

# Reproductive Performance in Camel (*Camelus dromedarius*)

Aminu Deen

Central Sheep and Wool Research Institute, Avikanagar,  
Malpura, Tonk, Rajasthan, India

Corresponding Author: aminudeen@scientist.com

Paper No. 2: MS Received: 19 May, 2012 MS Accepted: 12 September, 2012

## Abstract

The study was conducted to explore various aspects of reproduction in camels viz. Effect of breed on fertility, effect of repeat services during same estrous period on pregnancy rate, effect of copulation time on fertility in female dromedary camels, early versus late onset of sexual libido in males, male fertility and investigations into mating ability, semen donation efficiency in Artificial Vagina, gross characteristics of semen ejaculate, individual sperm motility examination and morphological evaluation of spermatozoa of sterile male camels. Bikaneri breeds of camels exhibited greater First service and overall conception rate as compared to Jaisalmeri and Kachchi breeds. Infertile females were also lesser in Bikaneri breed than Kachchi and Jaisalmeri. Repeated services during the same estrus period had no beneficial effect on pregnancy rate over single service, when females were selected for follicular phases prior to breeding. Copulation time did not vary significantly between males for single service, however few significant differences between males were observed in multiple services during same estrus period. Copulation time for the breeding resulting into successful or unsuccessful conception did not differed significantly. Late manifestation of sexual libido was observed in males, which was correlated with delayed onset of circulating testosterone rise. The fertility rate of males differed between breeds ranging 40-58, 10-33.3 and 0-100% in

Bikaneri, Jaisalmeri and Kachchi breeds. Sub-fertility in  $\frac{3}{4}$  Jaisalmeri studs and sterility in  $\frac{2}{4}$  Kachchi studs was recorded. Mating ability of sterile males was not lower than fertile males. Gross characteristics and individual sperm motility examinations for one of the two sterile male camels had been perfectly normal, while another sterile male had watery ejaculates with nil individual sperm motility on all occasions except once. Morphology of spermatozoa of sterile male camels had been poor. It is concluded that selection of females for follicular phases prior to mating omit the repeated services during the same estrus period without affecting the pregnancy rates. Late manifestation of sexual libido in males was correlated with late arousal of endocrine surge. Copulation time was not significantly different for successful and unsuccessful conceptions. Significant proportions of male studs were found sub-fertile and sterile.

©2012 New Delhi Publishers. All rights reserved

**Keywords:** First service conception rate, sterile, copulation time, Sperm morphology and motility.

## Introduction

Most often a negative argument against camel breeding is quoted that their

reproduction rate is low and uncertain (Novoa, 1970; Tibary and Anouassi, 1997; Skidmore, 2005 and Yagil, 2006), but scant reports of good fertility rate have also been published (Arthur *et al.*, 1989). Overall calving rates of less than 40% in 30 herds of Tunisia have been reported (Djellouli and Saint-Martin, 1992), while 80-90% calving rates out of mated females in Bedouins herds have been cited (Arthur *et al.*, 1989). Similarly, a total lifetime production of a female camel in Niger averaged 2.7 young only (Payne and Wilson, 1999), while Arthur *et al.* (1989) expressed that a female can yield a total of 12 offsprings. These citations speak of a huge differences in the actual reproductive performance in camel. It may be quite probable that the wide variation in the rate of reproduction is due to certain factors which are not fully known. Tibary and Anouassi, 1997 opined that in a well-nourished herd, management of breeding is the major factor affecting the reproductive performance. Major difficulty faced in management of camel breeding is to determine the optimum time to breed a female due to indistinct sexual behavior. It does not express the symptoms of estrus similar to that of cattle and buffalo to be identified for breeding. More troubling is that the behavior of female camels towards male was not correlated with ovarian follicular status (Skidmore, 2003). Due to these difficulties several workers (Yagil, 2006) recommended to mate the female daily for few days. Another problem confronted by workers

has been a high incidence of embryonic loss for which no clear reason could be assigned till date (Shalash, 1965, Tayeb, 1953 and Niemuller, 2007). Anatomical abnormalities (Shalash and Nawito, 1963) and pathological processes of female genitalia (Tibary and Anouassi, 1997) have also been reported as the main causes of infertility.

Unexplained sub-fertility and infertility in males, lack of libido, inability to ejaculate, sub-standard semen quality, immunologic and genetic causes of infertility (Tibary and Anouassi, 1997) are other major challenges for reproduction in male camels. Skidmore (2005) opined that research improving fertility have been lacking in camel as it is used in less well-developed countries. Merkt *et al.* (1992) reported that much research has concentrated on the anatomy and physiology of reproduction with little emphasis on practical aspects of reproductive performance. Attempts have been made in this study to narrate breedwise differences in fertility, effect of single vs. repeated mating on pregnancy rate, effect of copulation time on pregnancy rate and male factor as infertility in camels.

## Materials and Methods

### Animals

The study was conducted at National Research Centre on Camel, Bikaner on a total of 77 animals (Male (n=12) and Female (n=65)) of 3 breeds viz. Bikaneri (Male (n=4), Female (n=30), Jaisalmeri (Male (n=4), Female (n=17) and

Kachchi (Male (n=4), Female (n=18) camels (*Camelus dromedarius*). It included a heterogeneous group of animals of all age groups after sexual maturity.

### **Recto-Genital Examinations of females**

Through transrectal palpations, females were examined for mature stages of follicles in the ovaries and those possessing follicle were mated with the allotted males of same breed to avoid inbreeding, while those without follicle or with a small follicle were re examined periodically for appropriate stages of ovarian follicle to be bred.

### **Breeding**

The females were randomly assigned either a single or two services at an interval of 72 hours or three services once daily continually for 3 days. Copulation times were recorded for all matings.

### **Pregnancy Examinations**

Pregnancy examinations on day 14-15 after mating were accomplished with tail curling, serum progesterone concentration and transrectal palpation for corpus luteum. Those females, which were detected non-pregnant with tail curling test and serum progesterone concentration measured by RIA on these days, were only examined through transrectal palpations for corpus luteum. The females that failed to conceive were re bred at appropriate follicular phases.

### **Pregnancy rate**

Pregnancy rate for each of three breeds of camels and overall for the herd was derived with number of females that conceived out of total females mated irrespective of the number of services.

### **First service and overall conception rates**

Females conceived with first, second, third, fourth and fifth services were also derived breed wise and as overall for the herd. Infertile females for each breed were identified.

### **Effect of repeated services during same estrus period on pregnancy rate**

Number of females that conceived to single or repeated services during the same estrus period for each breed and overall for the herd was derived.

### **Investigations on Males**

Rutting behavior of males particularly onset of early/late sexual libido in males and its correlation with weekly monitored testosterone profiles was worked out. Fertility for males was derived, sub-fertile and sterile males were identified. A correlation of copulation time in relation to pregnancy was worked out. Mating ability, gross characteristics of semen ejaculate, individual sperm motility, morphology of spermatozoa and testosterone profiles were worked out for sterile male camels to arrive at etiological factor responsible for sterility.

**Results**

Fertility, infertility, first service and overall conception rate(s) of 3 breeds of camels are presented in Table 1, which shows conception rate of 90, 70.6 and 66.7%, respectively, in Bikaneri, Jaisalmeri and Kachchi breeds with herd's overall conception rate of 78.5%. Percentage of infertile females measured 10, 29.4 and 33.3%, respectively in 3 breeds. First service conception rate measured 53.5, 23.3 and 5.5%, respectively in 3 breeds with an overall herd first service conception rate of 32.3%. Fertile females of Bikaneri (n=27), Jaisalmeri (n=12) and Kachchi (n=12) breeds required average number of 1.88, 2.33 and 3.83 services with an overall figure of 2.45 services for all the fertile females (n=51). The fertility rate as well as first service conception rate

was higher and number of services per conception low in Bikaneri as compared to other 2 breeds.

Effect of single versus two services at an interval of 72 hours and 3 services once daily continually for 3 days have been presented in Table 2, which shows that pregnancy rate in Bikaneri, Kachchi and overall for 3 breeds was higher for single services than for 2 and 3 services.

Pregnancy rate of 12 studs, 4 each from 3 breeds have been presented in Table 3, which shows that pregnancy rate varied from 0-58% for different studs. Pregnancy rate of Bikaneri males were higher (40-58%) than Jaisalmeri (10-33.3%) and Kachchi (0-100%). Based on pregnancy results 2/4 Kachchi males were adjudged as sterile while 3/4 Jaisalmeri as sub fertile.

**Table 1:** Pregnancy rate, Percentage of non -pegnant females at the end of season and number of services for conception in different breeds of camels

Breed	No. of Services					
	Single Service		Two Services at 72 hr. interval		Three Services regularly for 3 days	
	No. of Services	No. of conception (Pregnancy rate %)	No. of Services	No. of conception (Pregnancy rate %)	No. of Services	No. of conception (Pregnancy rate %)
Bikaneri	35	17 (48.5)	19	8 (42.1)	7	2 (28.5)
Jaisalmeri	25	5 (20)	16	3 (18.7)	9	3 (33.3)
Kachchi	10	5 (50)	8	2 (25)	11	5 (45.4)
Overall	70	27 (38.5)	43	13 (30.2)	27	10 (37)

**Table 2:** Effect of single versus repeated services on pregnancy rates in female camels

Breed	N*	P**	NP***	Number of pregnant animals conceiving in regards to number of services required for conception				
				1 Service	2 Services	3 Services	4 Services	5 Services
Bikaneri	30	27(90%)	3(10%)	16(53.3%)	5(16.6%)	2(6.6%)	1(3.3%)	3(10.0%)
Jaisalmeri	17	12(70.6%)	5(29.4%)	4(23.5%)	4(23.5%)	1(5.8%)	2(11.7%)	1(5.8%)
Kachchi	18	12(66.7%)	6(33.3%)	1(5.5%)	3(16.6%)	4(22.2%)	2(11.1%)	2(11.1%)
Total	65	51(78.5%)	14(21.5%)	21(32.3%)	12(18.4%)	7(10.7%)	5(7.6%)	6(9.2%)

N\*- Number of animals mated, P\*\*- Number of pregnancies, NP\*\*\*- Number of non-pregnant animals at the end of season

**Table 3:** Pregnancy rate of male camels used for natural breeding

Camel	B-480	B-620	B-622	B-624	J-218	J-228	J-230	J-232	K-116	K-126	K-128	K-166	M-1	M-2
Pregnancy rate (%)	58	42	40	42	33.3	22	16	10	0	51.7	100	0	50	33
Remarks			SF	SF	SF	SF	SF	SF	S		*			S

Copulation time of 6 fertile male camels for single, double and three services have been presented in Table 4, which shows that differences between males for single service were not significant ( $P>0.05$ ). However few significant differences for 2 and 3 services between males were observed. Copulation time in relation to pregnancy has been presented in Table 5, which shows that it did not differ significantly for pregnancy.

Investigations on mating ability of 2 sterile male camels revealed that mating ability measured in terms of copulation time of 2 sterile camels compared with 6 fertile male camels used during the same period and premises and presented in Table 6 shows that copulation time of sterile males was not lower than fertile

males. In fact, copulation time of one of the two sterile was significantly higher ( $P<0.05$ ) than fertile males.

Investigations on gross evaluation of semen artificially collected from sterile males revealed that one particular male had ejaculated semen having absolutely normal gross characteristics while another sterile camel exhibited watery ejaculates. Gross characteristics of semen from 2 males have been depicted in Figures 1 & 2.

Investigations on individual sperm motility examination of one male revealed high percentage of progressively motile spermatozoa, which were viable under refrigeratory preservation, while sperm motility of

**Table 4:** Copulation time in relation to fertility of female camels

Single Service	Pregnant	5.215±0.891 (n=19) <sup>NS</sup>
Single Service	Non-pregnant	4.086±0.310 (n=23) <sup>NS</sup>
Double Services	Pregnant	4.044±0.600 (n=9) <sup>NS</sup>
Double Services	Non-pregnant	6.107±0.906 (n=21) <sup>NS</sup>
Three Services	Pregnant	8.325±1.304 (n=9) <sup>NS</sup>
Three Services	Non-pregnant	5.864±0.487 (n=10) <sup>NS</sup>

**Table 5:** Copulation time (Minutes) for 6 fertile male camels for single, double and triple services.

Camel	Single Service	Two Services	Three Services
B-480	4.33±0.51 (n=10)	5.72±2.90 (n=4)	5.6 (n=1)
B-620	4.96±0.52 (n=8)	3.93±0.75 (n=4)	5.0 (n=1)
B-622	3.83±0.87 (n=7)	2.95±0.50 (n=6)	-
B-624	3.46±0.84 (n=5)	8.07±1.49 (n=4)	4.70±0.92 (n=4)
K-126	5.57±0.64 (n=6)	7.04±1.75 (n=7)	8.58±0.99 (n=10)
J-218	5.43±0.46 (n=6)	5.73±0.87 (n=5)	6.13±0.64 (n=3)

**Table 6:** Copulation time of Fertile, Sterile and Sub-Fertile Camels.

Camel group/Individual identity	Single Service	Double Service
Fertile group	4.598±0.429 (n=42)	5.488±0.659 (n=30)
Sterile camel K-116	9.320±1.273* (n=5)	8.120±1.03* (n=12)
Sterile camel K-166	5.618±0.820 (n=11)	5.850±0.894 (n=8)
Sub-fertile J-228	4.229±0.952 (n=7)	4.600±1.75 (n=2)
Sub-fertile J-230	6.025±1.408 (n=4)	5.4 (n=1)
Sub-fertile J-232	2.933±0.186 (n=3)	4.558±0.704 (n=6)



**Fig. 1:** Semen ejaculate from a sterile male camel appearing grossly normal



**Fig. 2:** Semen ejaculate from a sterile camel appearing watery

another male was nil on all occasions except once, that too viability of sperm did not last longer.

Investigations on morphological assessment of spermatozoa revealed significant abnormal spermatozoa for both the sterile male camels.

Investigations into testosterone profiles revealed significant inter individual differences between animals in testosterone concentration. Average

testosterone profiles of one of the 2 sterile camels, one of the three sub-fertile camels and one of the six fertile male camels had been low than remaining males. The average individual levels of testosterone of fertile, sterile and sub-fertile camels have been presented in Fig. 3, which shows individual biological variation rather than association of testosterone profiles with infertility, sterility or fertility.



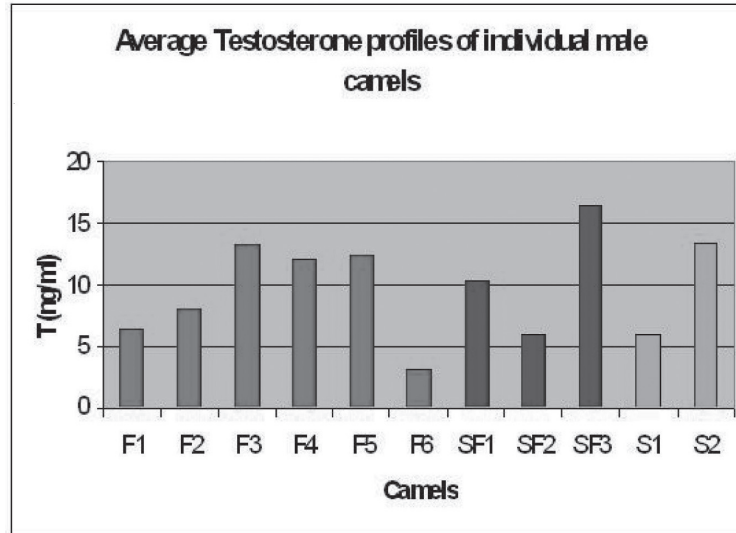


Fig. 3: Average testosterone profiles of Fertile (F1, F2, F3, F4, F5, F6), Sub-fertile (SF1, SF2, SF3) and sterile male camels (S1 and S2)

## Discussion

### Fertility Rate

Fertility rate ranged from 66.7 to 90% in different breeds of camels with an overall figure of 78.5% in this study. Fertility rate was higher in Bikaneri as compared to Jaisalmeri and Kachchi breeds. Khanna *et al.* (1990) also reported conception rates similar (91.9%) to present study in Bikaneri breed. Results of this study are superior to those of overall calving rate of approximately 40% for 30 herds in Tunisia (Djellouli and Saint-Martin (1992) with 4, 2.1, 37 and 6.1% birth rate 2 to 3, 3 to 4, 4 to 5 and 5 to 6 years of age groups and 29-56% to 7-13 years of age, of fertility rates of 50% or less (Keiken, 1976; Yuzlikaev and Akhmedier, 1969), of 31-48% fertility

and 42% fecundity in Niger (Saley, 1990), 0-5%, 2-26%, 8-41% in age groups of 3-4, 4-5 and 5-6 years, respectively, in Sudan (Saint-Martin *et al.*, 1990), of 4.5% in Oman, and 62% reproductive rate and 53.3% fecundity rate in Morocco (Chriqui, 1988; Sghiri, 1988). Abdel-Rahim and El-Nazier (1990) and Abdel-Rahim *et al.* (1994) reported that fertility can be as high as 85% with a parturition rate of 96% in well-managed herds. Tibary and Anouassi, 1997 cited reports (Mutugi *et al.*, 1992; Schwartz, 1989; Schwartz and Walsh, 1990; Schwartz *et al.*, 1982) of Kenyan commercial herds with improved ration or artificial pasture and health programs to obtain birth rate of 55-80% as compared to below 40% in traditional herds. They opined that nutrition and breeding management are



the two important factors to determine fertility rate.

#### **First Service Conception Rate**

First, second, third service and overall conception rate measured 53.3, 70, 76.6 and 90% in Bikaneri, 23.5, 47, 52.9 and 70.5% in Jaisalmeri and 5.5, 27.7, 44.4 and 66.6% in Kachchi breeds, respectively with overall herd first conception rate figures of 32.3, 50.7, 61.5 and 78.4%, respectively. The performance of Bikaneri camels was again superior to those of other 2 breeds. Bakkar and Basmaeil (1988) reported somewhat resembling figures of 38, 64 and 60-66.7% conceptions after first, second and overall services for Najdi camels. Aboul-Ela reported first service conception rate of 58% in United Arab Emirates. Tibary and Anouassi, 1997 opined that first service conception could reach to 72% in herds with close veterinary monitoring. The author also agrees with this opinion based on this study that close monitoring of the events can improve the performance as apparent in low figures of first service conception rate of 5.5 and 23.5% in Kachchi and Jaisalmeri breeds, which could be improved subsequently to 66.6 and 70.5%, respectively, after changing the studs.

#### **Number of services required per conception:**

Fertile females of Bikaneri (n=27), Jaisalmeri (n=12) and Kachchi (n=12) breeds required average number of 1.88, 2.33 and 3.83 services with an overall figure of 2.45 services for all the fertile

females (n=51). Numbers of services required per conception for fertile females to settle were low in Bikaneri than other two breeds. Low fertility in Jaisalmeri and Kachchi breeds can be attributed to sub-fertile and sterile males of these breeds. Khanna *et al.* (1990) reported similar figures of 1.94 services per conception for Bikaneri breed. Aboul-Ela (1984) reported superior results of  $1.63 \pm 0.2$  services per conception in United Arab Emirates. Apparently such an ideal result will be possible with improved management particularly selection of studs for higher fertility, nutrition and health.

#### **Infertility Rate in female camels**

About 10, 29.4 and 33.3% females of Bikaneri, Jaisalmeri and Kachchi breeds failed to settle. Tibary and Anouassi (1997) reported incidences of pathological processes of genitalia ranging from 15-35% in different herds. Improper development of follicles (Barminstev, 1951), anatomical abnormalities of the females (Shalash and Nawito, 1963) and foetal death (Tayeb, 1953 and Shalash, 1965) have been identified as important causes of infertility in female camels.

#### **Effect of Single Versus Repeated services on pregnancy rate**

Repeated services did not improve pregnancy rate over single service to females, which were selected for follicular phase prior to breeding in this study. These results contradict those of previously reported from our institute

(Sahani *et al.*, 2003) to mate the females twice at interval of 72 hrs. These results also contradicts views of Yagil (2006) to mate the female once a day for a few days as it is not certain at what stage of estradiol cycle the female is at the time of mating (Yagil and Van Creveld, 1990 and Skidmore and Billah, 2005). Probable reason of superior results with single service during present study might have been due to ascertaining follicular phase prior to breeding through recto-genital palpation. Previous results reported from our institute were derived from breeding without ascertaining follicular status. One can expect that breeding without ascertaining follicular phases will give poor fertility results than with ascertained follicular phases prior to breeding as done in present study, as estrus behavior in female camels is very vague and difficult to interpret, it does not often relate to follicular development in the ovaries (Skidmore, 2003) and that as much as 45% females presented for breeding had no follicular structures on the ovaries or only follicles smaller than 9-mm (Tibary and Anouassi, 2000). Yagil (2006) also recommended repeated daily services for few days on account of uncertainty to determine the stage of estradiol cycle in the female. Results obtained in this study have shown ascertained follicular phases in females prior to breeding helps in omitting the need of repeated services. This will give a new impetus to camel reproduction scientists, who were repeatedly mating a female camel over few days. Management of breeding using advanced

techniques such as monitoring of follicular activity by ultrasonography resulted in an ovulation rate of 88% and pregnancy rate of 85% following a single mating (Tibary *et al.*, 2005).

### **Copulation Time and its Correlation with conception**

Copulation time ranged from  $2.95 \pm 0.50$  on the lowest side to  $8.58 \pm 0.99$  for all type of service practices for 6 fertile male camels in this study. Copulation time of 6 fertile male camels did not differ significantly between males for matings of single service, while few significant differences between males were observed for double and triple services. Khanna *et al.* (1990) and Skidmore (2004) reported average copulation time of 5 minute 43 seconds and 5.5 minutes with a range of 3-25 minutes, respectively, which resemble to those of present study findings. Figures of 15 minutes reported in FAO Corporate Documentary Repository and 40 minutes by Yagil (2006) appears to be on higher side as an average. It is felt that overall average might vary between 3-10 minutes, higher values might be observed for occasionally used males.

Copulation time for successful and unsuccessful impregnation was not significantly ( $P > 0.05$ ) different. Tibary and Anouassi (1997) have also found that conception was possible even when duration of copulation was less than one minute but suggested that high ovulation and conception rates were attained only if the copulation time is at least 4 minutes.

Late onset of sexual libido in some males: It was observed during present study and consistently over several years that some males manifest sexual libido early in the season while some manifest it slightly later. The onset of sexual libido in present study was found correlated with the endocrine testosterone surge. Skidmore (2004) observed that onset and duration of the rutting was affected by individual male and the method of management, males that were let loose in the in the herd of female tend to come into season earlier and maintained it for a longer period than confined males.

#### **Fertility rate in male camels**

Pregnancy rate of Bikaneri males were higher (40-58%) than Jaisalmeri (10-33.3%) and Kachchi (0-100 %). Not much is published about fertility rate of male camels. Al-Qarawi (2005), while reviewing the causes, relations and implications on infertility in dromedary bulls has mentioned that there are camels that have pregnancy rates of above 60%. Based on pregnancy results 2/4 Kachchi males were adjudged as sterile while 3/4 Jaisalmeri as sub fertile. Tibary and Anouassi (1997) also reported similar sort of sub-fertility, infertility and sterility in males as observed in present study as un-explained sub-fertility and infertility.

#### **Sub-fertility and sterility in male camels**

A significant proportion of males were sub-fertile and sterile from Jaisalmeri

and Kachchi breeds, while fertility status of all the Bikaneri studs used in this study were satisfactory. Male infertility in camels is still poorly understood (Tibary *et al.*, 2005). Tibary and Anouassi (2000) reported that lack of libido associated with hormonal imbalance, high temperature, stress and presence of debilitating diseases, reduced libido due to acute systemic diseases such as hemorrhagic diseases and trypanosomiasis, ejaculatory problems and unexplained sub-fertility or infertility are the most commonly reported problems in camel. Lack or reduced libido of camels of this particular study as a causative agent of sterility can be ruled out as these revealed perfectly normal mating ability. Gross characteristics of semen ejaculates, microscopy for individual motility evaluation and refrigeratory preservability of one of the 2 sterile males of this study were perfectly normal, while those of another sterile male, most of the ejaculates have been watery with little spermatozoa. Individual sperm motility was negligible for this particular male in most of the ejaculates except once. The former sterile male resembles to those reported by Tibary and Anouassi (1997) with normal seminal parameters yet unable to impregnate the females by either natural or artificial inseminations. They suspected immunological or genetic causes for such disorders. In the later male, watery semen ejaculates indicate possible reduced spermatogenesis. According to Tibary and Anouassi

(1997) reduced spermatogenesis and testicular hypoplasia are often seen in racing dromedaries especially if they have been treated with anabolic steroids. Sub-standard semen quality can be observed in male infertility especially in overused or old animals. Al-Qarawi (2005) reported hyperoestrogenaemia, associated with autoimmune thyroiditis and trypanosomiasis to suppresses the secretion of testicular testosterone and augments the release of testicular histamine, which appears mandatory for quantitative reduction/loss of advanced spermatogenic cells in infertile dromedary bulls. After an examination of the plasma hormonal profiles and semen characteristics in the infected bulls Al-Qarawi et al. (2004) reported that altered Sertoli cell function due to formation of immune complexes, pituitary dysfunction, testicular degeneration and trypanotolerancy are possible factors responsible for poor semen characteristics and infertility induced by *T. evansi* infection in dromedary bulls.

#### **Investigations on sterile male camels**

**Mating Ability:** Copulation time of one sterile male camels did not differ significantly ( $P>0.05$ ) than fertile group of camels, while for another sterile male it was significantly higher ( $P<0.05$ ) than fertile groups. These data of present study indicated that sterile males were not inferior from fertile group of camels in respect to sexual libido. Therefore reduced libido or lack of libido as reported by Tibary and Anouassi (2000)

as one of major causes of infertility in male camel can be excluded for sterile camels of this study.

**Gross characteristics of semen ejaculates:** The gross characteristics of semen ejaculates from 2 sterile camels exhibited variations between males. Almost all ejaculates from one sterile male camel were adjudged normal for color, consistency, thick gel like resemblance and frothiness, whereas majority of the ejaculated from another sterile male camel K-116 were watery. In later case one can suspect testicular degeneration and related disorders resulting into impaired spermatogenesis, while in former case spermatogenesis should have been normal.

**Individual sperm motility examinations:** Like that of gross characteristics of semen ejaculates, individual sperm motility examinations also gave a variable picture between males. Almost all the samples obtained from one sterile male camel, which had grossly normal semen, exhibited normal individual sperm motility, while another sterile male camel that had watery ejaculates, exhibited non-motile spermatozoa on all occasions except once. Tibary and Anouassi (1997) have reported sterility in male camels, which exhibited perfectly normal gross and microscopic characteristics yet failed to impregnate females either with natural service or artificial inseminations. One of the two sterile male camels of present study resemble to that reported by these workers. As suspected by them

immunologic, genetic or similar sort of other causes for sterility needs further investigations. The other case of sterility in present study appears to fall in the category of abnormal testicular endocrine, chemical and sertoli cell dysfunctions as suggested by Al-Qarawi *et al.* (1994).

Sperm Morphological examinations: In both the sterile camels sperm abnormalities were relatively more.

Testosterone profiles: Significant inter individual differences have been observed between animals in testosterone concentration. Average testosterone profiles of one of the 2 sterile camels, one of the three sub-fertile camels and one of the six fertile male camels had been low than remaining males. The average individual levels of testosterone of fertile, sterile and sub-fertile camels appear individual biological variation rather than association of testosterone profiles with infertility, sterility or fertility.

### Acknowledgements

Facilities provided by Director of the institute and technical assistance rendered by Sri Nand Kishore and Dr. A.K. Bhati are thankfully acknowledged.

### References

Abou-Ela, M.B. 1984. Reproductive performance of one humped camel under traditional management in the United Arab Emirates. *J. Arid Environ.* **26**: 47-51.

Abdel-Rahim SE., Abdel-Rahman K. and El-Nazier AE. 1994. Production and reproduction of one-humped camels in the Al-qasim region, Saudi Arabia. *J. Arid Environ.* **26**: 53-59.

Abdel-Rahim SEA. and El-Nazier AE. 1990. Factors affecting camel reproductive performance in the tropics. Proceedings of the workshop "Is it possible to improve the reproductive performance of the camel"? Paris: 131-147.

Arthur G.H., Noakes DE. and Pearson H. 1989. Reproduction in the camel. In: Veterinary Reproduction and Obstetrics (Theriogenology). Sixth Edition. Published by Bailliere Tindall, London, U.K. P.No. 585-590.

Al-Qarawi AA. 2005. Infertility in the dromedary bull: a review of causes, relations and implications.: *Anim Reprod Sci.*, **87**:73-92.

Al-Qarawi AA, Omar HM, Abdel-Rahman HA, El-Mougy SA and El-Belely MS. 2004. Trypanosomiasis-induced infertility in dromedary (*Camelus dromedarius*) bulls: changes in plasma steroids concentration and semen characteristics. *Anim Reprod Sci.*, **84**:73-82.

Payne, W.J.A. and Wilson, R.T. 1999. Old world camels. In: An introduction to Animal Husbandry in the tropics. 485-520. Publisher- Blackwell Sciences Ltd. U.K.

Bakkar, M.N. and Basmal, S. 1988. Reproductive performance in Najdi camels. Proc. 11<sup>th</sup> Int. Congr. Reprod. Artif. Insem. **1**:529.

Barminstev V. 1951. Rectal examination of reproductive organs of the camel. *Conevodstvo*, **1**:38-42.

Chriqui A. 1988. Conduite de lelevage du dromadaire dans le sud Marocain. These de Doctorat Veterinaire, Institut Agronomique et Veterinaire Hassan II, Rabat, Maroc.

- Djellouli M and Saint-Martin G. 1992. Productivity and economy of camel breeding in Tunisia. In: Allen WR, Higgins AJ, Mayhew IG, Snow DH, Wade JF. (Ed.). *Proceedings of the 1st International Camel Conference*. Newmarket, UK: R&W Publications. pp.209-212.
- Keikin D. 1976. Camel breeding can be economical (R<sub>4</sub>). *Konevodstro i konnyi sport* **2**:12-13.
- Khanna ND., Rai AK. and Tandon SN. 1990. Reproduction in Camels. Proceedings of the workshop “Is it possible to improve the reproductive performance of the camel”? Paris:
- Merkt H., Musa BE., El-Nagger MA. and Rath D. 1992. Reproduction in camels. A review. FAO Animal Production and Health Paper No. 82, FAO, Rome.
- Mutugi MW., Olaho-Mukani W., Kuto B., Alushula H. and Njogu. A.R. (1992): Some reproductive parameters in a Kenyan population of *Camelus dromedarius*. *Bull. Anim. Hlth. Prod. Afr.* **40**:215-217.
- Niemuller C. 2007. Reproductive research-Profiling camels. Canadian Association of Zoos and Aquariums. 6-8.
- Novoa C. 1970. Reproduction in Camelidae. *J. Reprod. Fertil.* **22**: 3-20.
- Sahani MS., Sumant Vyas and Aminu Deen 2003. Improvement in reproductive efficiency in farm camels under hot arid region. *Indian J. Anim Reprod.* **24**: 95-98.
- Saley M. 1990. Reproductive performance of the dromedary in niger (*Camelus dromedarius*). Prospects for improvement. Proceedings of the workshop “Is it possible to improve the reproductive performance of the camel”? Paris: 379-386.
- Saint-martin G., millard A., Roy F. and Musa BE. 1990. Reproductive performance of camels in real life situation. Example of an inquiry in Butana, Sudan. Proceedings of the workshop “Is it possible to improve the reproductive performance of the camel”? Paris: 387-407.
- Schwartz HJ. 1989. Productivity and utilization of one-humped camel (*Camelus dromedarius*) in Africa. Consultant report to FAO, Rome and Berlin.
- Schwartz HJ. and Walsh MJH. 1990. Improving reproductive performance in the dromedary: Consequences to Production Systems. Proceedings of the workshop “Is it possible to improve the reproductive performance of the camel”? Paris: 409-425.
- Schwartz. H.J., Wilson AJ., Dolan R., Evans JO. and Fairhall J. 1982. Produktionsleistungen von Kamelen (*Camelus dromedarius*) in ausgewahter gebieten Kenias. *Prakt. Tierarzt.* **63**:964-969.
- Sghiri A. 1988. Evaluation des performances de reproduction d’un troupeau camelin a Laayoune (*Camelus dromedarius*). These de Doctorat Veterinaire, Institut Agronomique et Veterinaire Hassan II, Rabat, Maroc.
- Shalash MR. and Nawito M. 1963. Sterility in female camels. *Dt. Tierartz. Wschr.* **70**:522-530.
- Shalash MR. 1965. Some reproductive aspects in female camel. *World Rev. Anim. Prodn.* **1**:103-107
- Skidmore JA. 2003. The main challenges facing camel reproduction research in 21<sup>st</sup> century. *Reprod suppl.* **61**: 37-47.
- Skidmore L.2004. Reproductive Physiology of male camel. Lecture notes for the short course in Reproduction in the dromedary camel. International Veterinary Information Service, Ithaca NY. www.IVIS.org.
- Skidmore JA. 2005. Reproduction in



- dromedary camels. An update: *Anim. Reprod.* **2**:161-171.
- Tibary A. and Anouassi A. 1997. Theriogenology in Camelidae. Abu Dhabi printing and publishing Company. Mina Abu-Dhabi, united Arab Emirates.
- Tibary A. and Annouassi A. 2000. Reproductive disorders in male camelid. In: Recent Advances in Camelid Reproduction. (Editors) Skidmore, L. and Adams, G.P. International Veterinary Information Service. Ithaca NY (WWW. Ivis.org)
- Tibary A., Anouassi A. and Sghiri A. 2005. Factors affecting reproductive performance of camels of the herd and individual level. In. Desertification combat and Safety Food. (Editors B. Faye and P. Esenov); The added P.N. 97.
- Tayeb MA.F. 1953. Les organes geniteuk de la chamelle Revue Elev. Med. Vet. Pays trop. **6**: 17-20.
- Yagil R. 2006. Reproductive processes in camels (*Camelus dromedarius*). Israel *J. Vet. Med.* **61**(2):52-55.
- Yuzlikaev RD. and Akmediev A. 1965. Rapid reproduction in camels. *Zhivotnevodstvo, Mosk.* **27**:61-65.