

Influence of Seasons of the Year and Ages on the Testicular Measurements and Semen Characteristics of the Male Dromedary Camels

A. M. Samatar^{1,*}, A. M. Ashour¹ and A. E. Zeidan²

¹ Animal Production Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

² Animal Production Research Institute, Dokki, Giza, Egypt.

* Corresponding author E-mail: abdirahman@azhar.edu.eg (M. Hamed)

ABSTRACT:

This work aims to define the effects of different seasons of the year and ages on the testicular measurements and sperm characteristics of the male Maghrebi camels. Eighty-four (42 testes) during the breeding season and (42 testes) during non-breeding season were used. The animals were divided into first, second and third groups at <4-9, <9-14 and <14-19 years of age, respectively. The obtained results revealed that testes weight (gm), testicular volume (cm³) and scrotal circumference (cm) were significantly ($P<0.05$) higher at <9-14 or <14-19 than <4-9 years of age either the breeding or non-breeding seasons. However, testes tone firmer score and seminal hydrogen-ion concentration (pH) value at <4-9, <9-14 and <14-19 years of age were insignificant, during the breeding or non-breeding seasons, respectively. Semen color was Creamy white, Creamy white and Milky white during the breeding season and Greyish white, Light milky white and Watery white during non-breeding season in both at <4-9, <9-14 and <14-19 years of age, respectively. The percentage of motile spermatozoa and sperm-cell concentration ($\times 10^6/\text{ml}$) showed significantly ($P<0.05$) higher values during the breeding season than non-breeding season at <4-9, <9-14 and <14-19 years of age, respectively. While the percentages of dead spermatozoa, abnormal spermatozoa, acrosome damage and chromatin damage of spermatozoa were significantly ($P<0.05$) higher at <14-19 or <9-14 years than <4-9 years whether in the breeding or non-breeding season.

Key Words: Camels; Seasons; Age; Testicular Measurements; Sperm Characteristics.

INTRODUCTION

The male camel is described as a seasonal breeder with a marked peak in sexual activity during the breeding season and it is generally thought that the male is sexually quiescent for the remainder of the year, but it is capable of mating and fertilizing an ability of the female at any time of the year.

The breeding activity in the male dromedary camels in nomadic herds starts at five to six years of age and continues until 14 to 15 years, with some minor differences according to breed and geographical location (El-Wishy, 1988). Although reproductive management of females can influence the same parameters such as age at first service, conception rate, calving rate and calving interval (Khanna, 1990).

The rutting period in male camels has many physiological and behavioral peculiarities. The diameter of the seminiferous tubules is minimal during the rutting season, whereas the activity of the Leydig cells is maximal (Tingari *et al.*, 1984). El-Wishy (1988) also observed that Leydig cells are less active in the non-breeding season with a resulting reduction in steroidogenic activity by the testes.

Epididymal spermatozoa have been used in many laboratories because they are easier to get in some special species, cryopreserved epididymal spermatozoa are now used for intracytoplasmic sperm injection (ICSI) in human insemination (Patrizio, 2000). Epididymal spermatozoa have been obtained and Individual variation in cryoprotect toxicities have been studied for African antelope (Loskutoff *et al.*, 1996). Less information is available about reproductive management of the camel spermatozoa, especially at <4 to 9, <9 to 14 and <14 to 19 years of age during storage at 5°C.

The present study aimed to investigate the effects of different seasons of the year (the breeding and non-breeding seasons) and ages (<4 to 9, <9 to 14 and <14 to 19 years) on testicular measurements and epididymal sperm characteristics of the male dromedary camels under Egyptian environmental conditions.

MATERIALS AND METHODS

The experimental work was carried out at the Reproductive and Biotechnology Laboratory, Animal Production Research Institutes, Giza, Egypt. While the biochemical analyses were conducted at the Laboratory of Physiology, Department of Animal

Production, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. The testes samples were obtained from Belbies City Abattoirs, Sharkia Governorate, located in the north-eastern part of the Nile Delta (30°N) during the period from June, 2017 to May, 2018.

The experimental work aimed to investigate the effects of different ages (<4 to 9, <9 to 14 and <14 to 19 years) during the breeding season (December, January, February, March, April and May) and non-breeding season (June, July, August, September, October and November) of the male Maghrebi camels on the testicular measurements and epididymal sperm characteristics.

Materials:

Experimental animals:

Eighty-four (84 testes) from 42 male Maghrebi camels (*Camelus dromedarius*) aging <4 to 19 years old and 500 to 600 kg of live body weight in each season (the breeding: 42 testes and non-breeding: 42 testes) were used in the present study. The camels were divided into three groups according to their ages as follows from <4 to 9 years (n=14), <9 to 14 years (n=14) and <14 to 19 years (n=14) for the first, second and third groups, respectively. All camels were in healthy conditions and clinically free from external or internal parasites with a sound history of fertility in the herd. Palpation of the external genitalia showed that they were typically normal. The testicular tone was glandular, epididymal regions were present, both testes were almost equal in size and moved freely up and down within the scrotal pouches.

The age of animals was determined on the basis on dental formula according to Wilson (1984).

The temperature-humidity index (THI) was estimated according to Livestock and Poultry Heat Stress Indices (LPHSI, 1990) as the following formula:

$$THI = db^{\circ}F - (0.55 - 0.55 \times RH/100) (db^{\circ}F - 58.00).$$

db[°]F=dry bulb temperature in Fahrenheit and RH=relative humidity. The obtained values of THI were classified as follows: less than 72 = absence of heat stress, 72 to < 74 = moderate heat stress, 74 to < 78 = severe heat stress and over 78 = very severe heat stress. Minimum and maximum values of air temperature (°C), relative humidity (%), temperature-humidity index (THI) and length of daylight (hours),

during the breeding and non-breeding seasons are shown in Table (1).

Feeding and management:

The rations offered to camels were calculated according to Banerjee (1988). Two types of rations were used as follows:

Green season (from December to May):

The average amount given per head/day was 35kg Egyptian Clover (*Trifolium alexandrinum*) and 7kg rice straw.

Dry season (from June to November):

Each camel was received about 2kg commercial concentrate mixture, 2kg Egyptian Clover hay and 9kg rice straw daily.

Methods:

The experimental work aimed to investigate the effect of different ages (<4-9, <9-14 and <14-19 years) and seasons (the breeding and non-breeding seasons) of the male Maghrebi camels (*Camelus dromedarius*) on:

Testicular measurements of the camels included testes weight (gm), testicular volume (cm³), scrotal circumference (cm) and testes tone firmer (score).

Epididymal camel sperm characteristics (semen color, hydrogen-ion concentration (pH), percentages of sperm motility, dead spermatozoa, abnormal spermatozoa, acrosome damage of spermatozoa, chromatin damage and sperm-cell concentration (×10⁶/ml).

Testicular measurements:

Testes weight (gm):

Mean paired of the Maghrebi camels testes were weighed to the nearest gram by an ordinary balance immediately after slaughtering (Weibel, 1989).

Testicular volume (cm³):

Each testis was individually weighed on a balance to the nearest 0.01g and their dimensions (Length, Breadth and Thickness) were determined as the method described by Weibel (1989) using the following formula:

$$\text{Testicular volume} = (\pi \times L \times B \times T)/6$$

Where: $\pi = 3.14$, L = Length of the longitudinal axis of the testes, B = Breadth of the testes and T = Thickness of the testes.

Scrotal circumference (cm):

Scrotal circumference was measured with a flexible cloth measuring tape around the

largest diameter of the testes and scrotum placed after pushing the testes firmly into the scrotum (Mickelsen *et al.*, 1982).

Testes tone firmer (score):

Testes tone firmer (score) was determined via manual palpation (scored from 1: very soft and 9: very firm) as described by Wildeus and Hammond (1993).

Camel sperm collection:

Epididymal sperm was collected from the Maghrebi camel testes after slaughtering. A total number of 84 clinically normal testes were collected during the breeding (n=42) and non-breeding seasons (n=42).

Transportation of the samples:

The genitalia (epididymis attached to the testes) were removed from the carcass and transferred to the laboratory in a thermos flask containing sterile physiological saline (0.9%) supplemented with 100 µg/ml streptomycin at 25°C for semen analysis according to Goto *et al.* (1989) within 2-3 hours after slaughtering.

Sperm recovery:

The processing of the samples was carried out directly at arrival to the laboratory as soon as possible. Genitalia were dissected, isolating the epididymis and vas deferens from its corresponding testes. Sperm recovery was carried out on 84 epididymis.

Recovery by cuts (swimming up) method:

The testes (n=84) were thoroughly cleaned and the superficial blood vessels of the cauda were punctured so that most of the blood could be wiped off by using a sterile scalpel and forceps, the epididymis was sectioned into three respective parts, caput, corpus and cauda in three sterile petri dishes of 100 mm diameter. Longitudinal cuts were made in each epididymal segment using sterile sharp scalpel and covered by 5 ml S-TALP medium using sterile disposable syringe. The epididymal sperm suspension was incubated for 10 minutes at 39°C in high humidity atmosphere with 5% CO₂ in a tilted position (45° angle) according to Kaabi *et al.* (2003).

Epididymal sperm characteristics:

Semen colour:

Semen colour was determined directly from the collecting tube.

Hydrogen-ion concentration (pH):

Seminal pH value was measured using universal indicator paper and standard commercial stains according to Karras (1952).

Percentage of sperm motility (%):

Generally, camel sperm motility (%) was detected as an oscillatory motion of the flagellum but not progressive due to the viscous materials according to Zeidan *et al.* (2001). Sperm motility was estimated according to Plasson (1975).

Percentage of dead spermatozoa (%):

The eosin/nigrosin staining procedure was carried out according to Hackett and Macpherson (1965).

Percentage of abnormal spermatozoa (%):

The morphological of abnormal spermatozoa (%) was determined in the same smears prepared for live/dead spermatozoa ratio (Campbell, 1956).

Percentage of acrosome damage of spermatozoa (%):

Assessment of the percentages of acrosome damage was done according to Watson (1975).

The percentages of acrosome damage were calculated for 100 spermatozoa observed at random in each slide using oil immersion lens (×1000).

Percentage of chromatin damage of spermatozoa (%):

Toluidine blue staining was performed as the method described by Erenpreiss *et al.* (2004).

Sperm-cell concentration (×10⁶/ml):

The spermatozoa were counted using haemocytometer according to Khan (1971).

Statistical analysis:

Data were statistically analyzed by Factorial design (ANOVA) using General Linear Model (GLM) procedure of SAS (SAS, 2000). Duncan's New Multiple Range Test (Duncan, 1955) was used to detect significant differences among means. Percentage values were transformed to arc-sin values before being statistically analyzed.

The model used in the experiment was as follows:

$$Y_{ijk} = \mu + S_i + A_j + (S \times A)_{ij} + e_{ijk}$$

Where: μ = Overall mean, S_i = Effect of season, A_j = Effect of age, $S \times A_{ij}$ = Effect of

interaction between season and age and e_{ijk} = Effect of random error.

RESULTS AND DISCUSSION

Testicular measurements:

Testes weight (gm):

The testes weight was significantly ($P < 0.05$) higher during the breeding season than non-breeding season (Table 2). Ahmadi (2001) and Zeidan *et al.* (2001) confirmed that the testes weight was 83.67, 127.83 and 115.17 gm in winter, 70.83, 122.38 and 110.83 gm in spring, 58.67, 102.50 and 90.33 gm in summer and 73.50, 111.50 and 96.33 gm in autumn in the dromedary camels at 3-5, 6-11 and 12-20 years old respectively.

With regard to age, testes weight (gm) was significantly ($P < 0.05$) higher at < 9 to 14 and < 14 to 19 years of age than camels at < 4 to 9 years whether the breeding or non-breeding seasons (Table 2). Similarly, Zeidan *et al.* (2007) showed that the testes weight (gm) in the dromedary camel was significantly ($P < 0.01$) higher at 10 to 15 and 15 to 20 years old than at 5 to 10 years old.

Testicular volume (cm³):

The testicular volume (Table 2) was significantly ($P < 0.05$) higher in the breeding season than non-breeding season.

Zeidan *et al.* (2001) reported that the testicular volume was 91.78, 117.98 and 112.84 cm³ in winter, 87.78, 116.03 and 114.48 cm³ in spring, 55.58, 82.53 and 78.74 cm³ in summer and 72.63, 100.91 and 87.38 cm³ in autumn season for the dromedary camels at 3-5, 6-11 and 12-20 years old, respectively.

With regard to age, testicular volume (cm³) was significantly ($P < 0.05$) increased of the male Maghrebi camels at < 9 to 14 years compared to the camels at < 4 to 9 or < 14 to 19 years of age whether in the breeding or non-breeding season (Table 2). Zeidan *et al.* (2007) showed that the testicular volume (cm³) in the dromedary camels was significantly ($P < 0.01$) higher at 10 to 15 years old than camels at 5 to 10 and 15 to 20 years old.

Scrotal circumference (cm):

The scrotal circumference was significantly ($P < 0.05$) higher in the breeding season than the non-breeding season (Table 2).

Zeidan *et al.* (2001) found that the testicular circumference was 16.89, 15.89, 13.39 and 14.84 cm in winter, spring, summer and autumn seasons, respectively.

With regard to age, scrotal circumference (cm) showed significantly ($P < 0.05$) increased at < 9 to 14 years compared to the camels at < 4 to 9 and < 14 to 19 years of age either the breeding or non-breeding season (Table 2). Zeidan *et al.* (2007) showed also that the scrotal circumference (cm) in the dromedary camels was significantly ($P < 0.01$) higher at 10 to 15 years old than camels at 5 to 10 and 15 to 20 years old.

Testes tone firmer (score):

The testes tone firmer was insignificantly higher during the breeding season than the non-breeding season (Table 2). Zeidan and Abbas (2004) reported that testes tone firmer was significantly ($P < 0.01$) higher during the rutting compared with non-breeding season in the dromedary camels. Maiada (2011) found that the testes tone firmer score of the dromedary camels was significantly ($P < 0.05$) higher during the breeding than non-breeding season whether in the hot-dry or the hot-humid months.

With regard to age, testes tone firmer (score) showed insignificantly increased at < 9 to 14 years compared to the camels at < 4 to 9 or < 14 to 19 years of age either the breeding or non-breeding season (Table 2). Similar trends were recorded by Maiada (2011) in the dromedary camels.

Generally, photoperiod seems to play a major role in regulating the seasonal activity (the rutting season) of the camel testes which are regulated as short-day breeders in which change from long to short day seems to stimulate synthesis and release of gonadotropins hormones from the anterior pituitary gland, which in turn stimulate testicular activity and sexual behavior (Lincoln *et al.*, 1977).

Epididymal sperm characteristics:

Semen colour:

Seminal colour of the ejaculate can vary from a Grey translucent colour (Table 3), if the ejaculate is predominantly the gelatinous seminal plasma fraction and not very concentrated to a Creamy white colour as the concentration of spermatozoa increases (Skidmore *et al.*, 2013).

Semen colour was Creamy white, Creamy white, and Milky white during the breeding season, while, Greyish white, Light milky white and Watery white during non-breeding season of the Maghrebi camels at < 4 -9, < 9 -14 and < 14 -19 years, respectively (Zeidan *et al.*,

2001). These results are in agreement with those of Rai *et al.* (1997) and Zeidan and Abbas (2004). The different colour of semen during different seasons of the year may be due to the different concentrations of spermatozoa and semen consistency (Zeidan *et al.*, 2000). In addition, semen colour was Creamy white, Creamy white and Milky white of the male dromedary camels at <6-11, <11-16 and <16-21 years of age, respectively.

Hydrogen-ion concentration:

The hydrogen-ion concentration (pH) values (Table 3) were insignificant whether in the breeding or non-breeding seasons. Similar trend was reported by Abd El-Azim (1996). The alkalinity reaction of the camel semen was increased during sexual activity (the rutting season) period than during sexually rest period (Musa *et al.*, 1992). Ahmadi (2001) found also that the seminal hydrogen-ion concentration (pH) was insignificantly higher during winter and spring than summer and autumn seasons.

In respect to age (Table 3), the effect of age on seminal hydrogen-ion concentration (pH) values with different age was insignificant. Similarly, Ahmadi (2020) found that seminal pH values of the male dromedary camels at <6-11, <11-16 and <16-21 years of age, respectively.

Percentage of sperm motility (%):

Data presented in Table 3 revealed that the effect of season of the year on the percentage of motile Maghrebi camel spermatozoa was significantly ($P<0.05$) higher the percentage of sperm motility during the breeding than non-breeding seasons. Similar trend was reported by Abd El-Azim (1996) who found that the percentage of motile camel spermatozoa was significantly ($P<0.01$) higher during winter than spring, summer and autumn seasons. Similarly, Zeidan and Abbas (2004) and Maiada (2011) showed that the percentage of sperm motility was significantly ($P<0.01$) higher during the rutting compared with the non-breeding season in the male dromedary camels. These results may be attributed to the increase of the mature Leydig cells and spermatogenesis process are increased significantly during the rut season than summer one (non-breeding season). As the Leydig cells are mainly responsible for testosterone production, an improvement in semen quality is expected to occur during the rut season (Charnot, 1965).

In respect to age (Table 3), the effect of age on the percentage of motile Maghrebi camel spermatozoa was significantly ($P<0.05$) lower. The percentage of sperm motility at <14 to 19 years than <4 to 9 or <9 to 14 years of age. Zeidan *et al.* (2001) found that the highest value of the percentage of sperm motility was recorded in the male dromedary camels at over 5 to 10 years of age. Similarly, Ahmadi (2020) confirmed that the percentage of motile camel spermatozoa showed that they are significantly higher at <6-11 and <11-16 years of age than <16-21 years of age.

The decrease in motility with the advanced age could be explained by the decrease in Leydig cells activity with the advanced age which are considered to be testosterone hormone producing factor, so this is reflected on a bad semen characteristics produced by the aged of animals (Ibrahim *et al.*, 2016).

Percentage of dead spermatozoa (%):

The percentage of dead camel spermatozoa (Table 3) was significantly ($P<0.05$) higher during non-breeding season. The highest ($P<0.05$) value of the percentage of dead Maghrebi camel spermatozoa was recorded during non-breeding season, while, the lowest ($P<0.05$) value was recorded during the breeding season (Table 3).

Matter (2019) reported that the dead spermatozoa of the dromedary camels was significantly ($P<0.05$) higher during non-breeding season. Similar trends were recorded by Ahmadi (2020).

In respect to age, the highest ($P<0.05$) value of dead spermatozoa was recorded with the camels at <14 to 19 years, while, the lowest ($P<0.05$) value was recorded with the camels at <4 to 9 years and <9 to 14 years of age whether in the breeding or non-breeding season (Table 3). These results may be attributed to the fact that the advancement of age which may cause disturbance in spermatogenesis or destruction or even death of spermatozoa (Abdel-Raouf and Owaida, 1974 and Musa *et al.*, 1992).

Similarly, Ibrahim *et al.* (2016) reported that Livability of camel spermatozoa collected during the rutting season was significantly ($P<0.05$) higher than in non-rutting season of the dromedary camel aged 6-10 years. These results may be due to the decline of air temperature during short photoperiods (winter season) which have effect on the pituitary gland and activity of spermatogenic process and the critical temperature that

inhibits spermatogenesis (Rhynes and Ewing, 1973).

Percentage of abnormal spermatozoa (%):

The highest ($P<0.05$) value of the percentage of abnormal camel spermatozoa was recorded during non-breeding season, while, the lowest ($P<0.05$) value was recorded during the breeding season (Table 3). Ibrahim *et al.* (2016) reported that morphologically abnormal camel spermatozoa in the breeding season were significantly ($P<0.05$) lower than non-breeding season. These results are in agreement with those reported by Zeidan *et al.* (2001) who found that the percentage of abnormal camel spermatozoa was significantly ($P<0.01$) higher during spring, summer and autumn than winter seasons. Similar trend was reported by Abd El-Azim (1996) and Zeidan and Abbas (2004) in the dromedary camels.

In respect to age, the highest ($P<0.05$) value of abnormal spermatozoa was recorded with the camels at <14 to 19 years, while, the lowest ($P<0.05$) value was recorded with the camels at <4 to 9 years and <9 to 14 years. The percentage of abnormal camel spermatozoa was increased with the advanced age whether in the breeding or non-breeding season (Table 3). Similar trend was found by Hemeida *et al.* (1985).

Percentage of acrosome damage of spermatozoa (%):

The highest ($P<0.05$) value of the percentage of acrosome damage was recorded during non-breeding season, while the lowest ($P<0.05$) value was recorded during the breeding season (Table 3). These results are in agreement with those of Ibrahim *et al.* (2016) who reported that morphologically abnormal camel acrosomes in the breeding season were significantly ($P<0.05$) lower than non-breeding season. These results may be attributed to the onset of the rut which is marked by increase in activity in the Alpha and β secreting cells in the anterior pituitary and increase in Leydig cells activity during the breeding season with a resulting reduction in steroidogenic activity by the testes and high testosterone levels which due to improvement of spermatogenesis and decrease of acrosomal damage of spermatozoa (Zeidan *et al.*, 2001).

In respect to age, the highest ($P<0.05$) value of the percentage of acrosome damage was recorded with the camels at <14 to 19 years, while, the lowest ($P<0.05$) value was recorded with the camels at <4 to 9 years and <9 to 14 years whether in the breeding or non-breeding

season (Table 3). Ahmadi (2001) found that the lowest value of the percentage of acrosome damage was recorded in the male dromedary camels at 6 to 11 years and the highest value was recorded of the camels at 3 to 5 years of age.

Percentage of Chromatin damage (%):

The lowest ($P<0.05$) value of chromatin damage was recorded during the breeding season, while the highest ($P<0.05$) value was recorded during non-breeding season (Table 3). Similar trend was recorded by Ahmadi (2020) in the dromedary camels.

In respect to age (Table 3) the effect of age on the percentage of chromatin damage of Maghrebi camels at <14 to 19 years of age showed significantly ($P<0.05$) higher than the camels at <4 to 9 or <9 to 14 years of age either the breeding or non-breeding season (Table 3). Similar trends were recorded by Ahmadi (2020) in the dromedary camels.

During spermatogenesis, the sperm nucleus undergoes a series of important changes that made the chromatin a unique structure, which its quality is a determining factor of sperm ability to promote normal embryonic development, consequently related to fertility (Trujillo and Moreno, 2017). Similarly, Ahmadi (2020) observed that the percentage of chromatin damage of the dromedary camel spermatozoa at <16-21 years of age than <11-16 and <16-21 years of age.

Sperm-cell concentration ($\times 10^6/ml$):

The highest ($P<0.01$) value of the sperm-cell concentration was recorded during the breeding season, while the lowest ($P<0.01$) value was recorded during non-breeding season (Table 3). Similar trend was reported by Abd El-Azim (1996) and Zeidan and Abbas (2004) in the dromedary camels. The low sperm-cell concentration of the camel semen during non-breeding season may be attributed to the long day length, as well as, heat stress which led to reduction in the interstitial cells stimulating hormones, consequently, reduction in androgen production (Sinha and Prasad, 1993).

In respect to age, the effect of age on the sperm-cell concentration of the Maghrebi camels (Table 3) was significantly. The highest ($P<0.01$) value of sperm-cell concentration was recorded with the camels at <4 to 9 years and <9 to 14 years, while the lowest value ($P<0.01$) was recorded with the camels at <14 to 19 years of age whether in the breeding or non-breeding season. Similarly, Ahmadi (2001) and

Zeidan *et al.* (2001) reported that the highest value of sperm-cell concentration was recorded of the male dromedary camels at over 5 to 10 years and the lowest value was recorded of the camels at 2.5 to 5 years of age.

CONCLUSION

Based on the previous obtained results, it is interesting to note that testicular measurements and sperm characteristics of the male Maghrebi camels were better during the breeding season, especially of the camels at <4 to 9 and <9 to 14 years of age that have the potential being used in the laboratory investigations released to *in vitro* fertilization (IVF) and artificial insemination (AI) as a useful tool in animal breeding programmes whether the breeding or non-breeding season.

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Table 1: Means of meteorological data, during the breeding and non-breeding seasons according to the Egyptian Meteorological Authority

Season	Air temperature (°C)		Relative humidity (%)		Temperature – humidity index (THI)		Length of the day light (hr.)
	Min.	Max.	Min.	Max.	Min.	Max.	
Breeding	10.87 ^b ±0.14	21.73 ^b ±0.18	42.07 ±0.51	61.18 ±0.72	49.50 ^b	68.23 ^b	12.75
Non-breeding	17.90 ^a ±0.36	28.19 ^a ±0.42	38.94 ±0.25	56.13 ±0.88	62.05 ^a	76.56 ^a	14.26

Means bearing different letters within the same classifications, differ significantly (P<0.05).

Table 2: Effects of different ages on the testicular measurements during the breeding and non-breeding seasons in the male Maghrebi camels (Means \pm SE)

Testicular measurements	Breeding Season			Mean	Non-breeding season			Mean
	Age (years)				Age (years)			
	< 4-9	< 9-14	< 14-19		<4-9	<9-14	<14-19	
Testes weight (gm)	160.17 ^b ± 6.20	173.90 ^a ± 9.51	171.92 ^a ± 12.60	168.66 ^a ± 3.38	63.72 ^b ± 2.11	86.11 ^a ± 2.11	85.20 ^a ± 1.78	78.34 ^b ± 0.97
Testicular volume (cm ³)	100.16 ^c ± 2.62	135.15 ^a ± 2.27	121.40 ^b ± 3.01	118.90 ^a ± 1.31	60.72 ^c ± 3.11	82.16 ^a ± 2.24	76.18 ^b ± 2.16	73.02 ^b ± 0.34
Scrotal circumference (cm)	21.84 ^c ± 0.92	35.18 ^a ± 0.67	27.91 ^b ± 0.81	28.31 ^a ± 1.14	12.60 ^c ± 0.41	23.11 ^a ± 0.72	18.61 ^b ± 0.32	18.10 ^b ± 0.48
Testes tone firmer (score)	6.01 ^a ± 0.12	6.78 ^a ± 0.12	6.19 ^a ± 0.13	6.32 ^a ± 0.06	4.86 ^a ± 0.09	5.18 ^a ± 0.13	5.02 ^a ± 0.11	5.02 ^a ± 0.07

Means bearing different letters within the same classification, differ significantly (P<0.05).

Table 3: Effect of different seasons of the year (the breeding and non-breeding seasons) and ages on epididymal sperm characteristics in the male Maghrebi camels (Means \pm SE)

Semen characteristics	Season of the year						Means	
	Breeding			Non-breeding				
	Age (years)			Age (years)				
	< 4-9	< 9-14	< 14-19		< 4-9	< 9-14	< 14-19	
Semen colour	Creamy white	Creamy white	Milky white		Greyish white	Light Milky-white	Watery white	
Hydrogen-ion conc. (pH)	7.12 ^a ± 0.011	7.58 ^a ± 0.05	7.31 ^a ± 0.09	7.33 ^a ± 0.10	7.08 ^a ± 0.07	7.20 ^a ± 0.05	7.10 ^a ± 0.09	7.12 ^a ± 0.03
Sperm motility (%)	80.17 ^a ± 1.22	79.13 ^a ± 1.78	65.11 ^b ± 1.28	74.80 ^a ± 1.96	67.12 ^a ± 1.83	64.19 ^a ± 1.62	60.32 ^b ± 1.78	63.87 ^b ± 1.60
Dead spermatozoa (%)	13.78 ^c ± 0.51	17.42 ^b ± 0.61	23.16 ^a ± 0.072	18.12 ^b ± 0.22	19.49 ^c ± 0.81	25.18 ^b ± 0.78	30.28 ^a ± 0.81	24.98 ^a ± 1.54
Abnormal spermatozoa (%)	6.11 ^c ± 0.08	8.24 ^b ± 0.12	11.38 ^a ± 0.13	8.57 ^b ± 0.24	14.28 ^c ± 0.18	19.45 ^b ± 0.32	22.13 ^a ± 0.43	18.62 ^a ± 0.08
Acrosome damage (%)	2.82 ^c ± 0.08	4.23 ^b ± 0.07	8.16 ^a ± 0.06	5.07 ^b ± 0.33	10.76 ^c ± 0.09	15.83 ^b ± 0.13	19.67 ^a ± 0.23	15.42 ^a ± 0.10
Chromatin damage (%)	3.16 ^c ± 0.24	4.78 ^b ± 0.16	6.82 ^a ± 0.13	4.92 ^b ± 0.08	4.18 ^c ± 0.41	6.84 ^b ± 0.38	9.14 ^a ± 0.53	6.72 ^a ± 0.17
Sperm-cell concentration (x106/ml)	361.82 ^a ± 13.20	353.19 ^a ± 11.62	291.18 ^b ± 11.16	335.39 ^a ± 18.16	283.43 ^a ± 8.63	278.14 ^a ± 8.62	246.93 ^b ± 10.64	269.50 ^b ± 10.24

Means bearing different letters within the same classification, differs significantly (P<0.05).

تأثير مواسم السنة والأعمار على القياسات الخصوية وصفات السائل المنوي في ذكور الجمال العربية

عبد الرحمن محمود سمتر^{1*}، عبد الله محمد عاشور¹، علاء السيد زيدان²قسم الإنتاج الحيواني، كلية الزراعة، جامعة الأزهر، القاهرة، مصر.
معهد بحوث الإنتاج الحيواني، الدقي، الجيزة، مصر.

الملخص العربي:

يهدف العمل التجريبي إلى معرفة تأثير مواسم السنة وأعمار الجمال المختلفة على القياسات الخصوية وصفات السائل المنوي في ذكور الجمال المغربية. أجريت التجارب العملية على عدد 42 خصية في موسم النشاط الجنسي و42 خصية في موسم الحمل الجنسي. قسمت الحيوانات إلى ثلاثة مجاميع عند عمر 4-9 years، 9-14 years و14-19 years من العمر في المجموعة الأولى، الثانية والثالثة على التوالي. أوضحت النتائج أن وزن الخصية (gm)، حجم الخصية (cm³) ومحيط الخصية (cm) كانت أعلى معنويًا (على مستوى 0.05)، في حين أن ملمس كيس الصفن وقيمة درجة الحموضة (pH) للسائل المنوي عند عمر 4-9 years، 9-14 years و14-19 years سواء في موسم النشاط الجنسي أو الحمل الجنسي كانت غير معنوية. كان لون السائل المنوي كريمي أبيض، كريمي أبيض ولبيبي أبيض أثناء موسم النشاط الجنسي ورمادي أبيض، لبيبي أبيض شفاف ومائي أبيض أثناء موسم الحمل الجنسي عند عمر 4-9 years، 9-14 years و14-19 years، علي التوالي. زيادة النسبة المئوية للحيوانات المنوية المتحركة وتركيز الحيوانات المنوية بدرجة معنوية (على مستوى 0.05) أثناء موسم النشاط الجنسي عن موسم الحمل الجنسي عند عمر 4-9 years، 9-14 years و14-19 years علي التوالي. بينما زادت النسبة المئوية لكل من الحيوانات المنوية الميتة والحيوانات المنوية الشاذة وشذوذ الأكروسوم وشذوذ الكروماتين للحيوانات المنوية بدرجة معنوية (على مستوى 0.05) خاصة عند عمر 14-19 years و9-14 years بالمقارنة بتلك عند عمر 4-9 years سواء في موسم النشاط أو الحمل الجنسي.

الكلمات الاسترشادية: الإبل، المواسم، العمر، القياسات الخصوية، صفات الحيوانات المنوية.