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TESTICULAR MEASUREMENTS AND SEMEN CHARACTERISTICS OF THE MALE MAGHERBI CAMELS WITH DIFFERENT AGES DURING THE RUTTING AND NON- RUTTING SEASONS OF THE YEAR

Doaa M.A. Sarhan[1*], A.H. Daader[1], A. El-Darawany[1] and A.E.B. Zeidan[2]

1. Anim. Prod. Dept., Fac. Agric., Zagazig Univ., Egypt.

2. Anim. Prod. Res. Inst., Agric. Res. Cent., Dokki, Giza, Egypt.

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ABSTRACT: The present study aimed to investigate the effect of different ages (<4-8, <8-12 and < 12-16 years) during the rutting and non- rutting seasons on the testicular measurements and semen characteristics of the male Maghrebi camels. The results showed that the testes weight, testicular volume and scrotal circumference were significantly (P<0.05) increased of the male Maghrebi camels at <8 to 12 years during the rutting compared to non- rutting season of the camels specially at <4 to 8 and <12 to 16 years of age. However, testes tone firmer score was insignificantly increased during the rutting compared to non-rutting season or the male camel at <4 to 8 and < 12 to 16 years of age. Moreover, semen colour was Creamy white, Creamy white and Milky white during the rutting season. While, it was Creamy white, Watery white and Light Milky White during non-rutting season of the male Maghrebi camels at different ages (<4 to 8, < 8 to 12 or <12 to 16 years), respectively. Similarly, seminal hydrogen- ion concentration (pH) was insignificantly different in both the rutting and non-rutting seasons at different ages. Semen ejaculate- volume, percentage of sperm motility and sperm-cell concentration ($x10^6$/ml) of the male camels at <4 to 8 or < 8 to 12 years were significantly (P<0.05) higher than at <12 to 16 years of age either at the rutting or non-rutting season. While, the percentages of dead spermatozoa, abnormal spermatozoa, acrosome damage and chromatin damage were significantly (P<0.05) increased of the male camel at <12 to 16 years of age either at the rutting or non-rutting season specially at <4 to 8 and <8 to 12 years of age. In conclusion, testicular measurements and semen quality of the male Maghrebi camels at <4 to 8 or <8 to 12 years of age during the rutting season were improved compared with the camels at <12 to 16 years of age during non-rutting season.

Key words: Camel, season, age, testicular measurements, semen characteristics.

INTRODUCTION

In Egypt, necessarily increasing camel productivity and reproductive efficiency can help in minimizing the gap of the animal protein. A management strategy that promotes maximum reproductive efficiency depends in turn better understanding of reproductive biology of the camel (**Abd El-Raouf, 1994**).

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 intercytoplasmic 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**).

In addition the testes size was bigger in male camel during the rutting season in winter than summer during non-rutting season (**Volcani, 1954**). The variation of the testes weight in between the active (the rutting season) and inactive stages (non-rutting season) was 30% (average of 96

*** Corresponding author: Tel. :**+2 01092518542
E-mail address: doaa06603@gmail.com

and 66 gm, respectively). Studies concerning the optimum age and season in the male camels is still with good reproductive capacity semen to be leaking.

Moreover, the effects of different ages of the male camels (<4-8, <8-12 and <12-16 years) during the rutting season (December, January, February, March, April and May) and non-rutting season (June, July, and August, September, October and November) of the male Maghrebi camels (*Cameuls dromedarius*) on the tesicular measurements and epididymal semen characteristics, Egypt were recorded.

Generally**, Zeidan** and **Abbas (2004)** showed that the testicular volume was significantly higher (P<0.01) during the rutting compared with non-rutting season in the dromedary camels. **Maiada (2011)** confirmed that the scrotal circumference of the dromedary camels was significantly (P< 0.05) higher during the rutting than non-rutting season. **Zeidan and Abbas (2004)** showed also that testes tone firmer was significantly higher (P<0.01) during the rutting compared with the non- rutting season in the dromedary camels.

The present study aimed to investigate the effects of different seasons of the year (The rutting and non- rutting seasons) and ages (<4-8, <8-12 and <12-16 years) on the testicular measurements and semen characteristics of the male Maghrebi camels under Egyptian environmental conditions.

MATERIALS AND METHODS

The present study was conducted in the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. The experimental work was carried out in the Reproductive and Biotechnology Laboratory, Animal Production Research Institute, Dokky, Giza, Egypt. The testicular samples were obtained from Belbies City Abattoirs, Sharkiya Governorate, located in the North-eastern part of the Nile Delta (30ºN), during the period from June, 2019 to April, 2020.

Materials

Experimental animals and testes

The camels were divided into three groups (4 each) according to their ages. Twelve Maghrebi camels were used to investigate the effect at different ages (<4-8, <8-12 and <12-16 year) during the rutting season (December, January, Febraury, March, April, and May) and non-rutting season (June, July, August, Septemper, Octoper and November) according to **Abd El-Raouf *et al.* (1975).** The testicular measurements and semen characteristics were studied. In the male camels (*Camelus dromedaries*) at <4-16 years old and 500 to 600 kg of live body weight were used. All camels were in healthy conditions and clinically free from external and internal parasites with a sound history of fertility in the herd. The camels were divided into three groups according to their ages as follows: from < 4-8 years, < 8-12 years and <12-16 years.

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

Feeding and management

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

Green season (from December to May):

The average amounts given per head/day were 35 kg Egyptian clover (*Trifolium alexandrinun*) and 7 kg rice straw.

Dry season (from June to November)

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

Clean fresh water offered freely to all camels. The camels were housed in a yard which was provided with common feeding trough and a concrete floor provided with common sheltrerd water trough. The camels could move freely in enclosed area.

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

THI= dbºF- (0.55-0.55× RH/100) (dbºF-58.00).

Where, dbºF= dry bulb temperature in Fahrenheit and RH= relative humidity. The obtained values of THI were classified as follow: 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 (ºC), relative humidity (%), temperature- humidity index (THI) and length of daylight (hours), during the rutting and non-rutting seasons are shown in Table 1.

Methods

Testicular measurements

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

Procedures

Testicular measurements

Testes weight (gm)

Main paired of the testes were weighed to the nearest by ordinary balance immediately after slaughtering as the method described by **Wilson (1984)**.

Testicular volume (cm^3)

Main paired of the testicular volume was determined as the method described by **Weibel (1989)** using the following formulae:

$$TesticularVolume = \frac{\pi \times L \times B \times T}{6}$$

Where: $\pi = 3.14$

L= Length of the longitudinal axis of the testes.

B= Breadth of the testes.

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).**

The Camels Semen Collection

Semen was collected from twelve dromedary camels (three groups in each) between 08: 00 and 10: 00 a.m. using an artificial vagina (AV). A modified artificial vagina (30cm long and 5cm internal diameter, IMV, France) was used as described by **Zeidan (2002) and Mosaferi *et al*. (2005).**

Semen Characteristics

Semen colour

Semen colour of the male camels was determined directly after collection.

Semen-ejaculate volume (m)

Semen- ejaculate volume (ml) was determined using a conical graduated tube.

Hydrogen-ion concentration (pH)

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

Percentage of sperm motility

Sperm motility (%) was estimated by observing the approximate percentage of spermatozoa according to **Plasson (1975).**

Percentage of dead spermatozoa%

The eosin/nigrosin staining procedure was carried out by dissolving 1.67 gm eosin and 10 gm nigrosin in distilled water up to 100 ml as the method described by **Hackett** and **Macpherson (1965).**

Percentage of abnormal spermatozoa

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

Percentage of acrosome damage

The percentages of acrosome damage (%) of spermatozoa were done as the method described by **Watson (1975).** A drop of diluted semen was smeared on a pre-warmed slide.

Percentage of chromatin damage

Toliuidine blue staining was performed as the method described by **Erenpreiss *et al.* (2004).** Smears were fixed in ethanol-acetic acid glacial (3:1, *V/V*).

Sperm- cell concentration ($x10^6$/ml)

The spermatozoa were counted using haemocytometer according to **Salisbury *et al*. (1978)**.

Table 1. Means of meteorological data during the rutting and non-rutting seasons according to Egyptian Meteorological Authority

Season	Air temperature (°C)		Relative humidity (%)		Temperature-humidity index (THI)		Length of the day light (hrs)
	Min.	Max.	Min.	Max.	Min.	Max.	
The rutting	12.63±0.10	21.72±0.17	46.12±0.51	60.24±1.18	53.74	67.30	13.91
Non- rutting	19.02±0.34	28.26±0.48	42.81±0.63	62.30±0.92	63.64	74.91	16.24

Statistical Analysis

Data were statistically analyzed by one-way design (ANOVA) using General Linear Model (GLA) procedure of SAS (**Sas, 2006**). Duncan's Multiple Range test (**Duncan, 1955**) was used to detect significantly differences among means. Percentage values were transformed to arc-sin values before being statistically analyzed.

RESULTS AND DISCUSSION

Testicular Measurements

Testes weight (gm)

The testes weight (gm) of the male Magherbi camels was increased significantly (P<0.05) during the rutting compared to non-rutting season (Table 2). **Ahmadi (2001)** and **Zeidan *et al*. (2001)** found that the testes weight showed significantly (P<0.01) increased during winter and spring than summer and autumn seasons. **El-Sherief (1997)** and **Zeidan and Abbas (2004)** found also that the testes weight was increased in winter and decreased in summer season. These findings may be due to the increase of the amount interstitial tissues, spermatogenesis and growth of the soft palate that takes place during the rutting season (**Charnot and Racadot, 1963 and Charnot, 1964**).

With regard to age, the testes weight (Table 2) of the male Magherbi camels was significantly (P<0.05) increased at <4 to 8 years than < 8-12 and < 12 to 16 years of age compared with camels either in the rutting or non- rutting seasons. Similar trends were recorded by **Maiada (2011)** and **Matter (2019)** in the male dromedary camels.

Testicular volume (cm^3)

Testicular volume (cm^3) of the male Maghrebi camels showed significantly (P<0.05) higher in the rutting than non-rutting season (Table 2). **Zeidan** and **Abbas (2004)** showed also that testicular volume was significantly (P<0.01) higher in the rutting than non-rutting season in the dromedary camels. The increase of testicular volume during winter and spring seasons may be attributed to the increase of spermatogonia, spermatocytes, spermatids and spermatozoa. In addition, the testes dimensions increased during the rutting season reflecting higher spermatogenesis as affected by increase of testosterone concentraton and development of interstitial tissues, similar to that recorded by **Matter (2019)** in the dromedary camels.

In respect to age, testicular volume of the male Maghrebi camels (Table 2) was significantly (P<0.05) increased at <8-12 years compared with the camels in both the rutting and non-rutting seasons. Similar trends were reported by **Maiada (2011)** and **Matter (2019)** in the male dromedary camels.

Scrotal circumference (cm)

The scrotal circumference (cm) of the male Maghrebi camels (Table 2) was increased significantly (P< 0.05) during the rutting compared to non- rutting season. These results are in agreement with those reported by **Ahmadi (2001)** and **Zeidan *et al*. (2001)** who found that the scrotal circumference was significantly (P< 0.01) higher during winter and spring (the rutting season) than summer and autumn (non-rutting season). **Zeidan** and **Abbas (2004)** showed also that scrotal circumference showed

Table 2. Effects of different seasons of the year (the rutting and non-rutting) and ages on the testicular measurements of the male Maghrebi camels (Means ±SE)

Testicular measurements	The rutting season			Mean	Non-rutting season			Mean
	Age (year)				Age (year)			
	<4-8	<8-12	<12-16		<4-8	<8-12	<12-16	
Testes weight (gm)	128.11 ± 4.16^{c}	180.16 ±3.14^{a}	165.12 ± 4.22^{b}	174.48 ±3.02^{a}	86.19 ±1.92^{a}	88.13 ±2.18^{a}	71.82 ±2.11^{b}	82.04 ±0.92^{b}
Testicular volume (cm^3)	120.88 ±3.64^{b}	142.17 ±3.60^{a}	112.30 ±2.31^{c}	125.11 ±2.84^{a}	70.98 ±1.87^{b}	80.60 ±2.19^{a}	68.20 ±2.13^{b}	74.57 ±67^{b}
Scrotal circumference (cm^3)	28.16 ±0.47^{b}	34.62 ±00.53^{a}	30.89 ±0.64^{b}	27.89 ±0.19^{a}	19.25 ±0.43^{a}	20.18 ±0.9s1^{a}	14.62 ±0.34^{b}	18.01 ±0.14^{b}
Testes tone firmer (score)	6.68 ±0.43^{a}	6.72 ±0.10^{a}	6.11 ±0.19^{a}	6.50 ±0.04^{a}	5.13 ±0.42^{a}	5.82 ±0.12^{a}	4.75 ±0.18^{a}	5.23 ±0.09^{a}

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

significantly (P<0.01) during the rutting as compared to non-rutting season in the dromedary camels. These results may be attributed to the high environmental temperature during summer causing a more pendulous arrangement of the scrotum with reduced scrotal wrinkling (**Zeidan *et al*., 2001**).

In respect to age, scrotal circumference (Table 2) increased significantly (P<0.05) in the male Maghrebi camels at < 8 – 12 years as compared with the camels at < 12 to 16, <4 to 8 and <12 to 16 years of age. While, significantly (P<0.05) increased at the rutting than non-rutting season. Similar trends were reported by **Zeidan** and **Abbas (2004), Maiada (2011)** and **Matter (2019)** in the male dromedary camels.

Testes tone firmer (Score)

The testes tone firmer score of the male Maghrebi camels (Table 2) was insignificantly either the rutting or non-rutting season. **Zeidan *et al*. (2001)** and **Matter (2019)** found that testes tone firmer score was significantly (P<0.01) higher in winter and spring (the rutting season) than summer and autumn (non-rutting season) in the dromedary camels. Similar trend was reported by **Matter (2019)** in the male dromedary camels.

The Camel Semen Characteristics

Semen colour

The colour of the ejaculate Maghrebi camels semen can vary from a Grayish translucent colour (Table 3) if the ejaculate is predominantly the gelatinous seminal plasma fraction and not very concentration to a Creamy white colour as the concentration of spermatozoa increase (**Skidmore *et al*., 2013**).

Semen colour was Creamy white, Creamy white and Milky white during the rutting season, while, Creamy white, Watery white and Light milky white, during non- rutting season of the dromedary camels at < 4 to 8, < 8 to 12 and < 12-16 years of age, respectively. **Rai *et al*. (1997)** and **Zeidan** and **Abbas (2004)** showed that, camel semen colour was Creamy white during the rutting season, while Watery white during non-rutting season in the dromedary camels. Similarly **Abd El-Azim (1996) and Zeidan *et al*. (2001)** found that semen colour was Yellow white, Creamy white and Milky white during winter and spring (the rutting season), while, Gray white, Watery white and Light milky white during summer and autumn (non-rutting season) in the dromedary camels at 3-5, 6-11 and 12-20 years old, respectively.

Table 3. The effects of different seasons of the year (the rutting and non-rutting) and ages on semen characteristics of the male Maghrebi camels (Means ± SE)

Semen characteristics	The rutting season			Mean	Non-rutting season			Mean
	Age (year)				Age (year)			
	<4-8	<8-12	<12-16		<4-8	<8-12	<12-16	
Semen colour	**Creamish white**	**Creamish white**	**Milky white**		**Watery white**	**Watery white**	**Light milky white**	
Semen-ejaculate volume (ml)	6.81 ±0.13^{a}	6.92 ±0.12^{a}	4.78 ±0.11^{b}	6.17 ±0.13^{A}	2.36 ±0.04^{a}	2.51 ±0.06^{a}	1.45 ±0.08^{b}	2.10 ±0.08^{B}
Hydrogen-ion concentration (pH)	7.14 ±0.10^{a}	7.61 ±0.07^{a}	7.52. ±0.06^{a}	7.42 ±0.08^{A}	7.02 ±0.08^{a}	7.42 ±0.06^{a}	7.38 ±0.05^{a}	7.27 ±0.06^{A}
Sperm motility (%)	81.29 ±0.16^{a}	80.11 ±1.23^{a}	72.13 ±1.43^{b}	77.84 ±1.92^{A}	68.14 ±1.52^{a}	66.70 ±61.0^{a}	57.16 ±1.34^{b}	64.10 ±2.15^{B}
Dead spermatozoa (%)	11.81 ±0.72^{c}	15.72 ±0.51^{b}	20.78 ±61.0^{a}	16.1 ±0.72^{B}	18.72 ±0.62^{c}	23.17 ±0.74^{b}	32.24±0. 84^{a}	24.71 ±0.64 ^{A}
Abnormal spermatozoa (%)	7.14 ±0.09^{c}	12.81 ±0.8^{b}	16.72 ±0.11^{a}	12.22 ±0.16^{B}	13.61 ±0.13^{c}	17.23 ±0.16^{b}	26.19 ±0.19^{a}	19.01 ±0.17^{A}
Acrosome damage of spermatozoa (%)	3.16 ±0.04^{c}	6.14 ±0.02^{b}	8.11 ±0.06^{a}	5.80 ±0.13^{B}	7.42 ±0.1^{c}	9.25 ±0.13^{b}	15.81 ±0.18^{a}	10.82 ±0.11^{A}
Chromatin damage of spermatozoa (%)	1.15 ±0.05^{c}	4.17 ±0.06^{b}	6.18 ±0.08^{a}	3.83 ±0.08^{B}	3.17 ±0.05^{c}	6.38 ±0.09^{b}	11.16 ±0.11^{a}	6.90 ±0.09^{A}
Sperm-cell concentration (X10^{6}/ml)	372.18 ±8.61^{a}	368.19 ±10.17^{a}	301.65 ±9.70^{b}	347.34 ±10.61^{A}	291.65 ±7.11^{a}	288.71 ±9.23^{a}	260.19 ±5.18^{b}	280.18 ±8.62^{B}

Means a,b,c and overall means (A,B) bearing different letters within the same classification, differ significantly (P<0.05).

The different colour of semen during different seasons of the year may be due to different concentrations of spermatozoa and semen consistency (**Ahmadi, 2020**).

Semen-ejaculate volume (ml)

Semen-ejaculate volume (ml) of the Maghrebi camels was significantly (P<0.05) increased during the rutting compared to non-rutting season (Table 3).

Semen-ejaculate volume was significantly (P<0.05) higher in the male Maghrebi camels at <4 to 8 and <8 to 12 years than <12 to 16 years of age. While, it was insignificantly higher at <4 to 8 and <8 to 12 years of age (Table 3). The highest (P<0.05) value of semen- ejaculate volume was recorded at <8 to 12 years, while, the lowest (P<0.05) value was recorded at < 12 to 16 years of age. These results are in agreement with those reported by **Zeidan *et al.* (2001)** who found that, semen- ejaculate volume in the dromedary camels was 7.82, 8.12 and 7.94 ml at 2.5 to 5, over 5 to 10 and over 10 to 20 years of ages, respectively. Similar trend was recorded by **Garnica *et al.* (1993)** in Alpaca, **Zeidan *et al.* (2001)** and **Ahmadi (2020)** in the dromedary camels.

Hydrogen-ion concentration (pH)

Seminal hydrogen-ion concentration (pH) value of the male Maghrebi camels semen (Table 3) was not significantly, similar to that reported by **Abd El-Azim (1996)** and **Zeidan *et al.* (2001)** in the dromedary camel. The alkalinity reaction of the camel semen was increased during sexual activity (the rutting season) period during sexually rest period

(Musa *et al*., 1992). Ahmadi (2020) found also that the seminal hydrogen-ion concentration (pH) was not significantly.

In respect to age, the effect of ages on seminal hydrogen-ion concentration (pH) of the male dromedary camels was insignificantly (Table 3). The highest value of seminal hydrogen-ion concentration (pH) was recorded with the camels at <8-12 compared with <4-8 and <12-16. **Abd El-Salaam (2011)** recorded that seminal hydrogen-ion concentration (pH) value was insignificantly higher in the male dromedary camels at 15 to 20 years than 5 to 10 and 10 to 15 years of the age. These results are in agreement with those reported by **Zeidan *et al*. (2001) and Matter (2019)** in the male Maghrebi camels.

Percentage of sperm motility (%)

Data presented in Table 3 revealed that, the effect of different seasons of the year and age on the percentage of sperm motility of the dromedary camels was significantly (P<0.05). Similar trend was reported by **Abd El- Raouf** and **Owaida (1974) and Zeidan *et al*. (2001)** who found also that the percentage of sperm motility of the male dromedary camel was significantly (P<0.01) higher during winter than spring, summer and autumn seasons. Moreover, **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-rutting season in the male dromedary camels. These results may be attributed to the increase of the mature Leydig cells and spermatogenesis process which increased significantly during the rutting season than summer one (non- rutting season). As the Leydig cells are mainly responsible for testosterone production. So, an improvement in semen quality is expected to occur during the rutting season (**Charnot, 1965**)

In respect to age, the percentage of sperm motility of the male dromedary camels (Table 3) was significantly (P<0.05). The percentage of sperm motility was significantly (P<0.05) lower of the male camels at < 4-8 and < 8-12 years than <12-16 years of age. The highest (P<0.05) value of the percentage of sperm motility was recorded with the camel at <4-8 years of age, while the lowest (P<0.05) value was recorded with the camels at <12-16 years. Similar trend was reported by **Abd El-Salaam (2011)** who found that the percentage of sperm motility of the male dromedary camel was significantly (P<0.01) lower with the camels at 15-20 years than 5-10 years and 10-15 years. In addition, **Zeidan (1999)** 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.

Ibrahim *et al*. (2016) showed that the percentage of motile camel spermatozoa during the rutting season was significantly (P<0.05) higher than non-rutting season in the male dromedary camel aged between 6-10 years. Moreover, **Ahmadi (2001)** found that the highest value of the percentage of sperm motility was recorded in the male dromedary camels at 6 to 11 years old. The decrease in sperm motility with the advanced age could be explained by the decrease in the Leydig cells activity which are considered to be testosterone hormone producing factor, so this reflected on a bad semen characteristics produced by the aged animals (**Ibrahim *et al*., 2016**).

Ali *et al* (2014) reported that sperm motility percentage was significantly increased (P< 0.05) with the age progress in both seasons (the rutting and non- rutting). Also, sperm motility in camels over 4 years old was recorded significantly (P<0.05) higher than those of 2-3 years and 3-4 years old in cold and moderate hot seasons, similar to that recorded by **Matter (2019)** in the male dromedary camels.

Percentage of dead spermatozoa%

The percentage of dead camels spermatozoa was significantly (P<0.05) higher during non-rutting season. The highest (P<0.05) value of the percentage of dead camel spermatozoa was recorded during non- rutting season, while the lowest (P<0.05) value was recorded during the rutting season (Table 3). **Ali *et al* (2014)** found that the live percentage of the old camel spermatozoa (over 20 years) was 90.01% in the cold season with a significantly higher than 2-3 years old and 3-4 years old camels in both seasons. Similarly, **Ibrahim *et al*. (2016)** reported that Livability of the camel spermatozoa collected during the rutting season was significantly (P< 0.05) higher than non-rutting season of the

camel at 6-10 years of age. These results are in agreement with those reported by **Zeidan *et al*. (2001)** and **Matter (2019)** who found that the percentage of dead camel spermatozoa was significantly (P<0.01) higher during summer than autumn, winter and spring seasons. These results may be due to the decline of temperature during winter and short photoperiods which have effect on the pituitary gland and activity of spermatogenic process and the critical temperature that inhibits of spermatogenesis (**Rhynes and Ewing, 1973**). In addition, heat stress during summer (non- rutting season) which may be cause disturbance in spermatogenesis process due to degenerative changes with diminished number of mature spermatozoa or destruction or even death of spermatozoa (**Abd El- Raouf** and **Owaida, 1974** and **Zeidan *et al*., 2001**).

In respect to age, the effect of the male camels at <4-8, <8-12 and <12- 16 years of age on the percentage of dead camels spermatozoa was significantly (Table 3). The highest (P< 0.05) value of dead spermatozoa was recorded with the camels at <12-16 years of age, while the lowest (P<0.05) value was recorded at < 4 years and <8-12 years of age. In this work, the percentage of dead camel spermatozoa was increased with the advanced age. These results are in agreement with those reported by **Matter (2019)** in the dromedary camels. **Zeidan *et al*. (2001)** found also that the highest value of the percentage of dead camel spermatozoa was recorded of the camels at 10 to 20 years and the lowest value was recorded at over 5 to 10 years of age. Similarly, **Ahmadi (2001)** showed that, the highest value of the percentage of dead camel spermatozoa was recorded at 12 to 20 years and the lowest value was recorded at 6 to 11years of age. These results may be attributed to 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**).

Percentage of Abnormal spermatozoa%

The percentage of abnormal camel spermatozoa showed significantly effects (P<0.05). The highest (P<0.05) value of the percentage of abnormal spermatozoa was recorded during non- rutting season, while the lowest (P<0.05) value was recorded during the rutting season (Table 3).

Ahmadi (2001) and **Zeidan *et al*. (2001)** found that the percentage of abnormal camel spermatozoa was significantly (P<0.01) higher during spring, summer and autumn than winter season. Similar trend was reported by **Abd El-Azim (1996), Zeidan** and **Abbas (2004)** and **El-Mahdy (2019)** in the dromedary camels.

In respect to age, the effect of ages on the percentage of abnormal camel spermatozoa of the dromedary camels (Table 3) was significantly (P<0.05). The highest (P<0.05) value of abnormal spermatozoa was recorded with the camel at <4-8 years and < 8-12 years of age. In this work, the percentage of abnormal camel spermatozoa was increased with the advanced age. These results are in agreement with those reported by **Abd El-Salaam (2011)** who found that the lowest (P<0.05) value of abnormal spermatozoa was recorded in the male camels at 10-15 or 15-20 years than 10-15 years old. **Zeidan (1999)** found that the lowest value of the percentage of abnormal camel spermatozoa was recorded of the dromedary camels at over 5 to 10 years of age. Similarly, **Ahmadi (2001)** showed also that, the lowest value of the percentage of abnormal camel spermatozoa was recorded of 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. These results may be due to the decrease of testosterone hormone produced by aged male camels. Similar trend was found by **Ibrahim *et al*. (2016)** who reported that testicular degeneration increased by 10.9- 15.0% in the camels at 4 to 15 years to 25% at 5 to 20 years of age and to 50% in senile (over 20 years) camels, consequently, sperm production rates was decline by 32.2 to 92.4%.

Percentage of Acrosome damage %

The percentage of acrosome damage of the dromedary camels spermatozoa was significantly (P < 0.05) (summer). The highest (P<0.05) value of the percentage of acrosome damage was recorded during non- rutting season, while the lowest (P < 0.05) value was recorded during the rutting (spring, winter autumn) season (Table 3). These results may be attributed to the onset of the rut which is marked by increase during activity of Alpha and Beta secreting cells in the anterior pituitary and increase in Leydig cells active in the rut season with a resulting reduction

in steriodogenic activity by the testes and high testosterone levels which due to improvement of spermatogenesis and decrease of acrosome damage of spermatozoa (**Zeidan *et al*., 2001**). Howover, **Abd El-Samee *et al*. (2006)** and **Ahmadi (2020)** found that the percentage of acrosome damage of the camel spermatozoa was significantly (P< 0.01) higher during spring, summer and autumn than winter season. Similar trends were recorded by **El-Mahdy (2019)** and **Matter (2019)** in the male dromedary camels. **Ibrahim *et al*. (2016)** reported also that morphological abnormal acrosome of the camels spermatozoa during the rutting season were significantly (P<0.05) lower than non- rutting season.

In respect to age, the percentage of acrosome damage of the dromedary camels (Table 3) spermatozoa was significantly (P<0.05). The highest (P<0.05) value of the percentage of acrosome damage of spermatozoa was recorded of the male camel at <12-16 years, while the lowest (P<0.05) value was recorded at <4-8 years and <8-12 years of age. In this work, the percentage of acrosome damage was increased with the advanced age. **Ahmadi (2001)** found that the lowest value of the percentage of acrosome damage of the camel spermatozoa was recorded in the male dromedary camels at 6 to 11 years and the highest value was recorded at 3 to5 years of age, similar to that recorded by **Ahmadi (2020)** in the dromedary camels. These results are in agreement with those of **Abd El-Salaam (2011)** who found that the lowest (P<0.05) value of acrosome damage of spermatozoa was recorded of the camels at 5-10 years old and the highest value was recorded at 10-15 or 15- 20 years than 10-15 years old. **Zeidan (1999)** found also that the lowest value of acrosome damage of the spermatozoa was recorded of the camel at over 5 to 10 years and the highest value was recorded of the camels at 2.5 to 5 years of age.

Percentage of chromatin damage%

The percentage of chromatin damage of the male camels spermatozoa (Table 3) was significantly (P<0.05) higher during non-rutting than the rutting season with the camels at different ages specially at <4-8, <8-12 and <12-16 years of age. The percentage of chromatin damage of the male camel (Table 3). Similar trend was recorded by **El-Mahdy (2019)** and **Ahmadi (2020)** in the male dromedary camels.

With regard to age, the percentages of chromatin damage of the male camel spermatozoa was significantly (P<0.05) increased at < 8-12 and <12-16 years of age in both the rutting or non-rutting seasons (Table 3). Similarly, the percentages of chromatin damage of the camel spermatozoa showed significantly (P<0.05) decrease in the camels at <4-8 years of age either the rutting or non- rutting seasons.

Sperm- cell concentration (x 10^6/ml)

The sperm- cell concentration of the dromedary male camels was significantly (P<0.05). The highest (P<0.05) value of sperm- cell concentration (x 10^6/ml) was accorded during the rutting during the rutting season, while, the lowest (P<0.05) value was recorded during non- rutting season (Table 3). There was highly significantly differences (P<0.01) in the testicular sperm reserve (concentration) between the rutting and-non- rutting (9.90×10^9) seasons.

Ali *et al* (2014) noted that the concentration of the camel sperm was significantly (P<0.01) increased with the age progress in both seasons. However, the mean of the sperm- sell concentration in the cold season either the rutting or non-rutting season showed significantly (P <0.01) higher than those in moderate hot season in animals at 2-3 years old and camels over 4 years old. **Abd El-Raouf (1994)**, **Abd El-Azim (1996), Zeidan** and **Abbas (2004)** and **Abd El-Samee *et al*. (2006)** found that decreased significantly (P< 0.05) in sperm-sell concentration during non-rutting than the rutting season in the dromedary camels. The low sperm- cell concentration of the camel semen during non- rutting season may be attributed to the long day length, as well as, heat stress which lead to reduction in the interstitial cells stimulating hormones, consequently, reduction in androgen production (**Sinha and Prased, 1993**). In addition, the increase of sperm-cell concentration during the rutting season may be expected and parallel with the results obtained by **Fat-Halla** and **Ismail (1980)** who found that FSH hormone concentration in the male camels was the higher during the rutting season. A positive relationship between FSH level and spermatogenesis was reported by **Franchimont**

(1972). Moreover, the sperm- cell concentration in semen is affected by multitude factors such as virility of the males, frequencly of services, season of the year and the intensity of sexual excitement. Some these factors might have been responsible for the disparity in the findings of this investigation and those of other workers (**Agarwal *et al*., 2004**).

The effect of ages on the sperm-cell concentration (x 10^6/ml) of the dromedary camels (Table 3) was significantly (P<0.01). The highest (P<0.01) value of sperm - cell concentration (x 10^6/ml) was recorded the camel at <4-8 and 8-12 of age, while, the lowest value (P<0.01) was recorded at <12-16 years of age. Similarly, **Abd El-Salaam (2011)** found that the highest (P<0.01) value of sperm-cell concentration was recorded of the male camels at 5 to 10 years and the lowest value (P<0.01) was recorded at 15 to 20 years of age. Similarly, **Zeidan (1999), Ahmadi (2001)** and **Zeidan *et al*. (2001)** reported that, the highest value of sperm-cell concentration of the dromedary camels semen was recorded at over 5 to 10 years and the lowest value was recorded at 2.5 to 5 years of age.

Generally, variation in the reproductive traits are caused by physiological changes such as body development and release of sexual hormones and environmental conditions such as daylength, ambient temperature, relative humidity, availability of feed and nutritional condition. Usually there is a time log between these causes and their effects on the reproductive traits.

In conclusion, an overall improvements of the testicular measurements, progressive sperm motility, acrosome damage and chromatin integrity were recorded of the camels at <4 to 8 years of age during the rutting season compared with the camels at < 8 to 12 or < 12 to 16 years of age at non- rutting season.

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القياسات الخصوية وصفات السائل المنوي في ذكور الأبل المغربية ذات الأعمار المختلفة خلال موسمي النشاط والخمول الجنسي

دعـاء سرحـان - احمد دعــادر - عبد الحليم الدروانى – عـلاء زيــدان

1- قسم الانتاج الحيوانى، كلية الزراعة، جامعة الزقازيق، مصر

2- معهد بحوث الانتاج الحيوانى، مركز البحوث الزراعية، الدقى، الجيزة ، مصر

تهدف الدراسة إلى معرفة تأثير الأعمار المختلفة (< 4-8 ، < 8-12 و <12-16 سنة) خلال موسمي النشاط والخمول الجنسي على القياسات الخصوية، وصفات السائل المنوي في ذكور الجمال المغربية. أوضحت النتائج أن هناك زيادة بدرجة معنوية (على مستوى $P<0.05$) في وزن الخصية وحجم الخصية وملمس محيط الخصية وذلك في الجمال المغربية عند عمر < 8-12 سنة وذلك خلال موسم النشاط الجنسي مقارنة بموسم الخمول الجنسي وخاصة عند عمر < 4-8 و <12-16 سنة في حين كان هناك زيادة بدرجة غير معنوية في ملمس كيس الصفن وذلك خلال موسم النشاط الجنسي مقارنة بموسم الخمول الجنسي وخاصة في الجمال عند عمر < 4-8 أو عند عمر <12-16 سنة، كان لون السائل المنوي أبيض كريمي، وأبيض كريمى وأبيض بلون اللبن وذلك خلال موسم النشاط الجنسي، بينما كان لونه أبيض كريمي وأبيض مائي وأبيض مائي خفيف وذلك خلال موسم الخمول الجنسي. بالمثل كانت درجة حموضة السائل المنوي (pH) غير معنوية سواء في موسم النشاط أو الخمول الجنسي وذلك في ذكور الجمال المغربية في الأعمار المختلفة. كان هناك زيادة بدرجة معنوية (على مستوى $P<0.05$) في حجم السائل المنوي والنسبة المئوية لحركة الحيوانات المنوية وتركيز الحيوانات المنوية ($x10^6/ml$) وذلك في ذكور الجمال المغربية عند عمر < 4 – 8 سنة أو < 8 – 12 سنة عن الجمال عند عمر <12-16 سنة سواء في موسم النشاط أو الخمول الجنسي، بينما كان هناك زيادة معنوية (على مستوى $P<0.05$) في النسبة المئوية للحيوانات المنوية الميتة، الحيوانات المنوية الشاذة وشذوذ الأكروسوم وشذوذ الكروماتين في ذكور الإبل المغربية خاصة عند عمر < 12 – 16 سنة سواء في موسم النشاط أو الخمول الجنسي خاصة عند عمر < 4-8 سنة وكذلك عند عمر < 8 - 12 سنة. نستنتج من ذلك أن هناك تحسن في القياسات الخصوية وصفات السائل المنوي في ذكور الجمال خاصة عند عمر < 4 – 8 سنة أو عند عمر < 8 – 12 سنة خلال موسم النشاط الجنسي مقارنة بالجمال عند عمر < 12 – 16 سنة من العمر خلال موسم الخمول الجنسي.

الكلمات الإسترشادية: الجمال، الموسم، العمر، قياسات الخصية، صفات السائل المنوي.

المحكمـــون:

1- أ.د. حسن محمود الكيلاوى أستاذ فسيولوجيا الحيوان- كلية التكنولوجيا والتنمية- جامعة الزقازيق.

2- أ.د. خالد محمد المراكبـــي أستاذ فسيولوجيا الحيوان- كلية الزراعة- جامعة الزقازيق.