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Testicular Morphology and Stereological Evaluation of the Seminiferous Tubules Around the Rutting Season of Sahraoui Dromedary Camel

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Abstract: A total of 62 adult apparently healthy male camels reared in arid climatic conditions of the south eastern region of Algeria were used to study the morphology and histomorphometry of their testis during three different seasons (rutting: Nov-Feb, post-rutting: Mar-Jun and non-rutting: Jull-Oct). Significant high values of scrotal circumference, paired testicular weight and paired testicular volume were recorded during the rutting season. At this period, the outer and the inner diameters of the seminiferous tubules (ST) were significantly higher accompanied by dense and high seminiferous epithelium (56.42±14.52 µm) that occupied 85.50±8.45% of the ST surface. This high seasonal activity was also characterized by increased volume of ST (VST) and ratios of seminiferous tubules to interstitial area and volume (ST/IT, VST/VIT respectively). The average diameter of the Sertoli cell nuclei was significantly high during the rutting and post-rutting seasons indicates high activity of these cells compared with the non rutting season ($P<0.001$). The true number of Sertoli cells per paired testis was not influenced by the season. The spermatogenic activity showed a continuous process through the year, however, high level of cell proliferation were observed during the rutting and post-rutting seasons marked by high ratio of germ cells to Sertoli cells ($P<0.001$). Even so, the average percentage of ST containing spermatids and/or spermatozoa and the average number of spermatozoa per seminiferous tubule were higher in the rutting season (86% and 10.76 ± 9.34, $P<0.05$, $P<0.001$ respectively) compared to the rest of the year. Finally, high sperm reserves were observed in all epididymal segments during the rutting season. These results provide information on the relationship between seasonal changes of camel testicular morphology and the histomorphometry of the testicular exocrine compartment represented by the seminiferous tubules.

Key words: Camel · Epididymis · Seminiferous Tubules · Sertoli Cells

INTRODUCTION

The *dromedarius* camels are regarded as seasonal breeders. Sexually mature camels show a short annual rutting season which is an important factor for low reproductive performance and is considered a major obstacle in their population growth [1]. The environmental factors as well as the neuroendocrine mechanisms underlying seasonality in camel rutting were suspected. So, the rutting season of camels varies geographically, since the environmental factors affect temporally the pattern of reproduction in this species [2-4]. The impression gained is that the onset of rutting season during longer nights and shorter days usually reported for camels [5] can partially be explained by the correlate and significant increasing levels of melatonin and FSH stimulating mating during the rutting season [6] but it is obvious that, in dromedary camels near the equator factors such as rainfall, nutrition and management, may override the effect of photoperiod and allow rutting to occur throughout the year [7].

Compared with other classes of vertebrates, seasonal changes in camel gonads have been studied in far less detail. The sperm production, both in sound numbers and in functional status, is affected by the integrity of the seminiferous tubules and the epididymis. In this regard,

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sperm are first produced in the seminiferous tubules, subjected to maturation in the epididymis and finally stored under a quiescent state in the cauda region of that organ.

The Sertoli cell is the only somatic cell present in the seminiferous tubules and it provides morphological, nutritional and hormonal support for the germ cells [8]. It is believed that each Sertoli cell can support only a limited number of spermatids [9]. In addition, the number of Sertoli cells has been shown to account for a significant proportion of the variability in daily sperm production and testis mass [9]. So, efficiency of reproduction is highly correlated with density of seminiferous tubules, number of sertoli cell per gram of testis and the duration of the spermatogenic cycle [10] and can be accurately determined from the total number of sertoli cell and testis size [11].

No data available about the seasonal changes in the testicular spermatogenetic activity of Algerian camels. Therefore, the aim of the study was to investigate the testicular morphology and the histomorphometric changes of the exocrine compartment around the rutting season in Sahraoui camel breed.

MATERIALS AND METHODS

Description of the Study Area: The experiment was conducted at El Oued locality situated in south eastern of Algeria, lies between Lat: 33°5' and Lon: 6°11'. The area is characterized by arid climate with an average altitude of 63 m above sea level. Meteorological parameters as total rainfall, relative humidity, maximal, minimal and mean daily temperature were recorded monthly (Fig. 1). The relief of this region is composed of the great eastern erg which is a real sea of sand dunes, the Hamada is a tray vast and stony lands, the valleys fairly prospered and few depressions called the zone of the chotts.

Experimental Animals and Samples Collection: This investigation was carried out for three different rutting seasons named rutting season (R) from November to February, post-rutting (PR) season from March to Jun and non-rutting (NR) season from July to October. 62 slaughtered one-humped male Sahraoui camels aged 4-13 years were used for this study. They spread over the three seasons (R=20, PR=18 and NR=24). All animals had clinically normal reproductive organs and reared in semi-extensive system at El Oued region. After slaughter paired testes and epididymis were collected and dissected from the surrounding tissues then fixed in 10% formaldehyde for histological analysis.

Testicular Dimensions: Three testicular measurements were retained for each camel as the most variable biometric parameters in relation to the season [12]. The scrotal circumference in cm (SC) was measured in standing position [13, 14]. The paired testes weight (PTW) to the nearest 0.01 g and paired testes volume in cm^3 (PTV) were calculated Ex-situ respectively by digital scale and using the equation for ellipsoid volume: 4/3 π TL*TW*TT; TL.TW.TT = Testicular Length, Testicular Width and Testicular Thickness as axes of ellipsoid [12].

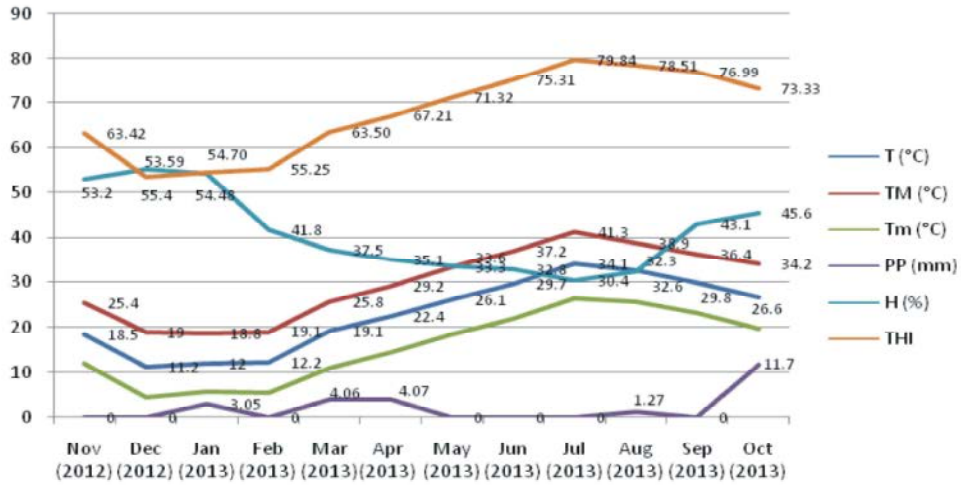

Fig. 1: Average monthly climatological parameters (Guemmar station 2014) T: Average Temperature (°C), TM: Maximum temperature (°C), Tm: Minimum temperature (°C), PP: Total rainfall (mm), H: Average relative humidity (%), Temperature-humidity index (THI).

Table 1: Descriptive statistics of exocrine compartment histomorphometric characteristics studied in different rutting seasons on male dromedary camels

Seminiferous tubules parameters			
STD (µm)	Calibrated ocular micrometer [47]	Seminiferous tubule diameter = C/π; C: external ST perimeter	30 cross sections of ST per testes (5 µm), objective (x40)
STLD (µm)	Calibrated ocular micrometer[47]	Seminiferous tubule lumen diameter (internal diameter)= r = c/π; c: internal ST perimeter	30 cross sections of ST per testes (5 µm), objective (x40)
STEH (µm)	Calibrated ocular micrometer [47]	Seminiferous tubule epithelium high (thickness)	30 cross sections of ST per testes (5 µm), objective (x100)
LST (%), SE (%)	Semi-Sedimented Sigmentation [54, 55]	The seminiferous tubules sections area occupied by lumen (LST) and the seminiferous epithelium (SE)	25 cross sections of ST per testes (5 µm), objective (x40)
SrtNu (µm)	Calibrated ocular micrometer [47]	Diameter of Sertoli cell nuclei	10 cross sections of ST per testis (5 µm), objective (x100)
Vst (µm^3), Vst (10TS)	Moura and Erickson [48]	Volume occupied by seminiferous tubule= π ×h × (STD2/4); h was the section thickness (5µm); Vst (10TS) is the volume occupied by ten seminiferous tubule cross-sections	30 cross sections of ST per testes (5 µm), objective (x40)
VST (cm3, %)	Point grid counting method [49]	Total volume per testis (cm^3) of ST = (ST points/Total points) x TV, it's respective % was also calculated	An average of 600 points per animal Counted taken at random within a cross-section (5µm) of a testis.
Cellular enumeration, tubular fertility index and Sertoli cells count			
Spg, ScyI, ScyII, Std, Spz and Srt	Cellular enumeration	Cells manual counter. Spg: spermatogonia, ScyI, II: spermatocyte 1st and 2nd order, Std: spermatid, Spz: Spermatozoid and Srt: Sertoli cell	10 cross sections of ST per testis (5 µm), objective (x40)
Srt/T(CN)	Erickson and Blend [50]	Crude number of Sertoli cells per testis = (V x $VST_{\%}$ x C)/(Vst x 10), C is the true number of Sertoli cells counted in ten cross-sections.	
Srt/T(TN)	Abercrombie [51] and Berndtson and Jones [52]	True number of Sertoli cells per testis = (crude number x section thickness)/ (section thickness + average nuclear diameter).	
Tubular fertility index	Franca and Russell, [53]	The ratio of germ cells to Sertoli cells. Percentages of the seminiferous tubules containing: Std and/or Stz (%)	10 cross sections of ST per testis (5 µm),
Ratio seminiferous tubules to interstitial tissue			
ST/IT	Semi-Sedimented Sigmentation [54, 55]	The ratio of the spaces occupied by the seminiferous tubules	10 testicular sections (5µm) per animal, objective (x10)
VST/VIT	Point grid counting	The ratio of the volumes occupied by the seminiferous tubules	10 testicular sections (5µm) per animal, objective (x10)
4) Epididymal (Caput, corpus and cauda) parameters			
ESR (%)	Semi-Sedimented Sigmentation	Filling state of 3 segments of epididymis (Epididymal sperm reserve in the caput, corpus and cauda)	10 cross sections of epididymis (5 µm), objective (x40)

Tissue Processing and Quantitative Testicular Histology: Pieces of tissue from the proximal, mid and distal portions of the testes were obtained and fixed immediately in 10% formaldehyde solution for 10-15 days. Tissue specimens were dehydrated in graded ethyl alcohol (65%, 75% and 95%) then cleared in xylene and embedded in paraffin wax (Automate circulation system LEICA TP1020 and inclusion station LIECA EG1160). Sections of 5µm thicknesses were cut (LEICA RM 2235) and stained with haematoxylin and eosin (H & E). All testes sections were examined using binocular microscope Optika B-600B equipped with a digital camera HiROCAM (5MP) and fitted with a micrometer eyepiece at x10, x40 and x100 magnification. Two processing softwares were used for quantitative histomorphometric study: Axovison Rel 4.6 (Carl Zeiss, Thornwood, NY) and Image J 1.45S (NIH, USA). Four techniques were retained for the stereological descriptions (Table 1): Micrometric length Measurements, Semi Sedimented Sigementation method, Grid Point Counting method and Cell Enumeration [15-17].

Statistical Analysis: One-way analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) were performed using Statistica software (V.7.0.61.0) to analyze the seasonal changes of the morphometric parameters. Data are presented as M±SD and significance was attributed if P<0.05, P<0.01 and P<0.001.

RESULTS

Seasonal Changes of Testicular Measurements: The average results of the seasonal testicular measurements were summarized in Table 2. The testicular weight and volume were maintained without significant variations between rutting and post-rutting seasons, however, testicular circumference dropped significantly between these two seasons (P <0.001). The lowest values of these three parameters were showed during the hot season, Which corresponded to the non rutting season (P<0.05).

Seasonal Changes of the Seminiferous Tubules: Table 3 showed seasonal variations of histomorphometric parameters in relation to the activity of the exocrine compartment (Seminiferous tubules). The outer (STD) and inner (STLD) diameters of the seminiferous tubules were significantly higher in rutting and post rutting seasons than in non-rutting season (P <0.01). The increased proliferation of the seminiferous epithelium during the rutting season showed a high cellular fraction (SE) that occupied 85.50±8.45% of ST section and a high thickness of germ cells layers (STEH) (56.42±14.52 µm). These results were significantly increased than those recorded in post-rutting and non-rutting seasons.

The seminiferous tubules volume (VST) and area (ST) occupied large proportions in the testes at the rutting and post rutting periods (P> 0.05) and showed a significant decrease in the non-rut season (P<0.001 and P<0.05, respectively) (Table 4). This histological change affected the ratios of seminiferous tubules to interstitial area and volume (ST/IT, VST/VIT) which were increased during the rutting season and decreased significantly in post-rutting and non-rutting periods.

Seasonal Changes of the Sertoli Cells: The average of the seasonal Sertoli cells numbers per testis were shown in Table 5. The average number of Sertoli cells per ten ST sections ($Srt_{(10ST)}$), the average nuclear diameter (Srt_{Nu})

Table 2: Mean±S.D. of scrotal circumference, pared testicular weight and paired testicular volume in male dromedary around rutting season

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
SC (cm)	31.20±2.08	26.03±3.06	22.12±4.03	***	***	*	***
PTW (g)	190.53±41.96	202.65±135.37	110.58±70.92	NS	**	*	*
PTV (cm^3)	169.63±63.83	130.52±73.02	62.39±40.69	NS	***	*	***

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

SC: scrotal circumference, PTW: paired testes weight, PTV: paired testes volume, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant.

Table 3: Mean±SEM of seminiferous tubules morphometric changes in the testis of dromedary camel around rutting season

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
STD (µm)	252.34±156.55	240.69±190.2	193.41±146.15	NS	**	**	**
STLD (µm)	121.30±119.23	129.16±131.9	91.20±66.68	NS	**	**	*
STEH (µm)	56.42±14.52	43.73±9.3	39.42±15.06	**	***	**	***
SE (%)	85.50±8.45	77.57±13.6	81.83±9.39	***	**	**	*
LST (%)	14.50±8.45	22.43±13.6	18.17±9.39	***	**	**	*

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

STD: seminiferous tubule diameter, STLD: Seminiferous tubule lumen diameter, STEH: Seminiferous tubule's epithelium high, *SE:* seminiferous epithelium area, LST: lumen area, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant

Table 4: Mean±S.D. of Seminiferous tubules area and volume per testis of male dromedary around rutting

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
VST (cm^3)	65.71±34.02	67.24±35.61	27.19±19.49	NS	***	***	***
ST (%)	48.61±14.63	42.23±14.55	35.40±10.54	NS	*	NS	*
VST/VIT	0.61±0.21	1,009±0.55	1.12±0.55	*	***	**	**
ST/IT	0.58±0.73	0,83±0.49	1.34±0.28	*	**	*	*

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

VST: Seminiferous tubules volume, ST: Seminiferous tubules area, VST/VIT: ratio of volume occupied by seminiferous tubules to interstitial tissue, ST/IT: ratio of area occupied by seminiferous tubules to interstitial tissue, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant

Table 5: Mean±S.D. of Sertoli cells number per testis of male dromedary around rutting season

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
$Srt_{(10\ ST)}$	282.60±48.97	237.67±52.48	173.70±67.62	***	***	***	***
Srt_{Nu} (µm)	11.22±2.77	11.14±2.76	7.05±1.57	NS	***	***	***
$Vst_{(10TS)}$ ($10^3 \mu m^3$)	4252.63±3437.7	3016.25±2208.5	2374.07±2170.6	**	***	*	***
$Srt/T_{(CN)}$ (10^9)	89.77±45.77	80.67±53.77	60.38±68.13	NS	**	*	**
$Srt/T_{(TN)}$ (10^9)	28.26±15.13	25.82±18.58	25.55±29.29	NS	NS	NS	NS

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

$Srt_{(10\ ST)}$: Sertoli cells number per ten ST, Srt_{Nu}: Sertoli cell diameter, $Vst_{(10TS)}$; Volume of ten seminiferous tubules, $Srt/T_{(CN)}$: Crude number of Sertoli cells per testis, $Srt/T_{(TN)}$: True number of Sertoli cells per testis, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant

Table 6: Mean±S.D. of number of different cell types and tubular fertility indexes of male dromedary around rutting season

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
Sg	67.19±32.82	73.14±32.10	39.83±31.31	NS	***	***	***
Scy I	61.38±21.96	52.96±26.69	28.21±27.01	NS	***	***	***
Scy II	118.67±55.22	133.02±76.34	31.75±46.79	NS	***	***	***
Std	36.10±26.04	26.10±32.88	5.49±11.77	NS	***	***	***
Stz	10.76±9.34	2.43±4.81	0.61±2.21	***	***	**	***
Srt	28.67±8.73	21.35±9.31	15.51±9.31	**	***	***	***
Percentages of the ST containing: Std and Stz (%)	86	63	35	*	***	**	**
The ratio of germ cells to Sertoli cells	10.22±3.11	14.42±6.74	6.46±4.83	***	**	***	***

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

Spg: spermatogonia, ScyI: spermatocyte 1st order, ScyII : spermatocyte 2nd order, Std: spermatid, Spz: Spermatozoid, Srt: Sertoli cell, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant

Table 7: Mean±S.D. of epididymal sperm content of male dromedary around rutting season

Parameters	R (n=20)	PR (n=18)	NR (n=24)	R/PR	R/NR	PR/NR	SL
ESR-cap (%)	20.08±14.76	11.14±6.91	5.66±2.93	*	**	*	*
ESR-cop (%)	41.55±15.91	36.64±21.74	19, 55±15.41	*	***	***	***
ESR-cad (%)	58.77±29.3	48.21±11.62	15.12±9.07	NS	***	***	***

Differences amongst various groups were significant at 5% (*), 1% (**) and 0.1% (***) levels,

ESR-cap: caput epididymal sperm reserve, ESC-cop: corpus epididymal sperm reserve, ESC-cad: cauda epididymal sperm reserve, SL: Significant level, R: Rut, PR: Post Rut, NR: Non Rut, NS: no significant

and the volume of ten seminiferous tubules ($Vst_{(10TS)}$) were significantly influenced by season ($P<0.05$, $P<0.01$, $P<0.001$), however the true number of Sertoli cells ($Srt/T_{(TN)}$) did not showed seasonal variation ($P>0.05$). The $Srt_{(10\ ST)}$ was noticed during the rutting season ($P<0.001$). The Srt_{Nu} was high during the rutting and post-rutting seasons ($P> 0.05$) which indicated the high activity of these cells during this period in contrast to the non rutting season, when the Srt_{Nu} decreased significantly ($P <0.001$).

Germ Cells Enumeration and Tubular Fertility Index: Table (6) showed the seasonal average number of germ and somatic cells per ST and the tubular fertility indexes. The spermatogenic activity was a continuous process throughout the year and was remarkably striking during the cold moths. The total number of germ cells (spermatogonia Sg to spermatid Std) per ST was high in the rutting season and didn't changed significantly in the post-rutting season ($P>0.05$). However, the highest average number of spermatozoa (Stz) per seminiferous tubule was recorded during the rutting season (10.76±9.34). Therefore, the average percentage of ST containing Std and/or Stz was high in the rutting season (86%) and decreased significantly and progressively until the non-rutting season (35%).

Seasonal Changes of Epididymal Sperm Felling: The seasonal effects in the epididymal sperm reserves in caput (ESR-cap), corpus (ESR-cop) and cauda (ESR-cad) were shown in Table (7). The high level of epididymal filling was recorded in the rutting season. Indeed, the ESR-cap and ESR-cop were gradually decreased between the rutting and post-rutting seasons ($P<0.05$), but remained

high in these two seasons for the ESR-cad. During the non rutting season, acute and very significant decline was noted for the ESR-cop, ESR-cad ($P<0.001$) and ESR-cap ($P<0.05$).

DISCUSSION

A number of reports have appeared on the environmental factors affecting the temporal pattern of testicular biometric and testicular histomorphometric characteristics of animals including the camel [18-21]. Data fromour study explain the changes of testicular morphology and the histomorphometry of the exocrine compartment in relation to the rutting season of Sahraoui dromedary camel.

The SC, PTW and PTV are the most sensitive parameters to the effect the interaction between the age and the rutting seasons in camels as it was found in previous study [12]. In the present study, pubertal camels had significant high values of SC, PTW and PTV during the rutting season (Winter). These results were somewhat similar to those obtained in previous studies [19, 21-23]. However, Ismail [24] reported that testis weight of the camel in Egypt was highest in the summer months and lowest in winter months. The low testis measurements during the non rutting season (Summer) may be due to exposure to heat stress which due to degeneration in the germinal epithelium and to a partial atrophy in the seminiferous tubules [25]. The obtained morphometric observations were associated to patterns of change in ST diameters, volume percentage of testis occupied by ST, the STV/ITV ratio, the number of different cells of the exocrine compartment and the level of epididymal sperm reserve. The outer and inner diameters of the seminiferous tubules were significantly higher in the rutting season than in non-rutting season ($P<0.01$). Similar findings were reported by Volcani [26] and Abdel Raouf *et al.* [27]. However our results appeared contradictory to those recorded by Tingari *et al.* [18], Pasha *et al*. [19] and Abd-Elaziz *et al*. [20] who observed that the average diameter of seminiferous tubules tended to become smaller during the rutting season in the period of cooler months (November to March) compared to the non-rutting season during the summer months (May to September). Moreover, our results were in agreement with other species like male goat [28] Arabian rams [29] Jungle crows [30] and mice [31].

One reason of low sperm production rates in camel testes compared with other farm animals may be due to lower contribution of the seminiferous tubules in the parenchymal weight due to the abundant interstitium. The VST, ST, VST/VIT and ST/IT were significantly higher during the rutting season compared to non rutting season. These results are in contrast with those reported by Tingari *et al.* [18] and Pasha *et al.* [19] who observed that the ST area remained high in the summer and autumn (Non rutting season) and low during the winter and spring (Rutting season). It is suggested that these parameters are correlated with DTS and their level of spermatogenesis during different seasons.

The crude number of Sertoli cells per paired testis ($Srt/T_{(CN)}$) showed seasonal significant differences, however, the true number of Sertoli cells per paired testis ($Srt/T_{(TN)}$) was not influenced by the rutting season ($P> 0.05$). Our results are in line with some reports in camel species [12, 15, 19, 20, 32] and bucks [33]. According to Foote *et al.* [34], Wing and Christensen [35] and Kerr [36] the number of Sertoli cells per unit length of ST was constant throughout all stages of the cycle of the seminiferous epithelium in several adult mammals.

The spermatogenesis decreased outside the rutting season but did not stop completely. Same observation was reported by Tingari *et al*. [18] and Singh and Bharadwaj [37] in male dromedary camels reared in Arabian Saudia and India climatic conditions. Therefore, different dynamic activity between phases of spermatogenesis was observed. The high and continuous cellular proliferation (Mitosis) and division (Meiosis) were recorded during the winter and spring (Rutting and post-rutting seasons) compared to summer and autumn (Non-rutting seasons) ($P<0.001$). However, the cellular differentiation (Spermiogenesis) was significantly higher during the rutting season than post rutting ($P<0.001$) and non rutting seasons ($P<0.05$). Same observation applied for the ratio of germ cells to Sertoli cells. Recent reports described the seasonal fall in tubular fertility during the non breeding season as moderate or severe degeneration of germinal epithelium and sertoli cells with no evidence of spermatogenesis or disorganization of the seminiferous tubules [38]. In addition, Maha *et al.* [38] and Hemeida *et al*. [39] recorded high number of camels with orchitis and epididymitis, mild, moderate and severe degeneration of testis and epididymis , necrosis and testicular atrophy during the non rutting season compared to the rutting season. Finally, Maha *et al.* [38] noticed that the testicular degeneration was the most frequent testicular pathological alteration during the non- rutting season. The indicated cellular and tissue changes related to testicular measurements in different rutting seasons were confirmed using ultrasound scans

[40-43].

In the current study, rutting season had indicated acute effects on the epididymal filling. Thus, the mass of sperm in light of the three segments decreased gradually between rutting and non-rutting seasons. These results conforms well to earlier reports [18] which showed that a compact mass of spermatozoa occupied almost the entire lumen of the intermediate part of the middle segment of the epididymis from October until March. Similar seasonal activity of the epididymis was recorded by Maha *et al*. [38], Ahmadi [44], Zeidan and Abbas [45] and El-Bahrawy and El Hassanein [46] who indicated that the epididymal sperm quality were significantly higher during breeding than non-breeding seasons.

The histological findings in our study influenced directly the seasonal weight and measurements of the testis. These results might be referred to the photoperiodic changes, feed availability and feed intake as well as, heat stress which lead to vary the androgen production and spermatogenesis process.

CONCLUSION

The testicular biometry and the histological sections of seminiferous tubules in pubertal Sahraoui camels during the rutting season showed high testicular dimensions and normal tissue architecture with high spermatogenic cell layers, high Sertoli cells activity, large volume of ST and high level tubular fertility and epididymal sperm reserves. Whereas those studied during the non rutting season showed severe testicular degenerations with reduction in number of spermatogenic cells, loss of tissue architecture and loss of epididymal sperm reserve associated to the decreased testicular dimensions. Further investigations required to explain the histomorphometric changes of the testicular interstitial compartment and to establish the functional relationships between the two testicular compartments of the male Sahraoui dromedary camels under Algerian arid environmental conditions.

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