were evaluated in 1999 and 16 were evaluated in the year 2000. Of the BG bucks, 8 were yearlings and 11 were mature (2 – 6 years old) while 11 yearlings and 4 matures (2 – 6 years old) comprised the CB bucks. Bucks have been separated from does since the preceding breeding season, for matures, or since weaning, for yearlings. Bucks were maintained in open-sided barns (with free access to water, shade and mineral blocks). The mature bucks were fed 0.8 kg/head per day concentrates (65–70% barley, 15–20% wheat bran, 15% soyabean meal) and 0.4 kg/head per day roughage (shredded straw and alfalfa). The yearlings were fed 0.5 kg/head per day concentrate and 0.3 kg/head per day roughage. Bucks were allowed to graze on natural pastures for 2–3 times a week. The natural pasture was available for the period from mid-January to the end of April and therefore, no forage was offered during this period.

Data Collection

Breeding soundness exam was applied once to all bucks prior to each breeding season. On the day of testing, all bucks were weighed and body condition scored (BCS, using score system 0–5; Hossamo, 1984). Scrotal Circumference (SC) was measured using a flexible tape at the widest scrotal diameter. Semen samples were collected using a battery-operated electro-ejaculator and a series of short electrical stimuli (approximately 5 s) were administered at 20s intervals (Buckrell et al., 1994; Belibasaki and Kouimtzis, 2000). The first ejaculate was discarded and the next one was used for semen evaluation. Because bucks were housed separated from females since the previous breeding season, it was essential to discard the first obtained ejaculate as it may contain a high percentage of dead and abnormal spermatozoa. Both Ejaculate Volume (EV) and Appearance (EA) were determined immediately after collection from a transparent graduated vial. Ejaculate Appearance (EA) was ranked as watery (0), cloudy (1), milky (2), creamy (3), and thick creamy (4). Mass and Forward Motilities (MM, FM) were evaluated as described by Al-Ghalban et al. (2004) MM was assessed as percentages by viewing one drop of semen at low magnification (40 X). Rate of FM was assessed by viewing a diluted drop of semen (with a drop of 0.1 M sodium citrate) at high magnification (400 X) with scores from 0 to 4 (dead to vigorous movement, respectively). An aliquot of semen was diluted in a physiological saline solution containing 0.01% mercury chloride at 1:400 (semen: diluent) for concentration (C) and Percentage of Abnormalities (AP) to be calculated using a hemocytometer (Chemineau et al., 1991). Concentration of Normal Sperms (NSC) was calculated as the difference between C and AP.

STATISTICAL ANALYSIS

Least-square analysis of variance was used to study the effect of age, horn, year and body condition score as main effects. All possible interactions were tested. The statistical analysis system (SAS, 1994) was used to accomplish the different analyses.

RESULTS

Effect of Breed

Breed (BG vs. CB) had no effect on buck Body Weight (BW; Table 1). Both breeds had similar body weights during both years of the experiment. Scrotal circumference differed ($P < 0.01$) between breeds averaging 24.8 ± 0.7 and 28.3 ± 1.0 cm for BG and CB bucks, respectively. Ejaculate volume and appearance along with other semen characteristics were similar between breeds although there was a numeric difference

($P > 0.05$) in semen concentration among BG and CB in favor of the CB bucks (Table 1).

Effect of Age

Buck age influenced body weight (Table 1). Mature bucks were significantly heavier than yearlings ($P < 0.001$) with significant correlation existing ($P < 0.001$) between BW and age (Table 2). Additionally, buck age had a significant influence on scrotal circumference ($P < 0.01$). Mature bucks had a scrotal circumference of 28.3 ± 0.9 cm compared with 24.8 ± 0.8 cm for yearlings. The difference in scrotal circumference between yearlings and matures was reflected upon EV as matures had significantly greater EV ($P < 0.05$) than yearlings (0.75 ± 0.1 ml and 1.34 ± 0.1 ml for yearling and mature bucks, respectively). Scrotal circumference and ejaculate volume tended to be correlated with age ($P < 0.10$) and BW ($P < 0.01$) (Table 2). Buck age had no significant influence on semen characteristics even though all variables were numerically better in mature bucks.

Effect of BCS

Bucks were classified as having a BCS of 2, 3 or 4 (Table 1). Within BCS, there was a strong tendency ($P < 0.10$) for breed by age interaction with respect to body weight. Yearling BG bucks had similar BW regardless of BCS, while within the mature BG bucks having a BCS of 4 were heavier than those with a BCS of 3. Body condition score was significantly correlated ($P < 0.01$) with BW. Even though it was not statistically significant, AP in CB bucks numerically increased as BCS decreased.

Effect of Horn

Horned bucks tended to be heavier ($P < 0.10$) than polled bucks. Similarly, horned, CB had greater scrotal circumferences ($P < 0.05$) than either polled or horned BG bucks. There were significant ($P < 0.05$) year-breed-age and age-horn interactions with respect to body weight (Table 1). In all cases, mature bucks were always heavier than yearlings. Mature, horned bucks were heavier than all others followed by mature polled bucks, while yearling polled and horned bucks had similar body weights (Table 1). Breed-horn interaction existed ($P < 0.05$) for scrotal circumference (Table 1) with horned CB bucks having the highest values. No horn effect was observed on semen characteristics.

Effect of Year

Semen variables were not influenced by any of the studied parameters (Table 1) with the exception of abnormality percentage (AP). The percentage of Abnormal Spermatozoa increased from 10.8 ± 2.1 in 1999 to 23.1 ± 3.1 % in the year 2000 ($P < 0.05$).

Ejaculate appearance had the highest correlation coefficient with most of the semen characteristics (Table 2). Correlation values ranged from -0.01 for the percentage of abnormal sperms to 0.79 for sperm concentration. Ejaculate appearance was strongly correlated ($P < 0.001$) with mass and forward motility.

DISCUSSION

Breed of buck did not influence BW. Mature bucks, however, were heavier than yearlings. Mature bucks were 2 to 6 years old at the time the experiment was conducted. Size of the testes determines the amount of sperm-producing tissue (Bearden and Fuquay, 1997). This, in turn, indicates whether the buck is a good or poor sperm producer. In this study, mature bucks of both breeds had larger scrotal circumferences than yearlings, which show their capability of serving more does provided that these bucks are healthy. Al-Ghalban et al. (2004) reported that mature Damascus bucks had greater SC than yearlings. The values for SC obtained by these authors are higher than those reported in the present study. This difference is probably related to breed, as Damascus goats are considerably larger in size than Mountain Black goats. The fact that horned bucks were heavier than polled bucks may be related to their ability to better compete for feed. The significant correlation between SC with age and BW are due to the fact that the testes are body parts that respond to tissue growth, which is observed by the improvement of body weight. These results are in agreement with Belibasaki and Kouimtzis (2000) who reported significantly higher SC in heavier breeds.

The significant interactions between breed and age

with horn are related to the fact that horned bucks have better reproductive performance than polled ones (Hasan and Shaker, 1990; Al-Ghalban et al., 2004). Al-Ghalban et al. (2004) reported that horned bucks had greater semen concentration and more viable spermatozoa than polled bucks. This would suggest the presence of genetic linkage between the locus of presence of horns and the fertility characteristics of bucks. Chemineau et al. (1991) suggested that replacement sires preferably should be horned, and all bucks from two polled parents should be excluded.

Buck age did not influence semen characteristics indicating that yearlings were sexually mature at the time of testing. Ejaculate volume was greater in mature bucks than yearlings. This difference is caused by the greater SC reported in mature bucks. Black goat bucks tended to have greater EV than crossbreds. This difference was reflected in the numerically greater semen concentration in the crossbreds (Table 1). The BG bucks may be more sensitive to electric stimulation than CB bucks resulting in the production of more seminal plasma. Gastel et al. (1995) reported that using electrical impulses for semen collection does not give a true indication of ejaculate volumes. Even though larger ejaculate volumes are obtained when using electrical impulses as compared with using artificial vaginas, the total number of sperms produced and the fertilizing capacity of sperms are about the same using both methods (Bearden and Fuquay, 1997).

Perez and Mateos (1996) reported that semen concentration in Verata and Malaguena bucks during increasing photoperiod was 5.7 x 10^9 and 4.7 x 10^9 sperm·ml^{-1} with 17.9 and 5.7 % abnormal cells, respectively. Similarly, Roca et al. (1992) reported semen concentration of 3.5 x 10^9 sperm·ml^{-1} with 8 % abnormal cells for Murciano-Granadina bucks. These concentrations are higher than the observations reported in the present study (Table 1). This variation may be due to breed differences and the method of semen collection. In the present study, semen was collected by electrical stimulation, which increases the amount of seminal fluids in the ejaculate thus decreasing semen concentration. The AP was similar among BG and CB and among yearling and mature bucks. Osinowo et al. (1988) did not find significant differences in abnormal sperm percentage between yearling and mature rams.

Body condition scores are important in determining the nutritional status of animals. Under-nutrition results in lower BCS, Thwaites (1995) reported that underfeeding decreases testicular volume. This is important as a decrease in testicular volume is correlated with a decrease in sperm output (Toe et al., 1994). In the current study, BCS did not influence any of the semen characteristics. The only effect of BCS was on BW. Bucks with higher BCS were always heavier. This is further proven by the significant correlation between these two variables.

The percentage of abnormal spermatozoa differed from year to year. This difference may be due to several factors including management and high ambient temperature which leads to testicular degeneration and a reduction in the percentage of normal and fertile spermatozoa in the ejaculate (Jainudeen and Hafez, 1993; Santos et al., 1998).

IMPLICATIONS

Based on these results, it appears that breed (BG vs. CB) of buck had no effect on semen characteristics despite the fact that CB bucks had larger scrotal circumferences indicating their capability of serving more females. The presence of horn had positive effects on body weight and scrotal circumference without influencing semen characteristics.

Table (1). Least square means (± SE) for semen characteristics of bucks of different ages and body condition scores[1].

d	N	BW kg	SC cm	EV ml	EA 0-4 score	SN X 10^6	CONC X 10^6	AP %	NSC X 10^6	MM %	FM 0-4 score
Breed			**								
BG	19	53.2±2.4	24.8±0.7	1.21±0.09	2.33±0.3	2919±702	2621±644	16.2±2.1	2304±617	71.6±8	3.4±0.3
CB	15	54.4±3.1	28.3±1.0	0.88±0.15	3.07±0.5	3389±1137	4001±1043	17.7±3.1	3314±911	78.3±11	3.6±0.4
Age		***	**	**							
Yearling	19	38.9±2.6	24.8±0.8b	0.75±0.11b	2.69±0.4	2803±821	3669±753	16.4±2.4	3243±705	78.5±9	3.6±0.3
Adult	15	68.8±2.8	28.3±0.9a	1.34±0.14a	2.71±0.5	3505±1055	2954±968	17.5±2.9	2375±845	71.4±10	3.3±0.4
Breed*Age											
BG											
Yearling	8	41.1±3.5	23.8±1.1	0.89±0.14	2.23±0.5	2342±1074	2686±985	18.3±3.5	2418±999	80.2±12	3.7±0.4
Adult	11	65.4±3.1	25.8±1.0	1.53±0.12	2.43±0.4	3496±905	2557±830	14.1±2.5	2190±724	62.9±9	3.2±0.3
CB											
Yearling	11	36.7±3.8	25.8±0.8	0.62±0.17	3.15±0.5	3263±1241	4652±1139	14.6±3.4	4069±994	76.7±12	3.6±0.4
Adult	4	72.2±4.7	30.8±1.4	1.15±0.26	3.00±0.8	3515±1906	3350±1749	20.8±5.3	2560±526	80.0±19	3.5±0.6
Year			*					**			
1999	18	52.3±2.4	25.1±0.7	1.11±0.10	2.87±0.3	3103±740	3084±679	10.8±2.1b	2919±608	71.0±7	3.4±0.3
2000	16	55.4±2.9	28.0±0.9	0.98±0.15	2.54±0.5	3205±1107	3539±1016	23.1±3.1a	2699±896	77.9±11	3.6±0.4
Horn		+									
Polled	22	50.2±2.2	26.2±0.7	0.96±0.16	2.3±0.5	2128±950	2650±846	12.9±2.7	2506±510	78.1±8	3.7±0.3
Horned	10	57.4±3.1	26.9±1.0	1.10±0.17	3.0±0.5	3336±977	3289±870	19.2±2.8	2289±514	67.2±8	3.2±0.3
BCS (Breed*Age)		+									
BG											
Yearling											
2	2	43.3±6.7d	26.0±2.1	0.92±0.30	0.90±1.0	377±2278	606±2090	28.5±8.2	804±2378	58.6±29	3.0±1.0
3	4	41.1±5.1d	23.9±1.6	0.74±0.20	2.80±0.6	2300±1611	3101±1478	11.5±4.5	2759±1290	87.1±16	4.0±0.5
4	2	38.8±6.7d	21.4±2.1	1.00±0.26	3.00±0.8	4350±1906	4350±1749	14.9±5.3	3690±1526	95.0±19	4.0±0.6
Adult											
2	2	61.8±7.0ac	25.5±2.2	2.12±0.29	1.83±0.9	2194±2131	465±1955	13.1±5.9	297±1706	43.3±22	2.7±0.7
3	6	57.4±3.4c	24.4±1.1	0.98±0.15	3.06±0.5	3596±1145	3828±1051	15.0±3.2	3338±917	74.7±11	3.6±0.4
4	3	77.0±5.0ab	27.6±1.5	1.49±0.21	2.39±0.7	4697±1588	3378±1457	14.3±4.4	2934±1272	70.6±15	3.3±0.5
CB											
Yearling											
2	1	26.0±9.6d	26.7±3.0	0.35±0.39	4.11±1.3	1813±2865	4309±2629	21.8±7.9	3217±2301	95.0±28	4.3±1.0
3	7	38.3±3.5d	25.8±1.1	0.65±0.15	3.33±0.5	3766±1100	5407±1010	17.6±3.2	5099±920	80.0±11	3.6±0.4
4	3	45.7±6.5d	24.9±2.0	0.85±0.26	2.00±0.8	4210±1906	4240±1749	4.2±5.3	3890±1526	50.0±19	3.0±0.6
Adult											
3	2	74.0±6.0b	30.9±1.9	1.35±0.45	3.00±1.4	3399±3301	2820±3029	22.3±9.1	2020±2643	70.0±32	3.0±1.1
4	2	70.3±7.1cb	30.8±2.2	0.95±0.26	3.00±0.8	3631±1906	3880±1749	19.3±5.3	3100±1526	90.0±19	4.0±0.6
Year*Breed											
1999											
BG	9	50.5±3.5	22.7±1.1	1.19±0.13	2.71±0.4	2711±941	2851±864	13.1±2.7	2643±795	70.6±10	3.3±0.3
CB	9	54.1±3.8	27.5±1.1	1.03±0.15	3.02±0.5	3495±1142	3316±1048	8.4±3.2	3196±920	73.3±11	3.4±0.4
2000											
BG	10	56.0±3.4	26.9±1.1	1.23±0.15	1.95±0.5	3127±1154	2392±1059	19.3±3.3	1964±959	72.5±12	3.5±0.4
CB	6	54.7±4.7	29.1±1.5	0.73±0.26	3.13±0.8	3283±1889	4685±1734	27.0±5.2	3433±1515	83.3±18	3.7±0.6
Year*Age											
1999											
Yearling1	11	37.3±3.1	23.2±1.0	0.82±0.13	2.94±0.4	2685±949	3136±871	12.1±2.8	3062±808	74.2±10	3.5±0.3
Adult	7	67.3±3.5	27.1±1.1	1.41±0.15	2.80±0.5	3521±1136	3031±1042	9.4±3.1	2776±909	69.8±11	3.3±0.4
2000											
Yearling1	8	40.5±4.2	26.4±1.3	0.69±0.17	2.45±0.6	2921±1302	4201±1195	20.7±3.7	3424±1076	82.7±13	3.8±0.5
Adult	8	70.3±4.1	29.6±1.3	1.27±0.24	2.63±0.8	3490±1791	2876±1643	25.5±5.0	1973±1434	73.1±17	3.4±0.6
Breed*Horn		+	*								
BG											
Polled	12	53.7±2.5ab	25.9±0.8a	1.22±0.13	1.90±0.4	2845±947	2418±844	17.4±4.2	1885±784	71.0±13	3.4±0.5
Horned	6	52.8±4.0ab	23.7±1.3a	1.17±0.21	3.10±0.6	3946±1258	3891±1120	12.7±4.0	3420±752	77.7±12	3.6±0.5
CB											
Polled	10	46.8±3.5a	26.6±1.1ab	0.70±0.30	2.70±0.8	1410±1869	2882±1665	8.5±5.7	3127±1059	85.3±17	4.0±0.6
Horned	4	62.1±5.3b	30.0±1.6b	0.98±0.29	2.90±0.8	2725±1697	2687±1512	25.6±5.4	1158±1009	56.7±16	2.9±0.6
Age*Horn		*									
Yearling											
Polled	12	39.5±3.2a	25.5±1.0	0.66±0.19	2.0±0.5	1913±1262	3246±1124	13.3±5.0	2893±832	82.8±15	3.9±0.6
Horned	5	38.3±4.1a	24.0±1.3	0.65±0.22	3.0±0.6	1421±1331	2422±1186	19.7±4.0	1604±746	59.4±12	3.0±0.4
Adult											
Polled	10	61.0±2.9b	27.0±0.9	1.27±0.24	2.70±0.7	2343±1545	2054±1287	12.6±5.0	2119±923	73.5±15	3.4±0.6

Horned	5	76.6±4.9c	29.7±1.5	1.50±0.27	3.00±0.7	5251±1602	4155±1427	18.6±4.9	2974±914	75.0±15	3.5±0.5
Year*Horn			*								
1999											
Polled	13	49.8±2.8	26.2±0.9a	1.02±0.17	2.6±0.5	1952±1026	2282±914	8.6±3.0	2569±557	77.2±9	3.6±0.3
Horned	5	54.8±4.3	24.0±1.3a	1.11±0.23	3.4±0.7	4317±1412	4317±1258	14.1±4.1	3419±762	62.3±12	3.0±0.5
2000											
Polled	9	50.7±3.1	26.3±1.0a	0.90±0.22	2.0±0.6	2304±1343	3019±1196	17.3±3.8	2444±710	79.1±11	3.7±0.4
Horned	5	60.0±4.6	29.7±1.4b	1.03±0.25	2.7±0.7	2355±1454	2260±1295	24.2±4.4	1159±810	72.1±13	3.5±0.5

+Significant at (P < 0.1), *Significant at (P < 0.05), **Significant at (P < 0.01), ***Significant at (P < 0.001).
a,b,c different letters indicate significant differences as indicated within group.
[1]Semen was collected by electroejaculator. [2]Body weight (BW), body condition score (BCS), scrotal circumference (SC), ejaculate volume (EV), ejaculate appearance (EA), sperm per ejaculate (SN), sperm concentration (CONC), abnormality percentage (AP), normal sperm concentration (NSC), mass motility (MM) and rate of forward movement (FM).

Table (2). Simple correlation among measurements collected to evaluate semen characteristics of bucks of different ages and body condition scores[a].

	BW	**SC**	**BCS**	**EV**	**EA**	**SN**	**CONC**	**AP**	**NSC**	**MM**	**FM**
AGE	0.77***	0.30+	0.24	0.35*	-0.05	0.19	-0.06	0.16	-0.17	-0.03	-0.06
BW		0.54***	0.37*	0.50**	-0.20	0.22	-0.16	-0.04	-0.21	-0.11	-0.17
SC			0.21	0.13	-0.17	0.05	-0.18	0.28	-0.15	0.05	-0.08
BCS				0.02	0.01	0.33+	0.23	-0.12	0.13	0.18	0.15
EV					-0.13	0.29	-0.19	-0.19	-0.26	-0.28	-0.27
EA						0.59***	0.79***	-0.01	0.72***	0.68***	0.61***
SN							0.79***	-0.16	0.76***	0.57**	0.53**
CONC								-0.08	0.99***	0.67***	0.63***
AP									-0.23	-0.03	-0.11
NSC										0.68***	0.64***
MM											0.95***

+Significant at (P < 0.1). *Significant at (P < 0.05), **Significant at (P < 0.01), ***Significant at (P < 0.001).
[a]Body weight (BW), body condition score (BCS), scrotal circumference (TC), ejaculate volume (EV), Ejaculate appearance (EA), sperm per ejaculate (SN), sperm concentration (CONC), abnormality percentage (AP), normal sperm concentration (NSC), mass motility (MM) and rate of forward movement (FM).

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دراسة مقارنة لمحيط الخصية وخصائص السائل المنوي للماعز الجبلي الأسود وهجينها مع الماعز الشامي وتأثرها بعوامل مختلفة

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ملخـص

صممت هذه الدراسة لاختبار نوعية السائل المنوي لتيوس المعز الجبلي الأسود وهجينه مع المعز الشامي قبل موسم التزاوج تحت الظروف الأردنية، حيث جمع السائل المنوي بواسطة محفز القذف الكهربائي، تأثر محيط الخصية معنويا بسلالة التيس ($P < 0.01$) وعمره ($P < 0.05$)، وانعكس الفرق في محيط الخصية بين الشعاري والتيوس الناضجة في حجم القذفة؛ إذ كان حجم القذفة للتيوس الناضجة معنويا ($P < 0.05$) أعلى من حجمه للشعاري، بينما كان هنالك توجه قوي ($P < 0.10$) ليكون حجم القذفة أكبر للماعز الجبلي الأسود مقارنة بهجينه مع المعز الشامي، وظهر توجه ($P < 0.10$) لوزن أعلى للتيوس ذات القرون مقارنة بالتيوس عديمة القرون دون ظهور أي تأثير على نوعية السائل المنوي، وأظهرت نتائج الدراسة عدم تأثير سلالة التيس على أي من خصائص السائل المنوي، بينما أثر عمر التيس ووجود القرون على وزنه ومحيط خصيتيه دون التأثير على نوعية السائل المنوي.

الكلمات الدالة: السائل المنوي للتيوس، تناسل، الماعز الجبلي الأسود، المعز الشامي.

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