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Effect of Season and Age on the Ovarian Size and Activity of One-Humped Camel (*Camelus dromedarius*)

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ABSTRACT : In this project, ovarian size and activity during the peak (November-April) and the low (May-October) breeding seasons in young and adult camels were studied. Ovaries of 92 camels (*Camelus dromedarius*), with clinically normal reproductive tracts, aged 3-15 years and slaughtered at Faisalabad or Lahore abattoirs over a period of 24 months, were collected. Jugular blood was collected from each animal before slaughter; the serum was separated and analyzed for oestradiol concentration. The size (length, width and thickness) and weight of each ovary were measured. Grossly observable Graafian follicles were counted and their diameter was measured using Vernier Calipers. The camels having ovaries presenting follicles more than 5 mm in diameter were taken as having active ovaries. The results showed that ovarian length, width and weight were significantly higher ($p<0.05$) during the peak than the low breeding season. The percentage of active ovaries was also significantly higher ($p<0.01$) during the peak than the low breeding season. However, the effect of season on ovarian thickness was non-significant. Similarly, the ovarian length, width, thickness, weight and activity did not vary significantly between young (3-7 years old) and adult (8-15 years old) animals. Serum oestradiol concentrations were significantly higher ($p<0.05$) during the peak (67.70±1.36 pg/ml) than the low breeding season (15.25±1.54 pg/ml). It was concluded that in Pakistani camels ovarian size and activity were higher during the peak than the low breeding season. However, age of the camel (from 3 to 15 years) had no effect on these parameters. (**Key Words :** Ovarian Size, Activity, Season, Age, Female Camel)

INTRODUCTION

On global basis there are about 19.5 million head of camels and the highest concentration is found in Somalia. In Pakistan, the camel population has shown a gradual increase from 0.4 million in 1955 to 1.2 million in 2004 (Anonymous, 2004). In this country, camels are an integral part of nomadic pastoral operations bearing per capita availability of about 1 camel for 14 inhabitants (Aujla et al., 1998).

Previous studies have shown a distinct seasonal breeding pattern in female camels kept in Egypt (Shalash, 1965; El-Wishy and Ghoneim, 1986), Saudi Arabia (Abdel-Rahim et al., 1994), United Arab Emirates (Abou-Ela, 1994), Morocco (Sghiri and Draincourt, 1999) and Japan (Yahaya et al., 1999). Females kept in these countries show higher breeding activity during winter and spring than summer and autumn seasons. Changes in food supply, mineral supplementation and photoperiod have been suggested to be responsible for not only productive performance but also for seasonal breeding pattern of female camel (Onjoro et al., 2006). From Kenya, Wilson (1984) recorded a continuous breeding pattern in camels which was attributed to better food supply and limited photoperiodic changes during the year in that country. However, such information about camels kept under sub-tropical climate could not be traced in the existing literature. Therefore, this project was planned to study ovarian size and activity during the low and peak breeding seasons in female dromedary camel (*Camelus dromedarius*) kept under sub-tropical climate of Pakistan.

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MATERIALS AND METHODS

Collection of samples

Ovaries of 92 female camels (*Camelus dromedarius*) with clinically normal reproductive tract, aged 3-15 years and slaughtered at Faisalabad and Lahore abattoirs of Pakistan over a period of 24 months were collected. Before slaughter, age of each camel was determined by observing

Figure 1. Reproductive tract of a female dromedary showing large variation in the size of Graafian follicles present on the ovaries.

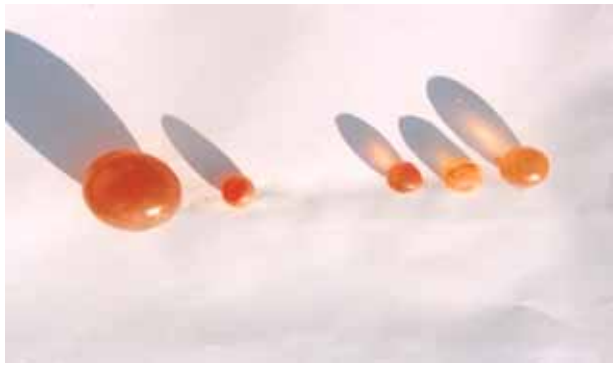

Figure 2. Intact follicles of various sizes removed from the ovaries of female dromedary.

the conformation of teeth and condition of the udder (Schwartz and Doili, 1992). About 15 ml jugular blood was also collected from each animal before slaughter, the serum was separated and stored at -20°C until analyzed for serum oestradiol concentrations. No pre-slaughter information regarding the nutritional or reproductive status of these camels was available.

Ovarian examination

Immediately after collection, ovaries were wrapped in plastic sheets, placed in an ice box and taken to the laboratory within one hour after slaughter. After removing the extraneous tissue, if any, the weight of each ovary was taken in grams. Size of each ovary (length×width× thickness) was measured using Vernier Calipers (Khan, 1985). Grossly observable Graafian follicles were counted and their diameter was measured with the help of Vernier Calipers. The camels having ovaries presenting follicles more than 5 mm in diameter were taken as having active ovaries (Sghiri and Driancourt, 1999) and these follicles were considered as active follicles.

Determination of serum oestradiol concentrations

Serum oestradiol concentrations were determined through Enzyme Immunoassay (EIA) technique, using Estradiol Enzyme Immunoassay test kit (BioCheck, Inc, Catalog Number: BC-1111). The lowest detection limit of the assay was 5.9 pg/ml and the cross reactivity with other steroids was <2.10%.

Statistical analysis

Mean values (±SE) of ovarian length, width, thickness, number of active follicles and serum oestradiol concentrations were computed for two age groups i.e. young (3-7 years) and adult (8-15 years), and for two seasons viz. peak breeding season (November-April) and low breeding season (May-October). The data were subjected to two-way analysis of variance by using General Linear Model of statistics (Forthofer and Lehnen, 1981).

RESULTS AND DISCUSSION

Ovarian shape

The ovary of the dromedary appeared as a reddish or pinkish organ, with a some what circular or oval outline. However, the shape of the ovary was greatly changed due to the presence of Graafian follicles or the corpora lutea. The large follicles or corpora lutea usually projected from the main contour of the ovary and gave the organ an exaggerated lobular form (Figure 1). In such cases, ovaries looked fissured and resembled a bunch of grapes. Well-developed follicles largely projected through the surface of the ovary, except for a very small part of its base, which remained embedded within the ovarian tissue. Thus, by a gentle digital pressure, the intact follicle could be easily removed from the ovary (Figure 2). The follicular wall appeared more vascular than in bovines.

These findings confirm the results of previous studies (Shalash, 1965; Tingari, 1987; El-Wishy, 1988, 1992). According to Shalash (1965) and El-Wishy (1988), the presence of numerous ovisacs on the surface of the camel ovary gave it the appearance of bunch of grapes, while the circular shape of the ovary during pregnancy was subjected to many variations depending on size, position and form of corpus luteum. Higgins (1986) and El-Wishy (1992) stated that the size and shape of the camel ovaries varied with age and with their contents of follicles and corpora lutea. In anoestrus nulliparous females, the ovaries were oval or circular and laterally flattened. The surface of the organ was irregular with many small follicles of 3 to 5 mm diameter. Higgins (1986) also observed that surface of the camel ovary was uneven and showed many small follicles.

Ovarian size

The size of the camel ovaries was measured in terms of length, width, thickness and weight. The overall mean

Table 1. Mean values (±SE) for ovarian length (cm) of female dromedaries of two age groups during the peak and the low breeding seasons

Ovarian side	Age	Peak breeding season	Low breeding season	Mean
Left	Young	4.29±0.18	3.70±0.25	3.99±0.15^{A}
	Adult	4.80±0.24	4.03±0.28	4.41±0.18^{A}
	Overall mean	4.54±0.15^{A}	3.86±0.19^{B}	4.24±0.12
Right	Young	4.15±0.18	3.43±0.25	3.79±0.15^{A}
	Adult	4.25±0.24	4.15±0.28	4.20±0.18^{A}
	Overall mean	4.20±0.15^{A}	3.79±0.18^{A}	4.02±0.12

Values having different superscripts within a row or a column for each side differ significantly ($p<0.01$) from each other.

Table 2. Mean values (±SE) for ovarian width (cm) of female dromedaries of two age groups during the peak and the low breeding seasons

Ovarian side	Age	Peak breeding season	Low breeding season	Mean
Left	Young	3.02±0.15	2.62±0.22	2.82±0.14^{A}
	Adult	3.50±0.21	2.82±0.24	3.16±0.16^{A}
	Overall mean	3.26±0.13^{A}	2.72±0.16^{B}	3.01±0.10
Right	Young	3.06±0.14	2.40±0.19	2.73±0.11^{A}
	Adult	3.27±0.18	2.86±0.21	3.03±0.14^{A}
	Overall mean	3.17±0.11^{A}	2.63±0.14^{B}	2.94±0.09

Values having different superscripts within a row or a column for each side differ significantly ($p<0.01$) from each other.

Table 3. Mean values (±SE) for ovarian thickness (cm) of female dromedaries of two age groups during the peak and the low breeding seasons

Ovarian side	Age	Peak breeding season	Low breeding season	Mean
Left	Young	1.94±0.25	1.89±0.35	1.91±0.21^{A}
	Adult	2.56±0.34	2.43±0.39	2.50±0.26^{A}
	Overall mean	2.25±0.21^{A}	2.16±0.26^{A}	2.15±0.16
Right	Young	1.85±0.24	1.80±0.33	1.82±0.20^{B}
	Adult	2.53±0.31	2.56±0.36	2.54±0.24^{A}
	Overall mean	2.19±0.19^{A}	2.17±0.24^{A}	2.12±0.15

Values having different superscripts within a row or a column for each side differ significantly ($p<0.05$) from each other.

length of the left and the right ovary averaged 4.24±0.12 and 4.02±0.12 cm, respectively (Table 1). The corresponding values of ovarian width were 3.01±0.10 and 2.94±0.09 cm (Table 2), while these values for ovarian thickness were 2.15±0.16 and 2.12±0.15 cm, respectively (Table 3). These values are comparable to those reported earlier. Higgins (1986) observed that the length, width and thickness of camel ovaries were 4.0, 2.5 and 0.5 cm, respectively. Tingari (1987) observed these values as 3.1, 2.25 and 0.8 cm, while according to El-Wishy (1992), these values were 2-3, 2.0-2.5 and 0.5-0.9 cm, respectively. Minor differences in the values for ovarian size of camels observed in the present and the previous studies can be attributed to breed differences. Moreover, age of the animal (El-Wishy, 1992) or the physiological stage of reproductive activity can also influence the size of the camel ovaries.

The overall weight of the left and right ovary averaged 12.60±1.41 and 12.69±2.08 g, respectively (Table 4). El-Wishy (1992) observed the weight of the camel ovaries as 3-4 g which is much lower than that observed in the present study. According to Shalash (1965), the weight of camel ovaries varied with the physiological state of the organ. He observed that weight of the inactive ovaries was 3.66±1.49 g for the right and 3.89±1.63 g for the left and was lower than those bearing follicles (5.51±2.69 g for right and 5.47±2.62 g for left) or those with corpus luteum of pregnancy (7.94±2.50 g for right and 8.51±2.66 g for left ovaries).

Effect of season on ovarian size

The results of the present study also revealed that ovarian length (Table 1), width (Table 2) and weight (Table 4) in the camel were significantly affected by the seasons. In general, the values of these parameters were higher during the peak than the low breeding season for both ovaries, which was anticipated. The camel is said to be a seasonal breeder, with the breeding activity higher during the winter (19.39%) and spring (27.48%) than in summer (6.66%) and autumn (6.88%) seasons (Shalash, 1965). Thus, the ovaries bear more and bigger follicles, or perhaps corpora lutea, during the peak than the low breeding season. This results in higher size and weight of ovaries during the peak than the low breeding season. However, contrary to the left ovary, the length of the right ovary was not affected

Table 4. Mean values (±SE) for ovarian weight (g) of female dromedaries of two age groups during the peak and the low breeding seasons

Ovarian side	Age	Peak breeding season	Low breeding season	Mean
Left	Young	13.51±2.19	8.83±3.06	11.17±1.88^{A}
	Adult	17.89±2.93	7.97±3.34	12.93±2.23^{A}
	Overall mean	15.70±1.83^{A}	8.40±2.28^{B}	12.60±1.41
Right	Young	15.24±3.28	6.50±4.59	10.87±2.82^{A}
	Adult	15.79±4.39	10.04±5.07	12.92±3.35^{A}
	Overall mean	15.52±2.74^{A}	8.27±3.42^{B}	12.69±2.08

Values having different superscripts within a row or a column for each side differ significantly ($p<0.05$) from each other.

Table 5. Mean values (±SE) for number of active follicles in female dromedaries of two age groups during the peak and the low breeding seasons

Ovarian side	Age	Peak breeding season	Low breeding season	Mean
Left	Young	1.49±0.03^{b}	0.55±0.07^{d}	1.02±0.02^{A}
	Adult	1.33±0.06^{c}	1.89±0.09^{a}	1.61±0.03^{A}
	Overall mean	1.41±0.02^{A}	1.22±0.04^{A}	1.32±0.16
Right	Young	1.37±0.03	0.55±0.06	0.96±0.02^{A}
	Adult	1.33±0.05	0.83±0.07	1.08±0.03^{A}
	Overall mean	1.35±0.22^{A}	0.69±0.03^{B}	1.10±0.13

Values having different superscripts within a column or a row for each side differ significantly ($p<0.05$) from each other.
$^{A, B}$ Main effect; $^{a, b, c, d}$ Interaction.

by the season in the present study. The physiological significance of this different seasonal effect on length of right and left ovary remains unclear.

Contrary to the length and width, the ovarian thickness was not affected by the season (Table 3). This seems to be due to position of the follicles or corpora lutea on the organ. According to Tingari (1987), the corpora lutea originate from ruptured follicles which were usually found towards the poles of the ovary, which can result in increased length and perhaps width also, but not thickness of the ovary.

Effect of age on ovarian size

Table 1-4 also show effect of age on the ovarian length, width, thickness and weight, respectively. These parameters, except thickness of the right ovary, were not affected by the age of the animal (3-15 years). This shows that 3-year old camels included in the present study were as mature as those 8-15 years old. Higgins (1986) has stated that female camels reach puberty at two years of age, but they are not mated until they are three years old. However, according to him the average age at maturity in female camel was four years. This discrepancy can be attributed to breed differences between the two studies.

Ovarian activity

In spontaneously ovulator animals (e.g. buffaloes, cows, sheep, goats, mares), a female with corpus luteum on its ovary is considered sexually active (cyclic). However, in the camel, which is an induced ovulator, the corpus luteum is seen only in pregnancy or after an infertile mating (El-Wishy, 1992). In the absence of mating, the mature follicle continues to grow until its regression occurs. Thus, presence of a corpus luteum can not be used to confirm cyclicity in this species. Therefore, as described earlier for camels (Sghiri and Draincourt, 1999), the females with ovaries presenting follicles more than 5 mm in diameter were considered as having active ovaries.

For the left ovary, the effect of season on the number of active follicles was non-significant. However, for the right ovary, mean numbers of active Graafian follicles was significantly ($p<0.05$) higher during the peak than the low breeding season. The difference between the mean numbers of active follicles between young and adult animals for right, as well as left, ovary was statistically non-significant (Table 5).

A significant interaction between the effects of age and season on the number of active follicles was observed for the left ovary only. During peak breeding season, young animals had higher number of active follicles than adult animals. However, reverse was true during the low breeding season (Table 5).

To have a better understanding about the ovarian activity, the data for right and left ovaries were pooled. Among 92 camels, four had plain ovaries without any Graafian follicles, while 18 had follicles of 5 mm or less in diameter and were considered as inactive. The remaining 70 (76.09%) animals had active ovaries bearing follicles >5 mm in diameter.

Among dromedaries examined during the low breeding season, only 45.83% had active ovaries against 86.76% of those examined during the peak breeding season, the difference was significant ($p<0.05$). When the data were analyzed according to age of the animal, 72.72% of young animals examined showed active ovaries versus 81.08% of

Table 6. Mean (±SE) serum estradiol concentrations (pg/ml) in young and adult camels during the low and the peak breeding seasons

Age groups	Peak breeding season	Low breeding season	Mean
Young	70.38±0.54	11.51±0.63	40.95±0.29^{A}
Adult	64.78±0.63	18.98±0.63	41.88±0.31^{A}
Overall mean	67.70±1.36^{A}	15.25±1.54^{B}	41.52±5.44

Values with different superscripts within a row or a column differ significantly ($p<0.01$) from each other.

adult animals, the difference was, however, non-significant. Similarly, serum oestradiol concentrations did not differ significantly between young and adult camels (Table 6). Thus, frequency of females having active ovaries was higher during the peak than the low breeding season. This was also confirmed through serum oestradiol concentrations, which were significantly higher ($p<0.05$) during the peak than the low breeding season (Table 6). However, age of the animal (3-15 years) had no effect on frequency of camels with active ovaries or serum oestradiol concentrations.

Shalash (1965) recorded higher ovarian activity in camels during winter (19.39%) and spring (27.48%) than summer (6.66%) or autumn (6.88%). Chamany and Khazali (1998) observed significantly higher plasma oestradiol-17β concentrations in 4 years old camels during the breeding (64.00±0.15 pg/ml) than non-breeding season (13.4±0.15 pg/ml). According to Sghiri and Draincourt (1999), there were significant seasonal changes ($p<0.05$) in the percentage of camels with active ovaries, since the proportion of such females was 74, 89 and 89 per cent for October-December, January-March and April-May, respectively. However, these workers could not study the ovarian activity for the period from June to September.

The results of the present study indicate that under the sub-tropical conditions of Pakistan, the camels appear to be seasonal breeder, with higher activity during the peak (November-April) than the low (May-October) breeding season. These results agree with a number of previous reports showing a clear breeding season in many countries where clear changes in photoperiod and/or food supply occur throughout the year (Egypt: Shalash, 1965; El-Wishy and Ghoneim, 1986; United Arab Emirates: Abou-Ela, 1994; Saudi Arabia: Abdel-Rahim et al., 1994; Morocco: Sghiri and Draincourt, 1999). However, these results contrast with the continuous breeding pattern of camel reported in countries having better food supply and limited photoperiodic changes during the year e.g. Kenya (Wilson, 1986). Hence, it may be hypothesized that camels may have the potential to breed all year around, but are prevented to do so by environmental cues. This view is supported by the observations that ovarian activity did not cease completely during summer and autumn seasons. Whether photoperiod or food supply is the key factor inducing seasonality in camels remains to be investigated. According to Sghiri and Draincourt (1999), food supply may be more important than day light duration. The complex interactions between photoperiodic and nutritional effects on the reproductive functions of camels warrant further investigation.

These results also showed that age of the animal (3-7 years versus 8-15 years) had no effect on the frequency of females with active ovaries. These results are supported by those of Sghiri and Draincourt (1999), who could not see any effect of age on the frequency of camels with active ovaries. However, these workers observed that during the transition phase from the non-breeding to breeding season, body condition significantly affected the frequency of females with active ovaries ($p<0.05$). Lean females displayed inactive ovaries more frequently than animals in fair body condition and fat females ($p<0.05$). Unfortunately, body condition scores could not be recorded for dromedaries used in the present study.

Based on the findings of the present study it was concluded that in Pakistani camels, ovarian size and activity were higher during the peak than the low breeding season. However, age of the camel from 3 to 15 years had no effect on these parameters.

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