OPEN ACCESS
Journal of Animal Health and Production

Research Article

Evaluation of Semen Characteristics, Testicular Measurements, and Blood Parameters for Three Genetic Groups of Goat Bucks in Iraq

Rwaida Adnan Ali[1], Rahman Hussain Hamza[1], Hayder Mohammed Hassan Habeeb[1], Ali J. Al-Nuaimi[2]

[1]Animal Production Department, College of Agricultural, Al-Qasim Green University, Babil, Iraq; [2]College of Veterinary medicine, University of Kerbala, Kerbala, Iraq.

Abstract | This study was conducted to evaluate the semen characteristics, testicular parameters, and blood parameters of three genetic groups of goat bucks. In this investigation, twelve mature bucks (average weight= 25 kg, average age= 2 years) were used: Cyprus (n=4), local black (n=4), and crossbreed (Cyprus X local black) (n=4). Semen and blood samples were collected from all groups every 2 weeks for 3 months. Semen volume, sperm concentration, mass activity , individual motility, live and dead sperm, abnormal sperm, testis weight, testicle circumference, testis length, red blood cell (RBC), white blood cell (WBC), hemoglobin concentration (Hb), urea, cholesterol, and total protein were measured in this study. The results showed that both mass activity and individual motility were significantly greater (P<0.01) in crossbred goat bucks than in local black and Cyprus goat bucks. In addition, the Cyprus goat showed a significant reduction (P<0.01) in dead and abnormal sperm compared with local black and crossbreed. However, local black and crossbreed exhibited significant increase in live sperm compared with Cyprus goat. Furthermore, testis weight, circumference, and length were significantly greater (P<0.05) in local black goats than in Cyprus and crossbreed goats. There were no significant differences between the genetic groups in term of semen volume and sperm concentration. The results revealed a positive correlation between ejaculate volume and RBC, WBC, and total protein levels and a negative correlation between sperm concentration and WBC, Hb, and total protein. In addition, there was a negative correlation between ejaculate volume, individual movement, live sperm, and testis parameters. We can conclude that local goat crossbreeding with high genetic groups may enhance male reproductive performance.

Keywords | Genetic group; Semen characteristics; Testicular measurements; Blood parameters; Goats

Received | February 03, 2024; **Accepted** | May 01, 2024; **Published** | May 31, 2024
***Correspondence** | Rwaida Adnan Ali, Animal Production Department, College of Agricultural, Al-Qasim Green University, Babil, Iraq; **Email:** Rwaida_aljebori@agre.uoqasim.edu.iq
Citation | Ali RA, Hamza RH, Habeeb HMH, Al-Nuaimi AJ (2024). Evaluation of semen characteristics, testicular measurements, and blood parameters for three genetic groups of goat bucks in iraq. J. Anim. Health Prod. 12(2): 233-239.
DOI | http://dx.doi.org/10.17582/journal.jahp/2024/12.2.233.239
ISSN (Online) | 2308-2801

INTRODUCTION

In many countries, goats are a vital component of livestock and are crucial to human food security.. The Arab world has a large goat breeding industry because goats are small, require low maintenance, and can live in various environmental conditions. After sheep and cows, goats are the third most common animal in Iraq (1.6 million in 2008) (Al-Qasimi and Al-Lami, 2016). Goats are considered to be one of the most important sources of supplying red meat and milk to consumer after cows and sheep. Therefore, they occupy a good position among animal breeders in Iraq because of their characteristics that encourage the breeder to raise them, as they are considered one of the animals characterized by a high rate of producing twins, which is considered a source for meat production, and it also has a high milk yield compared to sheep (Aljebori and Alrubaei, 2013). Even after thousands of years of existence

in the Arab world and ongoing artificial and natural selection through breeding and improvement initiatives, they still require more efforts to improve their genetic make-up and the environmental conditions in which they live to develop their reproductive performance and productivity (Al-Qasimi et al., 2015). Increasing live and free-abnormal sperm reaching the site of fertilization is a sign of the reproductive efficiency of males (Al-Janabi et al., 2023a), which positively reflects the growth of the productive efficiency of goats (Al-Ani, 2002). Semen characteristics are an important factor in predicting male productivity and breeding success (Al-Janabi et al., 2023b). Semen characteristics (e.g., sperm motility, concentration, and morphology) play a vital role in determining the fertility and reproductive outcome of goat bucks. These examples help breeders measure the value of semen, select superior sires for artificial insemination, and enhance overall breeding programs (Arrebola and Abecia, 2017). In addition, blood parameters are very sensitive indictors of physiological and pathological status and are routinely used to evaluate livestock management practices (Hayder et al.,2023). In addition, understanding semen characteristics can assist in recognizing any potential problems or abnormalities that may affect the productivity of goat bucks (Molnár et al., 2015). This will allow successful management programs and the overall genetic diversity of the flock to confirm successful reproduction in goat bucks, enhancing the potential for desirable traits to be passed on to future generations (Meijer et al., 2021; Ridler et al., 2012). Many studies have been conducted to improve the quality of local goat semen by crossbreeding. A study was conducted to investigate the effect of crossbreeding between local and Shami goats (Ishaq et al., 2005). They concluded that crossbreeding (local X Shami goat) reduced the number of dead and abnormal sperm compared with local and Shami male goats. Another study investigated the effect of crossbreeding on seminal and testicular parameters (Omari et.al., 2018). In this study, they concluded that semen concentration and testis width were the highest for (Shami X Mountain Black) compared to Shami and Mountain Black, respectively. Another investigation compared two crossbreeds in Indonesia (Etawah grade and Senduro bucks). In this investigation, the authors concluded that the semen concentration increased in Etawah grade bucks crossbred with Senduro bucks. In addition, hematological parameters in healthy goats show several variations in relation to breed, and reproductive status (Francesca et al., 2016). To the best of our knowledge, to date, there have been no studies comparing semen quality, testis circumference, and blood parameters between Cyprus, local black, and crossbreed (Cypurs X local black). Therefore, this study aimed to evaluate semen characteristics, testicular parameters, and blood parameters for three genetic groups (local black, Cyprus, and crossbreed (Cyprus X local black)). In this research, semen volume, concentration, mass activity, individual motility, live and dead sperm, abnormal sperm, testicular measurements (weight, length, and diameter of the testis), and blood parameters were also measured.

MATERIALS AND METHODS

The current research was conducted in the fields of sheep and goat breeders in the Al-Qasim district, south of the Babil Governorate. Twelve mature bucks (average weight= 25 kg, average age= 2 years) were used in this study: Cyprus (n=4), local black (n=4), and crossbreed (Cyprus X local black) (n=4). Bucks previously trained for semen collection by artificial vagina for two weeks and in good condition. Semen samples were collected and transported to the laboratory for evaluation.

Semen Characteristics

The semen volume was determined using a graduated tube immediately following semen collection using a 5 mL test tube monthly for 3 months. Sperm concentration was determined by Salisbury et al. (1943). Briefly, 0.05 µL semen sample (1:400) was placed in a 9.05 µL concentration solution (0.9% sodium chloride, 0.01% mercury chloride, and 0.2% eosin). Following dilution, a hemacytometer counting chamber was used to determine the sperm concentration. Mass activity was estimated by the method described by Walton (1933). Briefly, a drop of semen was placed on a glass slide at 37°C and examined under a microscope at 10X magnification. The percentage of sperm activity was estimated on the basis of waves and their density. The motility of individual sperm was assessed by observing their movement patterns at 40X magnification after placing a drop of semen on top of a small drop of sodium citrate (2.9%) on a glass slide at 37°C, according to the method outlined by Walton (1933). This method accurately estimates individual motility and provides insights into the sample's overall viability. The percentage of live and dead sperm was estimated according to the procedure described by Swanson and Bearden (1951). Briefly, a small drop of semen was mixed with a drop of eosin-nigrosine (1:2) on a glass slide at 37°C. The smear was placed on another slide and examined at 40X magnification. Pink sperm heads refer to dead sperm, whereas colorless sperm refer to live sperm. 200 sperm were counted in two different fields, and the percentage was estimated. The percentage of abnormal sperm was estimated according to the method described by Hancock (1951). Briefly, using the same slide to estimate the percentage of dead sperm, abnormalities were classified into abnormal head, mid-piece, and tail. The samples were examined under a microscope at 100x magnification. A total of 200 sperm were counted in two different fields, and the percentage was estimated.

Blood Collection

Blood samples (3 mL) were drawn via jugular venipuncture into vacutainer tubes (Terumo Corporation) containing ethylenediaminetetraacetic acid (EDTA). Blood samples were centrifuged within 30 min of collection at 3000 × g for 15 min. Plasma was pipetted into 12 × 75 mm glass tubes using sterilized plastic disposable Pasteur pipettes (Aliasghar et al, 2021). Whole blood samples were transported to the laboratory and processed within 2 h. Red blood cell (RBC), white blood cell (WBC), hemoglobin concentration (Hb), urea, cholesterol, and total protein were estimated using an automated hematology analyzer (Piccione and Caola, 2002).

Testis Measurements

Testicular measurements were recorded for 3 months. Briefly, the weight of the testis was measured using a volumetric flask. In addition, the length and testicular circumference were measured using flexible metric tape (Nora et al., 2024).

Statistical Analysis

Statistical computations were performed using SAS software (SAS, 2018) to explore the influence of genetic groups on the studied parameters according to a complete random design (CRD). Duncan's multiple range test (Duncan, 1955) was applied to compare means. The correlation coefficient was used to determine the association between semen, testis dimensions, and blood parameters. The statistical model was as follows:

$Yij = \mu + Gi + eij$

Where:

Yij = Dependent variable.

μ = Overall mean.

Ti= Effect of genetic groups.

eij = error term.

RESULTS AND DISCUSSION

Effect Of The Genetic Group On Seminal Characteristics

Semen volume and sperm concentration were not significantly different between the genetic groups. However, mass activity and individual motility were greater in the crossbreed (Cyprus X local black) (89.21± 0.71 ±, 88.01 ± 0.61 respectively), compared with Cyprus and local black goat (P<0.01) (Table 1). The superiority of crossbreed goats in terms of mass activity and individual motility could be due to the combination of genetic traits from both breeds. This suggests that crossbreeding enhances the reproductive performance of goats in these specific parameters. This result was in agreement with the results of Ishaq et al. (2005), who recorded a significant effect of the breed on mass activity and individual motility compared with local and Shami goats. In addition, the current results were in agreement with those of El-Saidy et al. (2007), who reported that carpet goats significantly increased in both mass activity and individual motility compared with Damascus and Alpine goats. However, this result was not supported by Hafizuddin et al. (2021) and Isnaini et al. (2021), who concluded that there were no significant differences between breeds raised in Indonesia (Anglo, Nubian, Aitao and the Sandro). Regarding live sperm, the data showed a significant increase (P<0.01) in crossbreed (Cyprus X local black) and local black (85.34 ± 0.65, and 84.93 ±1.02 respectively) compared with Cyprus (80.96 ±0.81%) goats (Table 1). In addition, the statistical analysis showed that the number of dead sperm was significantly reduced (P<0.01) in both crossbreed (Cyprus X local black) and local black goat (14.67±0.64 and 15.07±1.01% respectively) compared with Cyprus buck (19.05 ±0.81%) (Table 1). Moreover, the data showed that the abnormal sperm was significantly reduced (P<0.01) in both crossbreed (Cyprus X local black) and local black goat (11.13 ±0.69 and 11.63 ±0.81% respectively) compared with Cyprus buck (15.29±0.82%) (Table 1). These results were supported by El-Saidy et al. (2007); and Ishaq et al. (2005) but not supported by the results of Hafizuddin et al. (2021); and Mahfuza et al. (2022), which did not record a significant effect on different breeds of goats. These results might be due to variations in the methodology and protocols followed by different researchers, which could also contribute to the differing outcomes. In addition, factors such as the environmental conditions and the health status of the animals involved may have influenced the results obtained in each study, which require further investigation.

Effect Of The Genetic Group On Some Testis Dimensions

The statistical analysis showed a significant difference (P<0.01) between the groups on some testicular measurements. The testis weight was significantly greater (P<0.01) in local black goat bucks (825.34 ± 25.43 g) than in Cyprus and crossbreed (Cyprus X local black) (602.42± 68.52, 583.01± 26.98 g, respectively). In addition, the testicular circumference was significantly greater (P<0.05) in local black goat buck (39.31 ± 0.81 cm) than in Cyprus and crossbreed (Cyprus X local black) (36.09 ± 0.65, 36.17 ± 0.91 cm respectively). At the same time, testis length was significantly greater (P<0.05) in local black goat buck (29.26 ± 0.33 cm) than in Cyprus and crossbreed (Cyprus X local black) (25.64 ± 0.37 and 24.96 ± 0.49cm respectively) as presented in Table 2.

These results were supported by Gemeda and Workalemahu (2017), who reported a significant difference between Afar buck breeds in testicular measurements (testis weight, circumference, and length) compared with LES and WG

Table 1: The effect of genetic group of goat bucks (local black, Cyprus, Cyprus X local black) on some semen traits

Semen traits	Mean ± SE			Significance level
	Local black	Cyprus	Crossbreed (Cyprus X local black)	
Ejaculate volume (ml)	0.08±1.72	0.05± 1.65	0.09± 1.69	NS
Sperms concentration X (10^9)	0.25± 3.94	0.18± 4.01	0.20± 3.98	NS
Mass movement %	b 0.98± 84.14	b1.05± 84.62	a0.71±89.21	**
Individual movement %	b1.02± 84.12	b1.41± 83.18	a0.61± 88.01	**
Live sperms %	a1.02±84.93	b0.81± 80.96	a 0.65± 85.34	**
Dead sperms %	b1.01± 15.07	a0.81±19.05	b 0.64± 14.67	**
Deformed sperms	b0.81± 11.63	a0.82±15.29	b0.69± 11.13	**

Means having with the different letters in same row differed significantly,
** (P≤0.01), NS: Non-Significant.

Table 2: The effect of genetic group of goat bucks (local black, Cyprus, Cyprus X local black) on some testis dimensions (testis weight, testicular circumference, and testis length).

Testis traits	Mean ± SE			Significance level
	Local black	Cyprus	Crossbreed (Cyprus X local black)	
Testis weight (g)	825.34 ± 25.43 a	602.42 ± 68.52 b	583.01 ± 26.98 b	**
Testicular circumference (cm)	39.31 ± 0.81 a	36.09 ± 0.65 b	36.17 ± 0.91 b	*
Testis length (cm)	29.26 ± 0.33 a	25.64 ± 0.37 b	24.96 ± 0.49 b	*

Means having with the different letters in same row differed significantly,
** (P≤0.01), * (P≤0.05), NS: Non-Significant.

breeds in Ethiopia. However, the current results were not supported by Raji and Aliyu (2008), who reported that there was no significant difference in testicular parameters between the studied Nigerian goat breeds. A possible factor contributing to the variations in these measurements could be the environmental conditions in which the animals were raised. In addition, other variations might also be the reason for such a difference, e.g., nutrition, season, and body weight have an effect on scrotal measurements in farm animals (Mekasha et al., 2007). Furthermore, nutrition management might explain the differences observed in testis measurements between breeds (Raji and Aliyu, 2008).

Effect Of The Genetic Group On Some Blood Parameters

RBC count and total protein were significantly different (P<0.05) between the genetic groups (Table 3). RBC was significantly greater in the crossbreed (Cyprus X local black) (10.08 ± 0.56) than local black and Cyprus (9.57 ±0.68, 7.95 ±0.51 respectively). At the same time, total protein was significantly greater (P<0.05) in local black goat buck (7.79 ±0.48) than in Cyprus and crossbreed (6.23 ±0.49 and 7.57 ±0.36 respectively). Our findings suggest that crossbreed goats (Cyprus X local black) have a greater propensity to transport oxygen in situations of oxygen starvation. According to Francesca et al. (2016), who studied five goat breeds (Aspromontana, Girgentana, Messinese, Maltese, and Argentata dell'Etna) and reported that the influence of breed should be considered when evaluating goat hematology (Piccione et al., 2014).

Correlation Coefficient Between Blood Parameters, Semen Traits, And Testis Dimensions

The correlation between blood and semen parameters is listed in Table 4. The results revealed a positive correlation between ejaculate volume and RBC, WBC, and total protein levels and a negative correlation between sperm concentration and WBC, Hb, and total protein. These findings were consistent with previous findings that there is a considerable positive connection between ejaculate volume and total protein, contrary to the correlation between sperm concentration and total protein (Samir et al., 2024). In addition, all testis parameters were inversely correlated with RBC and total protein.

Correlation Coefficient Between Semen Characteristics And Testis Dimensions

The current study found correlations between testis dimensions and sperm characteristics (Table 5). There was a negative correlation between ejaculate volume, individual movement, live sperm and testis parameters. These findings disagree with those of Samir et al. (2024), who found a positive correlation between testis length and ejaculate volume, individual movement, live sperms. sperm

Table 3: The effect of genetic group of goat bucks (local black, Cyprus, Cyprus X local black) on some blood parameters.

Blood parameters	Mean ± SE			Significance level
	Local black	Cyprus	Crossbreed (Cyprus X local black)	
RBC (×10⁶/µl)	9.57 ±0.68 ab	7.95 ±0.51 b	10.08 ±0.56 a	*
WBC (×10³/µl)	8.847 ±4.47	7.545 ±3.59	7.922 ±5.26	NS
Hb (g/dl)	9.13 ±0.69	7.99 ±0.53	7.96 ±0.54	NS
Urea (mg/dl)	26.56 ±0.41	27.63 ±0.76	26.51 ±0.51	NS
Cholesterol (mg/dl)	7.22 ±0.73	8.64 ±0.51	8.28 ±0.49	NS
Total protein (g/dl)	7.79 ±0.48 a	6.23 ±0.49 b	7.57 ±0.36 ab	*

Means having with the different letters in same row differed significantly,
* (P≤0.05), NS: Non-Significant.

Table 4: Correlation coefficient between blood parameters and semen traits and testis dimensions

Parameters	Correlation coefficient-r and Significant level						
	Cholesterol	RBC	WBC	Hb	Urea	Cholesterol	Total protein
Semen:							
Ejaculate volume	-0.48 *	0.52 *	0.56 *	0.38 NS	-0.43 *	-0.48 *	0.66 **
Sperms concentration	0.52 *	-0.34 NS	-0.59 *	-0.48 *	0.36 NS	0.52 *	-0.61 **
Mass movement	0.18 NS	0.47 *	-0.17 NS	-0.27 NS	-0.21 NS	0.18 NS	0.20 NS
Individual movement	0.04 NS	0.53 *	-0.03 NS	-0.16 NS	-0.32 NS	0.04 NS	0.35 NS
Live sperms	-0.32 NS	0.67 **	0.37 NS	0.19 NS	-0.46 *	-0.32 NS	0.65 **
Dead sperms	0.32 NS	-0.66 **	-0.38 NS	-0.20 NS	0.46 *	0.32 NS	-0.66 **
Deformed sperms	0.31 NS	-0.69 **	-0.36 NS	-0.18 NS	0.47 *	0.31 NS	-0.65 **
Testis dimensions:							
Testis weight	0.32 NS	-0.55 *	-0.26 NS	-0.19 NS	0.25 NS	0.32 NS	-0.61 *
Testicular circumference	0.26 NS	-0.52 *	-0.31 NS	-0.23 NS	0.35 NS	0.26 NS	-0.55 *
Testis length	0.29 NS	-0.61 *	-0.24 NS	-0.16 NS	0.34 NS	0.29 NS	-0.54 *

* (P≤0.05), ** (P≤0.01), NS: Non-Significant.

Table 5: Correlation coefficient between Semen traits and Testis dimensions

Parameters	Correlation coefficient-r and Significant level						
	Ejaculate volume	Sperms concentration	Mass movement	Individual movement	Live sperms	Dead sperms	Deformed sperms
Testis weight	-0.77 **	0.72 **	-0.38 NS	-0.71 **	-0.87 **	0.87 **	0.87 **
Testis length	-0.75 **	0.62 *	-0.51 *	-0.84 **	0.84 **	0.84 **	0.84 **
Testicular circumference	-0.81 **	0.73 **	-0.30 NS	-0.53 *	-0.84 **	0.84 **	0.84 **

* (P≤0.05), ** (P≤0.01), NS: Non-Significant

concentration, dead sperm, and deformed sperm, all of which are favorably connected with testis parameters. This agrees with prior research that testicular length and width were positively correlated with the percentage of sperm (Samir et al. 2024). This could be related to the elongation of the testis, which is related to more hormonal supply, which could result in more desirable sperm morphology (Jurandy, 2018).

CONCLUSIONS AND RECOMMENDATIONS

The current study concluded that crossbreeding of local goats with other fertile breeds like (Cyprus X local black) may have a potential effect on semen characteristics. These results confirm the importance of crossbreeding with local breeds to survive harsh environmental conditions and exploit the strength of the crossbreed. This result requires

further investigation to study in depth the sexual behavior and reproductive performance of the crossbred goats. In addition, further research should focus on assessing the genetic potential and adaptability of crossbred offspring to determine their suitability for specific production systems and market demands.

ACKNOWLEDGEMENTS

The authors are thankful to the owners of the Al-Qasim district for their assistance during sample collection.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this manuscript.

AUTHORS CONTRIBUTION

All authors contributed equally.

NOVELTY STATEMENT

The novelty of this study is its focus on increasing fertility in Iraqi goat breeds through crossbreeding with other breeds and increasing their resistance to environmental conditions.

REFERENCES

Al-Ani T. (2002). The semen dilution in Shami goats. 1100-1500 (M.Sc. thesis, Anbar University. P:320.

Al-Janabi Y.A, Habeeb H.M.H., Al-Qasimi R.H.H. (2023a). Effect of Breed on Some Production Traits and Reproductive Traits of Local Sheep. IOP Conference Series: Earth Environ. Sci. 1262(7): 072096. https://iopscience.iop.org/article/10.1088/1755-1315/1262/7/072096

Al-Janabi Y.A., Habeeb H.M.H., Al-Qasimi R.H.H. (2023b). Effect of Breeds on Some Semen Characteristics of Awassi Ram and Its Crossbreed. IOP Conference Series: Earth Environ. Sci. 1262(7): 072112. https://iopscience.iop.org/article/10.1088/1755-1315/1262/7/072112

Al-Qasimi R., Al-Lami J. (2016). Effect of addition Iraqi probiotic to rations of local goat kids on some cellular and biochemical traits of blood. Euphrates J. Agricult., 8(2):155-160.

Al-Qasimi R., Al-Tayy H., AL-Khauzai A. (2015). The effect of genetic group for goat kids on som productive traits and chemical composition of carcass. Euphrates J. Agricult. Sci., 7(4): 73-78.

Aliasghar M., Hamid K., Peyman R., Ghadir S. (2021). Effect of intravaginal device type and treatment length on estrus synchronization and reproductive performance of Farahani ewes out of breeding season. Songklanakarin J. Sci. Technol., 43(1): 80-86.

Aljebori R.A., Alrubaei H.M. (2013). The role of sex chromatin in some blood parameters and prolificacy in Damascus goats. J. Kerbala University, 11(3): 124-130.

Arrebola F., Abecia J.A. (2017). Effects of season and artificial photoperiod on semen and seminal plasma characteristics in bucks of two goat breeds maintained in a semen collection center. Vet. World., 10(5):521–525. https://doi.org/10.14202%2Fvetworld.2017.521-525

Duncan D.B. (1955). Multiple Range and Multiple F Tests. Biometrics. https://doi.org/10.2307/3001478

El-Saidy B., El-Ayek M., Abdel-Khalek A., El-Maghraby M. (2007). Seasonal variation in physical semen characteristics of three goats kept under egyptian condition. J. Anim. Poult. Prod., 32(7): 5181–5195. https://doi.org/10.21608/jappmu.2007.219670

Francesca A., Francesco F., Maria R., Simona M., Elisa Z., Giuseppe P. (2016). Factors affecting the hematological parameters in different goat breeds from Italy. Ann. Anim. Sci., 16 (3):743–757. DOI: 10.1515/aoas-2015-0094

Gemeda A.E., Workalemahu K. (2017). Body Weight and Scrotal-Testicular Biometry in Three Indigenous Breeds of Bucks in Arid and Semiarid Agroecologies. Ethiopia. J. Vet. Med., 1–9. https://doi.org/10.1155/2017/5276106

Hafizuddin K., Praharani N.L., Setiadi M.A. (2021). Breed and age effects on concentration of adiponectin and reproductive performance in anglo nubian, etawah grade and its crossbred bucks. Biodiversitas., 22(3): 1112–1119. https://doi.org/10.13057/biodiv/d220305

Hancock J.L. (1951). A staining technique for the study of temperature-shock in Semen. Nature., 167(4243): 323–324. https://doi.org/10.1038/167323b0

Hayder M.H.H., Rwaida A.A., Ahmed M., Husain F.H., Badir R.K. (2023). Effect of *Moringa oleifera* Leaf Powder on Awassi Ewe's Blood Parameters. IOP Conference Series: Earth Environ. Sci. 1262(7): 072012. https://iopscience.iop.org/article/10.1088/1755-1315/1262/7/072012

Ishaq M.A., AbdulkareemT.A., Muhammad T.A. (2005). The effect of breeding group and treatment with vitamin C on some semen characteristics of bucks. Iraqi Agricult. Sci. J., 2(3): 87–94.

Isnaini N., Hakim A.A., Amertaningtyas D., Sulistyo H.E., Irsyammawati A ., Andri F. (2021). Comparative study of semen quality traits between Etawah grade and Senduro bucks. In IOP Conference Series: Earth Environ. Sci. (Vol. 888). https://doi.org/10.1088/1755-1315/888/1/012022

Jurandy M.P., Fabyano F.S., Simone F.G., Bruna W., Eduardo P.C., Victor G.L., Jeanne B.S., Denise S.O., Paula P.M., José D.G. (2018). Relationship of testicular biometry with semen variables in breeding soundness evaluation of Nellore bulls. Anim. Reprod. Sci., 196:168-175 https://doi.org/10.1016/j.anireprosci.2018.07.010.

Mahfuza S., Gopal S. Sukanta B., Ashit K.P. (2022). Collection and evaluation of indigenous buck semen at the coastal region of Bangladesh. Insights Vet. Sci., 6(1):001–004. https://doi.org/10.29328/journal.ivs.1001034

Meijer E., Goerlich V.C., Brom R., Giersberg M.F., Arndt S.S., Rodenburg T.B. (2021). Perspectives for Buck Kids in Dairy Goat Farming. Front. Vet. Sci. Frontiers Media S.A https://doi.org/10.3389/fvets.2021.662102

Mekasha Y., Tegegne A., Rodriguez-Martinez H. (2007). Sperm morphological attributes in indigenous male goats raised under extensive husbandry in Ethiopia. Anim. Reprod., (2): 15–22.

Molnár A., Sarlós P., Fáncsi G., Rátky J., Nagy S., Kovács A. (2015). A sperm tail defect associated with infertility in a

goat — Case report. Acta Vet. Hungar., 49(3): 341–348. https://doi.org/10.1556/004.49.2001.3.11

Nora H., Rajuddin, Hafizuddin, Suhanda R., Fathurrahman M. (2024). Antifertility effect of curcumin on sperm quality, morphology of testicular, and seminal vesicle in rats (*Rattus norvegicus*). Adv. Anim. Vet. Sci., 12(3):532-538. http://dx.doi..org/10.17582/journal.aavs/2024/12.3.532.538

Omari H., Al-Dawood A., Althenebat A. (2018). Testicular and epididymal sperm reserve evaluations in three jordanian goat breeds. J. Appl. Anim. Res., 46(1): 1522–1527. https://doi.org/10.1080/09712119.2018.1552152

Piccione G., Caola G. (2002). Biological rhythm in livestock. J. Vet. Sci., 3: 145–157.

Piccion G., Monteverde V., Rizzo M., Vazzana I., Assenza A., Zumbo A., Niut-ta P.P. (2014). Reference intervals of some electrophoretic and haematological parameters in Italian goats: comparison between Girgentana and Aspromontana breeds. J. Appl. Anim. Res., 42: 434–439.

Raji A.O., Aliyu J. (2008). Testicular biometry and its relationship with body weight of indigenous goats in a semi arid region of Nigeria. J. Agricult. Biolog. Sci., 3(4):6–9. https://api.semanticscholar.org/CorpusID:46182288

Ridler A.L., Smith S.L. West D.M. (2012). Ram and buck management.Anim. Reprod. Sci., 130(3–4): 180–183. https://doi.org/10.1016/j.anireprosci.2012.01.012

Samir I., Ali F., Mohamed R., Yousef N., Elsebaey A., Ibrahim R., Noseer E., Nour S., Hussein H. (2024). 'Testicular Biometry, Spermigram, and Biochemical Parameters In Male Goats', Egyptian J. Vet. Sci., 55(3):671-679. https://doi.org/10.21608/EJVS.2023.235081.1607

Salisbury G.W., Beck G.H., Elliott I., Willett E.L. (1943). Rapid Methods for Estimating the Number of Spermatozoa in Bull Semen. J. Dairy Sci., 26(1): 69–78. https://doi.org/10.3168/jds.S0022-0302(43)92695-5

SAS. (2018). Statistical Analysis System, User's Guide. Statistical. Version 9.6 th ed. SAS. Inst. Inc. Cary. N.C. USA.

Swanson E.W., Bearden H.J. (1951). An Eosin-Nigrosin Stain for Differentiating Live and Dead Bovine Spermatozoa. J. Anim. Sci., 10: 981–987. https://doi.org/10.2527/jas1951.104981x.

Walton A. (1933). The technique of artificial insemination Imperial Bureau Animal. Genet., 5(2):56-66.