

SEMEN QUALITY, TESTICULAR CHARACTERISTIC, BIOCHEMICAL PROFILE AND HISTOPATHOLOGY OF TESTES OF GOATS UNDER HEAT STRESS CONDITIONS

RAGAB HASSAN MOHAMED ¹; RASHA S. MOHAMED ²;
IBRAHIM SAMIR ABD EL-HAMID ³; FATMA A. MADKOUR ⁴, AHMED M. SALLAM ⁵;
FATMA ALI ⁶ AND HASSAN A. HUSSEIN ⁷

¹Theriogenology Department, Faculty of Veterinary Medicine, Aswan University, Aswan, Egypt.

²Department of Animal Health, Animal and Poultry Production Division, Desert Research Center, Cairo, Egypt.

³Department of Animal and poultry physiology, Animal and Poultry Production Division, Desert Research Center, Cairo, Egypt

⁴Department of Anatomy and Embryology, Faculty of Veterinary Medicine, South Valley University, Qena, Egypt.

⁵Department of Animal and Poultry Breeding, Animal and Poultry Production Division, Desert Research Center, Cairo, Egypt

⁶Physiology Department, Faculty of Veterinary Medicine, Aswan University, Aswan, Egypt

⁷Department of Theriogenology, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt.

Received: 13 November 2022; **Accepted:** 15 December 2022

ABSTRACT

High temperature during hot summer months is associated with poor animal reproductive performance. The study aimed to explore the seasonal thermal impacts on the bucks fertility. Twenty healthy mature bucks were used in this study. Depending on environmental temperature, bucks were equally divided into two groups: Winter season (n=10) and Summer season (n=10). Scrotal width, circumferences, length and diameter of right and left testicles, as well as length of right and left testicles were evaluated. From each goat, the semen samples were collected once a month during Summer and Winter seasons. Immediately after collection of semen, volume of semen, pH, concentration, motility, live sperm percentage, sperm morphology (1st abnormalities and 2nd abnormalities), sperm viability and intact acrosome were evaluated. Plasma triglyceride, cholesterol, glucose and testosterone concentrations were monitored. The results revealed that scrotal circumferences, length, diameter of right and left testicles and length of right and left testicles were lower ($p < 0.05$) in Summer season than winter. Scrotal width was not different between the seasons. The Semen volume, concentration, motility, percentage of live sperm and intact acrosome in the Summer season were lower ($p < 0.05$) compared to winter. Semen pH, 1st abnormalities and 2nd abnormalities in Summer season were higher ($p < 0.05$) compared to winter. Plasma triglyceride, cholesterol, glucose and testosterone concentrations were decreased ($p < 0.05$) during summer than in winter. Histopathological lesions were found in Summer group in comparison to winter. In conclusion, the findings confirm that a high temperature during summer conditions negatively affects bucks semen quality.

Keywords: Heat stress, season, subtropical climate, male goats, fertility.

Corresponding author: Fatma Ali

E-mail address: fatma.ali@vet.aswu.edu.eg

Present address: Physiology Department, Faculty of Veterinary Medicine, Aswan University, Aswan, Egypt

INTRODUCTION

Recognizing the effects of environmental changes, including temperature, humidity and daylight, is critical for successful livestock health and production. Heat stress is one of the major serious environmental stresses that threaten animal and poultry production (Belhadj Slimen *et al.*, 2016, Auboghaba *et al.*, 2021). The rise in ambient temperature harmed livestock welfare, production and reproduction (Jamal *et al.*, 2021). Many studies have been reported the negative impacts of heat stress on male reproductive functions like sperm quality, steroid hormone production, sexual desire and fertility (Al-Kanaan *et al.*, 2015). Heat stress has an immediate impact on fertility by impairing the function of reproductive cells and can indirectly alert reproduction because heat-stressed animals typically have lower nutrient intake (Sejian *et al.*, 2018). Also, it has a direct deleterious impact on the morphology of sperm and fertility (Shahat, *et al.*, 2020). Additionally, heat stress decreased the flow of blood to the testicles (Samir *et al.*, 2018; Hedia *et al.*, 2020).

Goat is thought to be more resistant to fluctuations of temperature compared to other farm animals because they reduce their metabolic rate while increasing their respiratory and cardiac rates (El-Sherbiny *et al.*, 2022). Moreover, goats respond differently to handling stress depending on individual responses, breed and province (Sharma *et al.*, 2013; Salama *et al.*, 2014). Baladi goat is sensitive to thermal stress compared to crossbred goat in subtropical conditions (Teama and El-Tarabany 2016; El-Tarabany *et al.*, 2017). The environmental factors affecting animal reproduction are temperature, humidity and daylight. Due to seasonal variables, the quality of bucks semen might fluctuate over time (Dias *et al.*, 2017; Isnaini *et al.*, 2020). The main indicator used to monitor the thermal stress condition for animal is the temperature humidity index (THI) (Ribeiro

et al., 2018a). Elevation of THI to more than 75 was considered a heat stress status for animals (Sejian *et al.*, 2018). Additionally, heat stress influences sperm quality in bucks semen, although decreased semen quality was collected during high THI (Isnaini *et al.*, 2020).

The climate seasons (summer and winter) in Shalateen, Halayib have variables ambient temperatures, relative humidity and THI. Shalateen, Halayib province located in southeastern Egypt, has the hottest dry season (summer). The objective of the current study is to characterize the degree of testicular damage on bucks in Shalateen, Halayib caused by summer thermal stress.

MATERIALS AND METHODS

Animals

Twenty healthy mature bucks, 4 to 5 years of age and weighed 41 ± 4.3 kg were used in the present study. Bucks were reared in the experimental animal Farm, Shalateen, Halayib, Egypt. Shalateen, Halayib province is located in the southeastern region of Egypt where the climate is subtropical. Depending on the environmental temperatures (Table 1 & Figure 1), bucks were divided into two groups: Winter season (n = 10) from December 2021 to February 2022 and Summer season from June to August, 2022 (N = 10). The climate data including the temperature, relative humidity percentage and daylight hours were obtained from the local meteorological center (Meteorological authority, Egypt, Shalateen, Halayib province). To calculate THI, the following equation was used: $THI = (1.8 \times T + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T - 26)]$ (Kendall and Webster 2009).

The protocol was approved by the Animal Care Committee, South Valley University, Qena Governorate with ethical approval number (No.71/27.09.2022). Bucks husbandry and experimental procedures were performed under the South Valley University, Veterinary Medicine Faculty Animal Care Guidelines.

Testicular characteristics measurement

Testicular characteristics in bucks including scrotum circumference, length and width, right testicular length (TD) and diameter (TD), as well as left testicular length and diameter were measured monthly before semen collection. Metal calipers were used to measure TD and TL. A measuring tape was used to measure scrotum circumference and width.

Collection of semen and evaluation

Before the study, bucks were trained to collect semen samples by use of an artificial vagina. Ejaculates used in the study were selected according to the basic sperm parameters as follows; semen volume (≥ 0.2 mL), sperm concentration (10^6 /ml) and spermatozoa motility (60 %). From bucks, semen was collected monthly (last Thursday of each month) during 8.30 am -12.30 pm. After semen collection, Semen volume was determined in the spermiatic fraction using a graduated plastic tube. Sperm concentration was estimated using a Neubauer hemocytometer (Komsky-Elbaz and Roth, 2018). Sperm morphology was examined using eosin-nigrosin staining. Semen drop (5 μ l) was smeared on a slide and stained with eosin-nigrosin staining. The sperm abnormalities percentage (1st and 2nd abnormalities) was recorded after the examination of sperms (around 200 sperms) using bright field microscopy (magnification 1000x, oil immersion objective).

Sperm viability and acrosome integrity

Sperm viability and acrosome integrity were evaluated as described previously (Nur *et al.*, 2005). Briefly, 50 μ l of diluted semen mixed with 50 μ l of sodium citrate 2.9%. From the mixture a smear was prepared. The smears were fixed with 10% formal solution (15 min), washed with water (15 min) and then immersed in Giemsa stain (3 hrs). The stained slides were rinsed with tap water for 15 minutes before drying. Under a microscope (x 100 magnification), about 100 spermatozoa were randomly selected per slide and examined for live sperm with intact

acrosomes to determine viability and acrosome reaction.

Hormonal and biochemical analyses

Jugular vein puncture was used to collect plasma into vacutainer tubes without anticoagulant (Essawi *et al.*, 2021; Mohamed *et al.*, 2021a). Tube was centrifuged at 3000 g/15 minutes. The plasma was collected, gathered and kept with -20 $^{\circ}$ c till analysis. Testosterone concentrations in plasma were determined by ELISA technique using the commercial kits (Monobind USA Cod: 3725-300). The Coefficients of variation of intra assay was 4.8% and inter assay was 9.7%. Utilizing a commercial kit, glucose levels were measured spectrophotometrically (Spectrum Egypt, Cod: 250- 001) (Mohamed *et al.*, 2021b). Commercially available kits were used to estimate cholesterol concentrations (Cod; CHOL230001, Spectrum, Egypt). Utilizing commercially available kits, triglyceride levels were calculated (Cod; M4200, Spectrum, Egypt).

Histopathological examination

Specimens of the bucks testes were taken and they were then dipped into 10% neutral buffered formal saline. The samples were cleaned and embedded in paraffin wax after being dehydrated in different alcohol grades. For general histological investigation, paraffin sections (3-5 μ m) were cut by a microtome (Leica RM2235, Leica Biosystems) and immersed in hematoxylin and eosin stains (Suvarna *et al.*; 2018).

Data analysis

Statistical comparison was made using Graph Pad Prism 5 statistics. Climate parameters such as temperature, humidity, THI and daytime were compared between seasons by analysis of variance (ANOVA) and a post-hoc test with Bonferroni. The differences in semen characteristics, testicular characteristics and biochemical parameters between seasons were analyzed using a student t-test. $P < 0.05$ was considered statistically significant. The data was expressed as mean \pm SEM

RESULTS

Figure (1) and Table (1) showed the seasonal and monthly changes in ambient temperature, relative humidity as well as THI in Shalateen, Halayib region. Summer had the highest mean ambient temperature, which was higher ($p<0.05$) compared with winter. Winter had the highest mean relative humidity and was higher ($p<0.05$) compared with summer. Summer had the highest THI and was higher ($p<0.05$) compared with winter. Summer had a longer daytime and was higher ($p<0.05$) compared with winter.

Testicular measurements variation across seasons

Testicular measurements varied by season as shown in Table (2). The SC, SL, RTL, LTL, RTD, and LTD were smaller ($p<0.05$) during summer compared with winter. SW was not significantly different across seasons.

Effect of season on semen parameters

Parameters of semen quality varied by season Table (3). Semen volume, spermatozoa concentration, spermatozoa motility, live sperm % and intact acrosome% in the summer season were lower ($p<0.05$) compared with the winter. However, semen pH value, 1st abnormalities percentage, and 2nd abnormalities percentage in the summer

season were higher ($p<0.05$) compared with the winter.

Impact of season on biochemical and hormonal parameters

The study showed that in summer when the temperature was high, plasma triglyceride, cholesterol, glucose and testosterone concentrations were lower ($p<0.05$) compared with the winter Table (4).

Effect of season on histology of testes

The current result investigated the histomorphological changes of the bucks testes under the seasonal variation. The normal testicular histological appearance was demonstrated within a moderate temperature season as Winter (F. 2A). On the other hand, in the high-temperature season as Summer season, the testicular histology showed some changes which influence the spermatogenesis process. These changes included degeneration of the seminiferous tubules, the appearance of excessive fragmented and desquamated epithelial cells within the lumen of the tubules, and edema within the interstitial tissues besides hemorrhage. Furthermore, vacuoles were observed within the lining of spermatogonic cells. The heat stress might be inducing shrinkage of the wall of the seminiferous tubules and decreasing the number of the sperms and spermatocytes (F. 2,B to H).

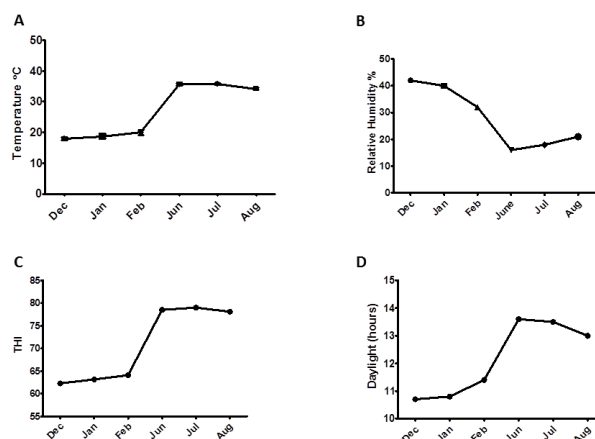


Figure (1). Environmental temperature (1A), Percentage of humidity (1B), Temperature and humidity index or THI (1C) and Daylight (1D) during Winter and Summer seasons were obtained from the Egyptian Meteorological Authority for Shalateen, Halayib province. Values are expressed as mean \pm SEM.

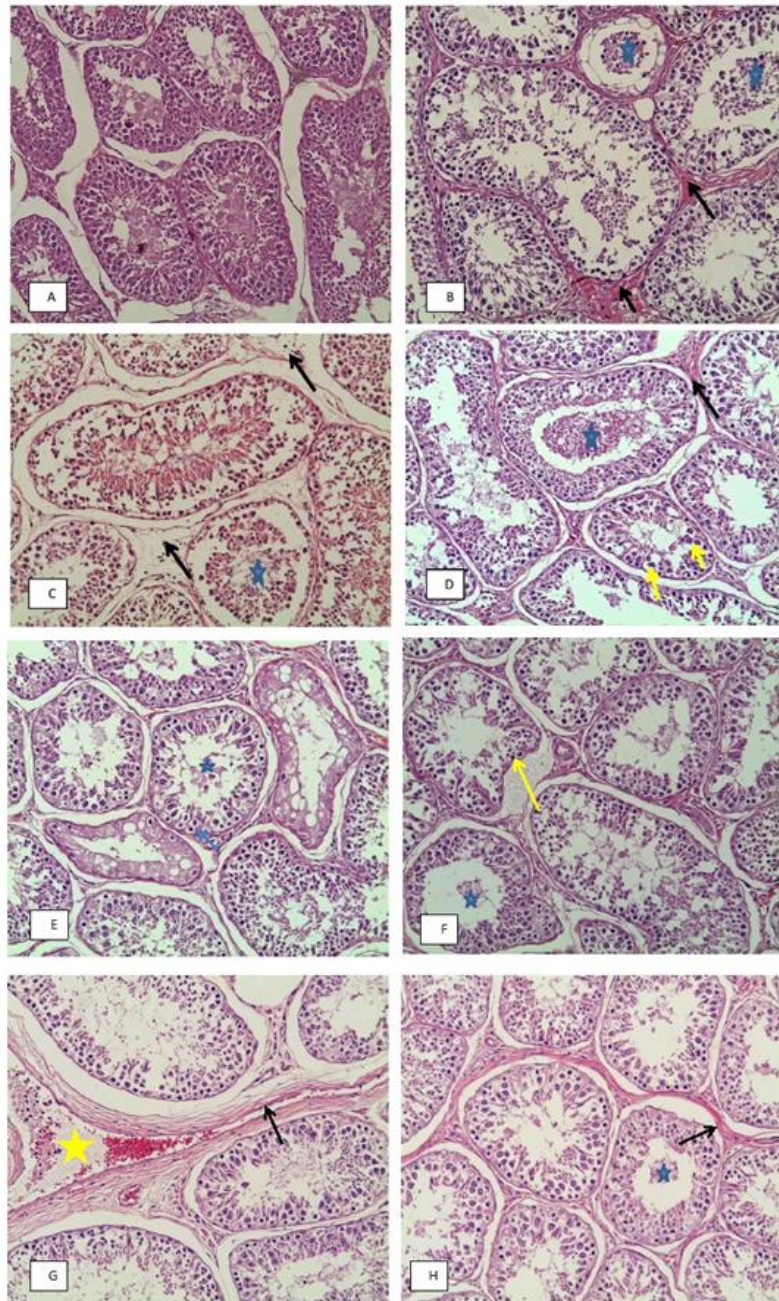


Figure (2): A: Testes showing normal appearance. B, C &D: Showing degeneration of seminiferous tubules, desquamated epithelial cells inside the lumen of tubules (star), interstitial edema (black arrow) and vacuolation of spermatogonic cells (yellow arrow). E, F, G&H: Testes showing degenerated seminiferous tubules, desquamated epithelial cells inside the lumen of seminiferous tubule (blue star), vacuolation of spermatogonic cells (blue arrow), severe interstitial edema (black arrow), G: desquamated epithelial cells and hemorrhage (yellow star), F: shrinkage of the wall of seminiferous tubule (yellow arrow). H&E stain, X10 magnification.

Table 1: Observed average monthly ambient temperature, relative humidity percentage, temperature and humidity index (THI), and daylight hours during Winter and Summer months based on data from the Egyptian Meteorological Authority for Shalateen, Halayib province.

Parameters	Temperature(°c)	Relative humidity (%)	THI (%)	Daylight (hrs)
Winter	18.8± 0.2 ^b	38±0.8 ^a	63.2±0.1 ^b	10.9±0.1 ^b
Summer	35.2±0.1 ^a	18.3±0.6 ^b	78.5±0.05 ^a	13.4±0.08 ^a

Means±SEM in the same column with different superscripts differ significantly at (p<0.05).

Table 2: Effect of Winter and Summer seasons on bucks testicular characteristic.

Parameters	Winter Mean ± SEM	Summer Mean ± SEM	P value	
Scrotal circumstanes (SC)	24.6 ± 0.7	18.6 ± 0.4	0.002	
Scrotal length (SL)	12.6 ± 0.1	11 ± 0.3	0.006	
Scrotal width (SW)	9.8 ± 0.3	11 ± 0.3	0.23	
Testicular diameter (TD)	Right (R)	16.8 ± 0.2	12 ± 0.5	0.0001
	Left (L)	15.2 ± 0.2	14 ± 0.2	0.02
Testicular length (TL)	Right (R)	14.8 ± 0.2	12.4 ± 0.3	0.002
	Left (L)	14 ± 0.3	12.2 ± 0.2	0.003

Values are expressed as mean± SEM, means in the same row differ significantly at (p<0.05).

Table 3: Mean and standard error of the mean (SEM) of considered traits for bucks semen in the groups designated by climate condition (Winter and Summer).

Semen characteristic	Winter Mean ± SEM	Summer Mean ± SEM	P value
Semen volume (ml)	1.14± 0.1	1±0.1	0.02
PH	6.5 ± 0.1	6.9 ± 0.03	0.001
Concentration (10 ⁶ /ml)	1599.6 ± 1.5	1139.8 ± 2.4	0.0001
Motility (%)	85 ± 0.4	62 ± 1	0.0001
Live sperm (%)	81 ± 0.4	60 ± 0.9	0.0001
1 st abnormalities (%)	2.8 ± 0.2	13.6 ± 1	0.0001
2 nd abnormalities (%)	8.6 ± 0.5	16.8 ± 0.7	0.0001
Intact acrosome (%)	85.6 ± 0.1	56 ± 0.7	0.0001

Values are expressed as mean ±SEM, means in the same row differ significantly at (p<0.05).

Table 4: Impact of Winter and Summer seasons on blood biochemical parameters and testosterone concentration in bucks.

Parameters	Winter Mean \pm SEM	Summer Mean \pm SEM	P value
Testosterone (ng/ml)	5.4 \pm 0.03	5 \pm 0.08	0.001
Triglyceride (mg/ml)	51.8 \pm 0.06	50.6 \pm 0.07	0.004
Cholesterol (mg/ml)	82.9 \pm 0.07	80.5 \pm 0.09	0.001
Glucose (mg/ml)	52.5 \pm 0.1	50.6 \pm 0.1	0.005

Values are expressed as mean \pm SEM. Means in the same row differ significantly at ($p < 0.05$).

DISCUSSION

In this study, testes dimensions as well as histopathology, sperm quantity, and quality of bucks during the winter and summer in Shalateen, Halayib region, Egypt, were evaluated and differentiated according to the seasons. The findings suggested that from June to August, the captured amounts of bucks' semen were tiny with relatively low sperm concentration, motility, and viability. Between June and August, testosterone concentrations were relatively the lowest and testes were smaller in size. From December to February, these variable values started to rise. Temperature, humidity, THI, and the length of the day were all related to changes in reproductive and endocrine activities, with higher-quality semen being generated in December and February when temperatures were lower and daylight hours were shorter. The study assess the relationship between semen characteristics, testosterone concentrations, and testes morphology collected during summer and winter to a length of daylight and temperature, confirming that the best time for bucks to breed in Shalateen, Halayib region is December to March.

The concentrations of reproductive hormones in the blood are most commonly used as an effective indicator for testicular function (Mandour *et al.*; 2022). In the current study, testosterone concentration was significantly reduced in summer compared to the winter, indicating that as the length of the day lengthened and ambient temperatures rose, testosterone level

decreased. Previous studies on goats (Delgadillo *et al.*, 2004) and rams (Ntemka *et al.*, 2019) have well documented the effects of environmental conditions on testosterone concentrations. The length of the day is an important regulatory factor influencing buck sperm quality. There is an improvement in buck sperm quality during a short-day season (El Kadili *et al.*, 2019). Changes in photoperiod and semen characteristics in bucks show distinct seasonal variation (Hammoudi *et al.*, 2010; Talebi *et al.*, 2009). It has been observed in goats that photoperiod changes over time cause changes in testosterone concentration due to changes in the melatonin secretory pattern (FARSI *et al.*, 2018; Swelum *et al.*, 2018). Melatonin is a key regulator of GnRH secretion, regulating testosterone secretion from the testis via the release of luteinizing hormone (LH) pulses (Samir *et al.*, 2020). Furthermore, it was reported that using an eye mask and inserting implants of melatonin increased bucks and rams reproductive performance (Malpaux *et al.*, 2020; Zarazaga *et al.*, 2021).

From the current findings, elevation in ambient temperatures and daytime length during summer was associated with decreased values of testicular dimensions in bucks (SC, SL, SW, TD, and TL) compared to winter. Previous research found similar seasonal variations in the size and dimension of testes (El Kadili *et al.*, 2019). The increase in bucks testicular dimensions during the breeding season (winter) could be contributed to the high testosterone concentration during the breeding season

which increases spermatogenesis (Shi *et al.*, 2018). The high environmental temperatures adversely impact the male reproductive activity (Boni and Development 2019), disrupt spermatogenesis, and sperm output, and raise the proportion of sperm with defective morphology (Abdelhamid *et al.*, 2019; Kanter *et al.*, 2013). Based on that, the current study showed that the high temperatures induce some histopathological alterations of the testicular tissue of the bucks. The findings are in line with those of the previous data that have shown that the changes in the testicular structure were noticed in mammals exposed to thermal stress (Setchell 2018). Some changes are represented in the appearance of excessive desquamated epithelial cells within the lumen of the seminiferous tubules, and shrinkage of the wall of the tubules. In this respect, Gao *et al.* (2012) reported that the testicular histology changes included; reduced epithelium thickness, presence of cellular debris, fragmented cells, and a lack of sperm and spermatocytes (Gao *et al.*, 2012). Additionally, the mitochondria degenerate, SER dilated, and functional disruption of Leydig cells. The former authors clarified that the rate of spermatogenesis is reduced by 14% for every 1°C increase in testicular temperature (Durairajanayagam *et al.*, 2015). Moreover, heat stress induces low testicular blood flow which impairs testicular functions (Hedia *et al.*, 2020).

Interestingly, these changes in testicular dimensions were linked to a reduction in the sperm quantity and quality produced during the summer. The current study found that values for bucks sperm variables varied between the Summer and Winter seasons. Furthermore, sperm volume, concentration, motility, and viability were reduced in Summer than in Winter. Several studies (Abdi-Benemar *et al.*, 2018; Kulaksız *et al.*, 2019; Samir *et al.*, 2020) reported seasonal differences in semen volume in other goat breeds. Particularly, in the Summer group semen volume significantly decreased in Summer group compared with Winter group.

Similarly, bucks study in Nigeria (Maina *et al.*, 2006) found lower semen volume during the dry seasons (non-breeding season) when ambient temperatures were higher. Seasonal variation in semen quality has also been reported in rams (Goshme *et al.*, 2020), and bulls (Sinha *et al.*, 2021). In the current study, seasonality had an impact on sperm morphology, demonstrating that high temperatures can lead to the creation of sperm cell structures that are morphologically aberrant.

In addition, the triglyceride, cholesterol, and glucose concentrations in the Summer group were significantly lower compared to the Winter group. According to some studies, when goats are exposed to high temperature, glucose and cholesterol levels in the blood decrease, indicating a failure in the body homeostasis (Ribeiro *et al.*, 2016; Ribeiro *et al.*, 2018b; Sezen and GÜNEY 2010). Cholesterol, phospholipids, and triglycerides are the three types of lipids in plasma. Triglycerides are mobilized as an energy source when glucose requirements are not met (Ribeiro *et al.*, 2018a). Heat stress induce decrease on total cholesterol concentration, which may be attributed to the increased fatty acids use for production of energy in heat-stressed animals due to decreased glucose concentration (Mundim *et al.*, 2007).

In conclusion, the findings clearly showed that climate conditions affect the reproductive capacity of bucks in the Shalateen, Halayib region, Egypt. Small amounts of sperm with lower gross motility, concentration, and velocity were collected from June to August when the days were longer and the temperatures were high. Bucks produced less testosterone during these months due to an increase in photoperiodic stimuli, resulting in smaller testes. There was a stimulated reproductive axis as well as an increase in the volume of high-quality semen during the short daytime (winter). The results of the study clearly indicate the impacts of high summer

temperatures on characteristics of the testicles and quality of sperm in goats.

REFERENCES

- Abdelhamid, M.H.M.; Walschaerts, M.; Ahmad, G.; Mieusset, R.; Bujan, L. and Hamdi, S. (2019):* Mild experimental increase in testis and epididymis temperature in men: effects on sperm morphology according to spermatogenesis stages. *Translational Andrology and Urology*, 8(6), 651.
- Abdi-Benemar, H.; Khalili, B.; Zamiri, M.; Ezazi, H.J.O.L.S. and Technologies (2018):* Seasonal variation in seminal characteristics, testicular measurements and plasma testosterone concentration in Iranian Khalkhali bucks. *Journal of Livestock Science*, 6(2), 33-39.
- Abuoghaba, A.A.K.; Ali, F.; Ismail, I.I. and Saleh, M.J.P.S. (2021):* Impact of acute short-term high thermal stress during early embryogenesis on hatchability, physiological body reaction, and ovarian follicles development of quails. *Poultry Science*, 100(2), 1213-1220.
- Al-Kanaan, A.; König, S. and Brügemann, K. (2015):* Effects of heat stress on semen characteristics of Holstein bulls estimated on a continuous phenotypic and genetic scale. *Livestock Science*, 177, 15-24.
- Belhadj Slimen, I.; Najjar, T.; Ghram, A.; Abdrrabba, M.J.O.A.P. and Nutrition, A. (2016):* Heat stress effects on livestock: molecular, cellular and metabolic aspects, a review. *Journal of animal physiology*, 100(3), 401-412.
- Boni, R. and Development (2019):* Heat stress, a serious threat to reproductive function in animals and humans. *Molecular Reproduction*, 86(10), 1307-1323.
- Delgadillo, J.A.; Cortez, M.E.; Duarte, G.; Chemineau, P. and Malpoux, B.J.R.N.D. (2004):* Evidence that the photoperiod controls the annual changes in testosterone secretion, testicular and body weight in subtropical male goats. *Reproduction Nutrition Development*, 44(3), 183-193.
- Dias, J.C.O.; Veloso, C.M.; Santos, M.C.D.R.; Oliveira, C.T.S.A.M.D.; Silveira, C.O.; Iglesias, E.; Maitan, P.P. and Sanglard, L.M.P. (2017):* Seasonal variation in the reproductive activity of male goats raised under tropical climate conditions. *Revista Brasileira de Zootecnia*, 46, 192-201.
- Durairajanayagam, D.; Agarwal, A. and Ong, C. (2015):* Causes, effects and molecular mechanisms of testicular heat stress. *Reproductive Biomedicine Online*, 30(1), 14-27.
- El-Sherbiny, H.R.; Abdelnaby, E.A.; El-Shahat, K.; Salem, N.Y.; Ramadan, E.S.; Yehia, S.G. and Fathi, M. (2022):* Coenzyme Q10 Supplementation enhances testicular volume and hemodynamics, reproductive hormones, sperm quality, and seminal antioxidant capacity in goat bucks under summer hot humid conditions. *Veterinary Research Communications*, 1-13.
- El-Tarabany, M.S.; El-Tarabany, A.A. and Atta, M.A.J.I.J.O.B. (2017):* Physiological and lactation responses of Egyptian dairy Baladi goats to natural thermal stress under subtropical environmental conditions. *International Journal of Biometeorology*, 61(1), 61-68.
- El Kadili, S.; Raes, M.; Bister, J.L.; Archa, B.; Chentouf, M. and Kirschvink, N. (2019):* Effect of season on sexual behavior, testicular measurements and seminal characteristics in " Beni aouss" North Moroccan bucks. *Animal reproduction science*, 201, 41-54.
- Essawi, W.M.; El-Raghi, A.A.; Ali, F.; Nassan, M.A.; Neamat-Allah, A.N. and Hassan, M. A.J.A. (2021):* The Association of the Potential Risk Factors and Nutrition Elements with Abortion and Calving Rates of

- Egyptian Buffaloes (*Bubalus bubalis*). *Animals*, 11(7), 2043.
- Farsi, H.; Mhani, M.; Achaaban, M.; Boukhliq, R.; Tibary, A. and El Allali, K. (2018): Environmental cues and seasonal patterns of reproduction in goats. *Revue Marocaine des Sciences Agronomiques et Vétérinaires*, 6(2), 158-167.
- Gao, J.; Zuo, Y.; So, K.H.; Yeung, W.S.; Ng, E.H. and Lee, K.F. (2012): Electroacupuncture enhances spermatogenesis in rats after scrotal heat treatment. *Spermatogenesis*, 2(1), 53-62.
- Goshme, S.; Banerjee, S.; Rekik, M.; Haile, A.; Yitagesu, E. and Getachew, T. (2020): Evaluation and characterization of semen quality in rams of Menz, Dorper and Awassi crosses in different seasons in Ethiopia. *Livest. Res. Rural Dev*, 32(11).
- Hammoudi, S.; Ait-Amrane, A.; Belhamiti, T.; Khiati, B.; Niar, A. and Guetarni, D. (2010): Seasonal variations of sexual activity of local bucks in western Algeria. *African Journal of Biotechnology*, 9(3).
- Hedia, M.G.; El-Belely, M.S.; Ismail, S.T. and Abo El-Maaty, A.M. (2020): Seasonal variation in testicular blood flow dynamics and their relation to systemic and testicular oxidant/antioxidant biomarkers and androgens in rams. *Reproduction in Domestic Animals*, 55(7), 861-869.
- Isnaini, N.; Ciptadi, G.; Herwijanti, E.; Walidah, N.I.P. and Putra, M.W.S.N. (2020): Effects of seasons and environmental conditions on semen quality of Senduro goats reared under tropical climate. *Turkish Journal of Veterinary Animal Sciences*, 44(3), 594-599.
- Jamal, A.; Rashid, M.A. and Malik, M.I. (2021): Effects of sodium bicarbonate and chromium propionate supplementation on growth performance, blood indices of Beetal bucks under heat stress. *Tropical Animal Health Production*, 53(5), 1-9.
- Kanter, M.; Aktas, C. and Erboga, M. (2013): Heat stress decreases testicular germ cell proliferation and increases apoptosis in short term: an immunohistochemical and ultrastructural study. *Toxicology Industrial Health*, 29(2), 99-113.
- Kendall, P. and Webster, J. (2009): Season and physiological status affects the circadian body temperature rhythm of dairy cows. *Livestock Science*, 125(2-3), 155-160.
- Komsky-Elbaz, A. and Roth, Z. (2018): Fluorimetric techniques for the assessment of sperm membranes. *JoVE* (141), e58622.
- Kulaksız, R.; Ari, U.Ç.; Kuru, M.; Yıldız, S.; Lehimcioğlu, N.C.; Öztürkler, Y. and Atakışi, E. (2019): Seasonal changes in testes size, fresh and post-thawing semen characteristics, serum testosterone level, and phospholipase A2 activity in Gurcu male goats. *Journal of Animal and Plant Sciences*, 29(2), 353-358.
- Maina, V.; Chaudhari, S.; Mshelia, G. and Williams, A. (2006): Influence of season on semen characteristics of Sahel bucks in Borno state. *Journal of Applied Sciences*, 6(2), 353-356.
- Malpoux, B.; Chemineau, P. and Pelletier, J. (2020): Melatonin and reproduction in sheep and goats. In *Melatonin* (pp. 253-287): CRC Press.
- Mandour, A.S.; Samir, H.; El-Beltagy, M.A.; Hamabe, L.; Abdelmageed, H.A.; Watanabe, I. and Al-Rejaie, S. (2022): Monthly Dynamics of Plasma Elements, Hematology, Oxidative Stress Markers, and Hormonal Concentrations in Growing Male Shiba Goats (*Capra hircus*) Reared in Tokyo-Japan. *Animals*, 12(5), 645.
- Mohamed, R.H.; El-Maaty, A.M.A.; Mohamed, R.S.; Wehrend, A.; Ali, F. and Hussein, H.A. J.V.W. (2021a): Investigations on the vaginal temperature, cycle stages, and steroid hormone concentrations during the

- breeding season in camels (*Camelus dromedarius*). *Veterinary world*, 14(5), 1102.
- Mohamed, R.H.; Ali, F. and Nour, S.Y. (2021b): Comparative studies on ovarian hormones and hematobiochemical profile of lactating and non-lactating she-camels (*Camelus dromedarius*). *Comparative Clinical Pathology*, 30(3), 415-420.
- Mundim, A.; Costa, A.; Mundim, S.; Guimarães, E. and Espindola, F. (2007): Influência da ordem e estádios da lactação no perfil bioquímico sanguíneo de cabras da raça Saanen. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 59, 306-312.
- Ntemka, A.; Kiossis, E.; Boscos, C.; Theodoridis, A.; Kourousekos, G. and Tsakmakidis, I. (2019): Impact of old age and season on Chios ram semen quality. *Small Ruminant Research*, 178, 15-17.
- Nur, Z.; Dogan, I.; Gunay, U. and Soylu, M. K. (2005): Relationships between sperm membrane integrity and other semen quality characteristics of the semen of saanen goat bucks. *Bulletin of the Veterinary Institute in Pulawy*, 49(2), 183-187.
- Ribeiro, M.N.; Ribeiro, N.L.; Bozzi, R. and Costa, R.G. (2018a): Physiological and biochemical blood variables of goats subjected to heat stress—a review. *Journal of Applied Animal Research*, 46(1), 1036-1041.
- Ribeiro, N.L.; Costa, R.G.; Pimenta Filho, E.C.; Ribeiro, M.N.; Crovetti, A.; Saraiva, E.P. and Bozzi, R. (2016): Adaptive profile of Garfagnina goat breed assessed through physiological, haematological, biochemical and hormonal parameters. *Small Ruminant Research*, 144, 236-241.
- Ribeiro, N.L.; Germano Costa, R.; Pimenta Filho, E.C.; Ribeiro, M.N. and Bozzi, R. (2018b): Effects of the dry and the rainy season on endocrine and physiologic profiles of goats in the Brazilian semi-arid region. *Italian Journal of Animal Science*, 17(2), 454-461.
- Salama, A.; Caja, G.; Hamzaoui, S.; Badaoui, B.; Castro-Costa, A.; Façanha, D.; Guilhermino, M.M. and Bozzi, R. (2014): Different levels of response to heat stress in dairy goats. *Small Ruminant Research*, 121(1), 73-79.
- Samir, H.; Nyametease, P.; Elbadawy, M.; Nagaoka, K.; Sasaki, K. and Watanabe, G. (2020): Administration of melatonin improves testicular blood flow, circulating hormones, and semen quality in Shiba goats. *Theriogenology*, 146, 111-119.
- Samir, H.; Nyametease, P.; Nagaoka, K. and Watanabe, G. (2018): Effect of seasonality on testicular blood flow as determined by color Doppler ultrasonography and hormonal profiles in Shiba goats. *Animal Reproduction Science*, 197, 185-192.
- Sejian, V.; Bhatta, R.; Gaughan, J.; Dunshea, F. and Lacetera, N. (2018): Adaptation of animals to heat stress. *Animal*, 12(s2), s431-s444.
- Setchell, B. (2018): The effects of heat on the testes of mammals. *Animal Reproduction*, 3(2), 81-91.
- Sezen, O. and GÜNEY, O. (2010): Physiological responses and some blood parameters of bucks under Mediterranean climate conditions. *Anadolu Tarım Bilimleri Dergisi* 25(2), 113-119.
- Shahat, A.; Rizzoto, G. and Kastelic, J. (2020): Amelioration of heat stress-induced damage to testes and sperm quality. *Theriogenology*, 158, 84-96.
- Sharma, S.; Ramesh, K.; Hyder, I.; Uniyal, S.; Yadav, V.; Panda, R.; Maurya, V. P.; Singh, G.; Kumar, P. and Mitra, A. (2013): Effect of melatonin administration on thyroid hormones, cortisol and expression profile of heat shock proteins in goats (*Capra hircus*) exposed to heat stress. *Small Ruminant Research*, 112(1-3), 216-223.
- Shi, L.; Song, R.; Yao, X.; Duan, Y.; Ren, Y.; Zhang, C.; Yue, Wenbin and Lei, F.

- (2018): Effects of maternal dietary selenium (Se-enriched yeast) on testis development, testosterone level and testicular steroidogenesis-related gene expression of their male kids in Taihang Black Goats. *Theriogenology*, 114, 95-102.
- Sinha, R.; Bhakat, M.; Mohanty, T.K.; Kumar, R.; Ranjan, A.; Rahim, A.; Lone, S.A.; Shah, N.; Paray, A.R.; Patil, C.S. (2021): Seasonal variation of sperm kinematics in Murrah bulls under the tropical climatic condition. *Buffalo Bulletin*, 40(1), 87-98.
- Suvarna, K.S.; Layton, C. and Bancroft, J.D. (2018): Bancroft's Theory and Practice of Histological Techniques E-Book: Elsevier health sciences.
- Swelum, A.A.A.; Saadeldin, I.M.; Ba-Awad, H. and Alowaimer, A.N. (2018): Effects of melatonin implants on the reproductive performance and endocrine function of camel (*Camelus dromedarius*) bulls during the non-breeding and subsequent breeding seasons. *Theriogenology*, 119, 18-27.
- Talebi, J.; Souri, M.; Moghaddam, A.; Karimi, I. and Mirmahmoodi, M. (2009): Characteristics and seasonal variation in the semen of Markhoz bucks in western Iran. *Small Ruminant Research*, 85(1), 18-22.
- Teama, F.E.I. and El-Tarabany, A.A. (2016): Physiological and biochemical response to Omega-3 plus as a dietary supplement to growing goats under hot summer conditions. *Revista Brasileira de Zootecnia*, 45, 174-180.
- Zarazaga, L.A.; Gatica, M.C.; Delgado-Pertíñez, M.; Hernández, H.; Guzmán, J.L. and Delgadillo, J.A. (2021): Photoperiod-treatment in Mediterranean bucks can improve the reproductive performance of the male effect depending on the extent of their seasonality. *Animals*, 11(2), 400.

جودة السائل المنوي ، خصائص الخصية ، الخصائص الكيميائية الحيوية و التشريح المرضي للخصيتين في الماعز تحت ظروف الإجهاد الحراري

رجب حسن محمد ، رشا صلاح محمد ، إبراهيم سمير عبد الحميد ، فاطمة عباس مذكور ، أحمد محمد سلام ، فاطمة على ، حسن عبد الصبور حسين

E-mail: fatma.ali@vet.aswu.edu.eg Assiut University web-site: www.aun.edu.eg

ترتبط درجات الحرارة المرتفعة خلال أشهر الصيف بضعف الأداء التناسلي للحيوانات. هدفت الدراسة إلى استكشاف التأثيرات الحرارية الموسمية على التيوس. تم استخدام عشرين من التيوس الصحية في هذه الدراسة اعتمادًا على درجة الحرارة البيئية ، تم تقسيم التيوس بالتساوي إلى مجموعتين: فصل الشتاء (ن = 10) وفصل الصيف (ن = 10). تم تقييم عرض الصفن وظروفها وطولها وقطرها للخصيتين اليمنى واليسرى وكذلك طول الخصيتين اليمنى واليسرى. تم جمع عينات السائل المنوي من كل تيس مرة واحدة في الشهر خلال فصلي الصيف والشتاء. مباشرة بعد جمع السائل المنوي ، تم تقييم حجم السائل المنوي ، درجة الحموضة ، التركيز ، الحركة ، نسبة الحيوانات المنوية الحية ، مورفولوجيا الحيوانات المنوية (التشوهات الأولية والثانوية) وحيوية الحيوانات المنوية والأكروسوم السليم. تم رصد تركيزات الدهون الثلاثية والكوليسترول والجلوكوز والتستوستيرون في البلازما. أظهرت النتائج أن ظروف كيس الصفن وطول وقطر الخصيتين اليمنى واليسرى وطول الخصيتين اليمنى واليسرى كانت أقل ($p < 0.05$) في موسم الصيف عنها في الشتاء. عرض الصفن لا يختلف بين الفصول. كان حجم السائل المنوي وتركيزه وحركته ونسبة الحيوانات المنوية الحية والأكروسوم السليم في فصل الصيف أقل ($P < 0.05$) مقارنة بالشتاء. كان الرقم الهيدروجيني للسائل المنوي والتشوهات الأولى والثانية في موسم الصيف أعلى ($p < 0.05$) مقارنة بالشتاء. انخفضت تركيزات الدهون الثلاثية والكوليسترول والجلوكوز والتستوستيرون في البلازما ($p < 0.05$) خلال الصيف عنها في الشتاء. تم العثور على الإفات النسيجية المرضية في المجموعة الصيفية مقارنة بالشتاء. في الختام ، أكدت النتائج أن ارتفاع درجة الحرارة خلال ظروف الصيف يؤثر سلبيًا على جودة السائل المنوي لذكور الماعز.