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Postpartum Reproductive Performance Of High And Low Milk Yield Lactating Maghrebi She-Camels

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Abstract

The objective of this study was to investigate the relationship between milk yield level in the first 21weeks of lactation and post-partum reproductive performance of dromedary she-camels. A total of 14 female camels were equally divided into two groups according to their previous lactation milk yield level as: high (≥4 kg milk per day) and low (< 4 kg milk per day) milk yield groups. Camels were examined by ultrasonography weekly after parturition. Blood samples were collected for progesterone assay after mating. Results revealed that average of daily milk was (5.53±0.1kg. vs. 3.32±0.1kg.) for high and low milk groups, respectively. Interval from calving to first estrus was a bit similar in both groups; average was (29.8 days). The low milk group tended to have significant increase of first and second postpartum estrus duration (42.4±3.3h and 54.0±2.44h), comparing with the high milk group (23.9±1.0h and 37.1±3.4h). The mean interval for uterine involution was almost the same in both high and low groups (30.6 day). Serum progesterone after mating was basal in low milk group, while increased in 3 camels of high milk group. Ovarian ultrasound examination during eight weeks postpartum revealed follicular growth in high milk group; estrus was detected in 6/7 females and ovulation occurred in 3/7 (43%) of mated camels; while, low milk group showed less follicular growth; estrus was detected in 4 camels, but with absence of corpus luteum. It was concluded that high milk yield did not negatively affect postpartum reproductive performance.

Key words: Dromedary camels, reproductive performance, ovarian activity, milk yield.

Introduction

Reproductive efficiency is a key factor for improved livestock performance. Therefore, maintenance of a high level of reproductive efficiency in livestock is essential not only for profitable production but also for maximum opportunity for selection. Under normal conditions, camels were reported to have low reproductive performance (**Kaufmann, 2005**; **Kalla et al., 2008**; **Hermans, 2009**). The short breeding season, delay of puberty, the long gestation period, the prolonged period of lactation (anestrus for 8-10 months) are the principal causes for this low reproductive performance. (**Kamoun and Jemmali, 2014**)

Djellouli and Saint-Martin (1992); El-Azab et al., (1997) and **Zeidan, (1999)** reported low calving rate of approximately 40% in Tunisia, 39.1% in Libya and 41% in Egypt, respectively.

Animal productivity could be determined by calving interval, which consider an important fertility index; female camel is bred in one season, calve in the next breeding season and remain sexually inactive until the subsequent breeding season, leading to long inter-calving period and significant economic losses **(Wilson, 1989).**

Nutritional status and environmental factors affect the sexual development and reproduction performance of camels. Female camels reach puberty at 2-3 years of age, allowed to be bred at 3-4 years old, as a result; the female camel would give birth at 5-6 years old **(Atakan et al., 2016).**

Two main factors affecting postpartum fertility are uterine involution and resumption of ovarian activity. Uterine involution is considered as a temporary barrier for delaying fertility in earlier postpartum period. In dromedary camels, the uterine involution period lasts from 15 to 42 days after parturition **(Musa and Makawi, 1985; Derar et al., 2014).**

Merkt et al.,(1990) reported that in late pregnancy period follicles could develop, and this might be the reason for the early signs of heat that observed after parturition in camels. The postpartum estrus has been reported to occur 14 to 25 days after calving and females continued cycling during the rutting season until fertilization had taken place, and involution of the uterus is completed by the 5th week postpartum **(Vyas and Sahani, 2000).** While other research workers have reported that the first postpartum heat was delayed until the next breeding season **(Musa and Makawi, 1985).**

Serum progesterone concentrations of the non-pregnant postpartum camels were varying between 0 ng/ml and 0.41 ng/ml, while exceeding 1.5 ng/ml after a fertile mating and continue of increasing during pregnancy and falls at parturition **(Kaufmann, 2005;Vyas et al.,2008).**

In camels milk yield drops significantly by 60 days of gestation; hence, shortening the calving interval

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by early breeding would result in a significant decrease in milk production **(Nagy and Juhasz, 2012).**

Dromedary camels exhibited wide individual variation in milk producing ability. Assumption that milk production level affects reproductive performance, then traits such as involution of the uterus and cervix, an interval from parturition to first and subsequent ovulation, estrus detection, and conception rate should differ among she-camels with different levels of milk yield. Therefore, the aim of the present study was to identify relationships between high and low milk yield and reproductive traits of lactating Maghrabi she-camels.

Material and methods

2.1. Animals

The present study was carried out at the Camel Studies and Production Development Center in Matrouh governorate which belongs to Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. The camels were clinically healthy and they were fed a diet of mixed concentrates and hay once a day and were given water ad libitum. A total of 14 multiparous she- camels were selected based on their average milk production of the previous season. Animals were divided into two groups of high milk yield (≥4kg milk per day) and low milk yield (< 4kg milk per day). The age of experimental camels ranged from 8 to18 years, with a mean live body weight of (477.13±32.29 kg.). Estrus was detected when a she-camel approached the male and accepted his trials to mount her showing squatting before him.

2.2. Milk yield

To estimate daily milk yield, camels were completely milked bi-monthly by hand into a clean container following stimulation by the calf for one minute. Milk yield of individual she-camels was recorded twice a day at each milking and archived as daily milk yields (kg). Average daily milk yield was calculated for the lactation period.

2.3. Ultrasonic examination of uterus and ovaries

Ultrasound examination of ovaries and uterus was done using a portable ultrasound machine **(Agroscan Linear, Ecm 1"6 Bd De La Republique, F 16000 Angouleme, France)** having a dual frequency linear array transducer (5.0e7.5 MHz) to record follicle recruitment and uterine involution in she-camels. The images were saved using a multimedia kit (Portable Multiple player-100, SIGMATEK) attached to the ultrasound machine. The saved images were subsequently transferred and stored on a computer. Camels were restrained by ropes tied to both fore and hind legs separately in a sternal recumbency during the examination. The rectum was evacuated of the feces and the probe of the ultrasound covered with a sterile sleeve was introduced into the rectum of the animal, moved to get the best view and the diameters of the uterine, previously gravid uterine horns and non-gravid horns. Uterine involution was considered to be complete when no further reduction in their diameters was recorded for three successive examinations. The ovaries were also examined for follicular recruitment, and luteal development.

2.4. Serum progesterone assay

Blood samples (10 ml) were collected at 0, 14, 21 and 28 days post-mating for progesterone assay and the serum was separated and stored at −20 °C until subsequent assay for progesterone which was done using commercially available enzyme immunoassay kits (DIALAB Wiener Neudorf, Austria). The absorbance and progesterone concentration were read on ELISA reader (Multi Scan M S India) using 450 nm filter. The specificity of the test was high and the intra and interassay coefficient of variation was 5.7% and 9%, respectively. Values above 1 ng/mL (3.18 nmol/L) were considered as a sign of luteal activity and pregnancy.

2.5. Statistical analysis

Data were analyzed using SAS version 9.3 Statistical software **(SAS, 1999).** Means were analyzed by Duncan's multiple range tests. Diameters of the previously gravid horn, non-gravid horn, and cervix were analyzed for period effects using repeated measure analysis of variance, with Fisher's protected least significant difference (LSD) as the post-ANOVA test. A 5% significance level was used. The regression rate (cm/day) of the uterine horns and uterine involution was taken as the difference between maximum and minimum diameters of these organs divided by the duration of their involution during the postpartum period. The growth rate of the follicle and CL (cm/day) was considered as the difference between maximum and minimum diameters of the ovulatory follicle or the CL divided by the duration of their growth. The atretic and regression rates of the follicle and CL were considered as the difference between the maximum and minimum diameters of both these structures divided by duration of their atresia and regression.

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Results

3.1. Milk yield

The monthly average of milk yield for high milk yield and low milk yield groups for the first seven months of lactation was shown in **(Fig.1)**. The highest average daily milk yield recorded during the first three months of lactation was (7.5 ±0.10 kg), whereas the least average daily milk recorded was (2.0 ±0.10 kg) after six months of lactation.

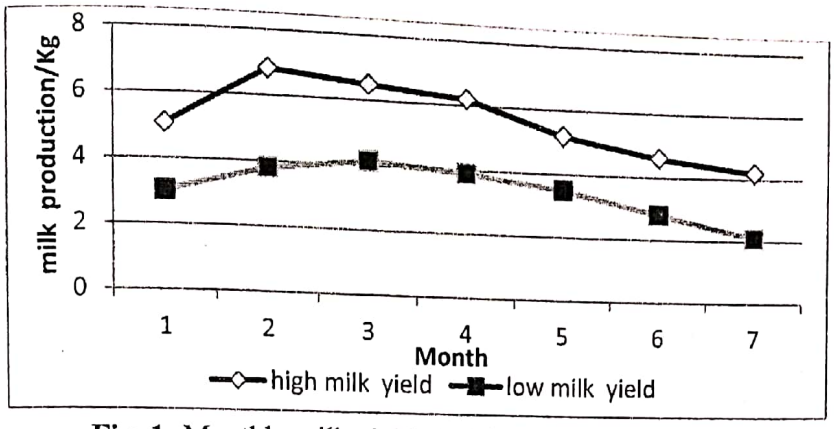

Fig. 1: Monthly milk yield of high and low milk groups.

Table 1 shows milk yield in the two camel groups. The average daily milk yield for high and low milk groups was (5.53±0.1kg) and (3.31±0.1kg), respectively. There was significant difference (P<0.05) in daily milk yield and total milk yield per lactation between the two groups.

Table.1 Milk yield in high and low groups (Mean ± SD)

Trait	high milk yild group	low milk yield group
Average milk /day/camel(kg.)	5.53±0.1[a]	3.32±o.1[b]
Lactation period (days)	210	210
Total milk yield /lactaion(kg.)	1161.3±o.1[a]	697.2±0.2[b]

Means with different superscripts vary on P<0.05

3.2. Postpartum Reproductive Performance

3.2.1. Interval from parturition to first estrus

The postpartum reproductive traits are presented in **Table 2**. In the present study, the interval from parturition to first estrus was similar for high milk group and low milk group (29.3±8.5d **vs.** 30.3±4.8 d).

3.2.2. Estrus duration

Duration of first post-partum estrous cycle was 23.9±1.0 h in high milk group while in low milk group it increased significantly (P<0.05) to 42.4±3.3h. The duration of second postpartum estrus increased from the first cycle, and the difference between the two groups was significant (P<0.05). The duration was (37.1±3.4h **vs.** 54.0±2.4h) for high and low milk groups, respectively. The low milk group was associated with significant increase of first and second estrus duration compare with the high milk group **(Table 2)**.

Table 2 Postpartum reproductive performance of high and low milk groups(Mean±SD)

Trait	High milk group	Low milk group
First postpartum detected estrus(days)	29.3±8.5[a]	30.3±4.8[a]
First postpartum estrous duration (h)	23.9±1.0[b]	42.4±3.3[a]
Second postpartum estrous duration (h)	37.1±3.4[b]	54±2.4[a]
Interval to uterus involution (days)	31±1.0[a]	30±1.02[a]
Interval to first insemination (days)	30±1.0[a]	33±1.0[a]
Mean of follicles no. during 60 days postpartum	4.7±1.1[a]	3.22±0.8[b]
Mean of follicles no. on right ovary	1.87	0.67
Mean of follicles no. on left ovary	3.00	2.56

Means with different superscripts vary on P<0.05

3.2.3. Interval to uterus involution (days)

The present study showed that the uterine involution period was a little longer in high milk group than for low milk group (31±1.0 d vs. 30.0±1.02 d) respectively, with no significant (P>0.05) difference. Also, the interval from calving to fist mating was so close between the high and low milk groups.

3.2.4. Mean of follicles number

Table 2 shows the mean numbers of follicles for the two groups during first and second postpartum estrus. It was significantly ($P<0.05$) higher in the high milk group (4.7±1.1) than the low milk group (3.22±0.8). When comparing the mean of follicle numbers considering right and left ovary, there was no significant difference between groups, but generally the mean number of follicles increased on the left ovary than on the right ovary in both high and low milk groups.

3.3. Progesterone concentration

Table 3 illustrates the progesterone concentration measured on periods after mating. Samples were taken on days 0, 14, 21, and 28, three female camels from the high milk group showed luteal activity, while in the low milk group progesterone concentration was at basal level in this early stage.

3.4. Uterine involution

Ultrasound examination shows the postpartum involution in the uterine body, gravid and non-gravid uterine horns, on two periods after parturition in high and low milk groups. **Fig.2** represents the uterine involution into a camel from the high milk group 4 days postpartum, the diameter of uterine body was 80.1mm, the diameter of the gravid (left) horn was 86.6mm the lochia was obvious in this horn, while the diameter of non-gravid (right) horn was 61.9mm. While **Fig.3** also shows the uterine involution after 24 days postpartum, where the diameter of uterine body decreased to 36.6mm, the gravid (left) horn was 38.7mm, non-gravid (right) horn was 31.4mm. **Fig.4** shows the postpartum involution into a camel from the low milk group 11 days postpartum. The diameter of uterine body was 72.0mm, the diameter of the gravid (left) horn was 80.0mm, and the diameter of non-gravid (right) horn was 61.5mm.

The diameter of uterine body 31 days postpartum decreased to 36.2mm, the gravid (left) horn was 38.8mm, and the diameter of non-gravid (right) horn was 22.3mm. **(Fig.5)**.

Table 3. Serum progesterone levels (ng/mL) in high and low milk groups after mating

High milk group					Low milk group				
Days / Camel no.	Day0	Day14	Day21	Day28	Days / Camel no.	Day0	Day14	Day21	Day28
1	ND	0.13	0.12	0.12	11	ND	0.12	0.1	0.13
2	0.12	0.13	0.12	0.1	10	0.11	0.12	0.12	0.13
4	0.13	0.29	2.1	2.4	8	0.12	0.13	0.11	0.12
5	0.12	0.34	1.7	2.1	12	ND	0.13	0.12	0.12
6	0.16	0.32	1.9	2.2					
7	ND	0.12	0.11	0.1					

ND: Not detectable i.e. <0.10ng/ml

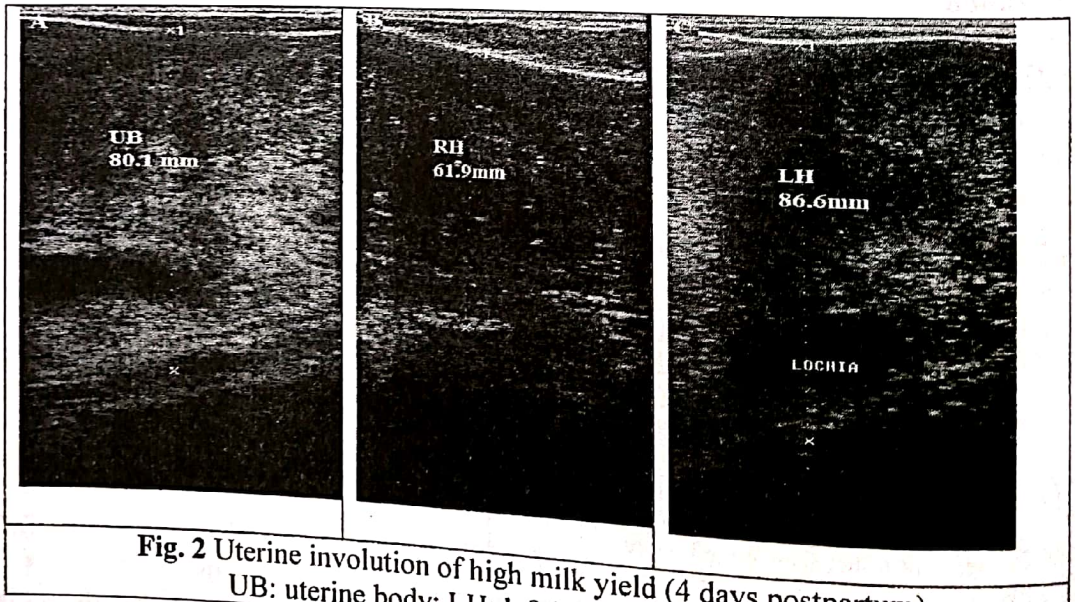

Fig. 2 Uterine involution of high milk yield (4 days postpartum)
UB: uterine body; LH: left horn; RH: right horn.

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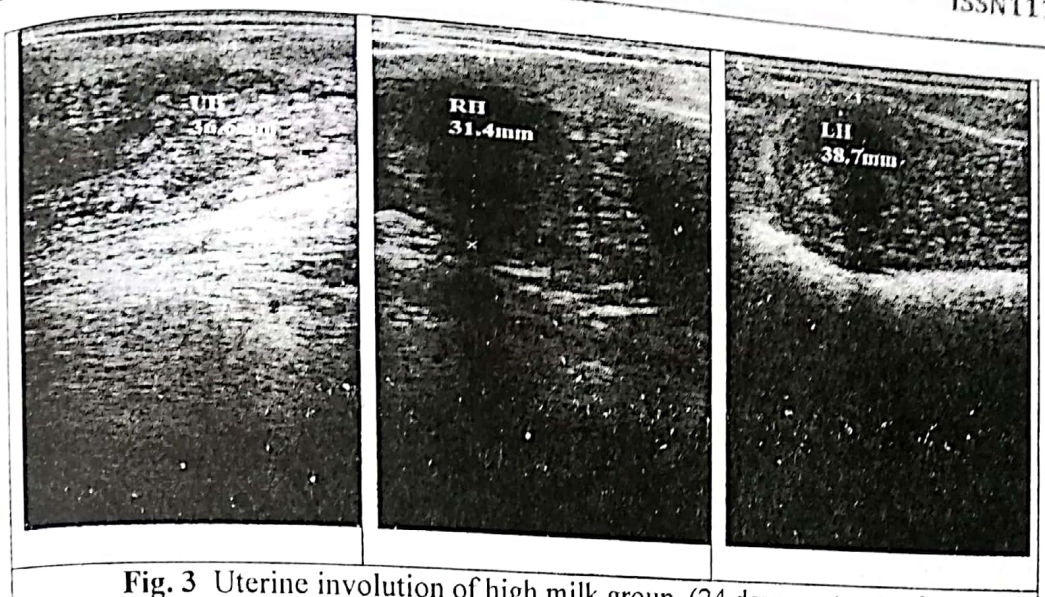

Fig. 3 Uterine involution of high milk group (24 days postpartum)
UB: uterine body; LH: left horn; RH: right horn.

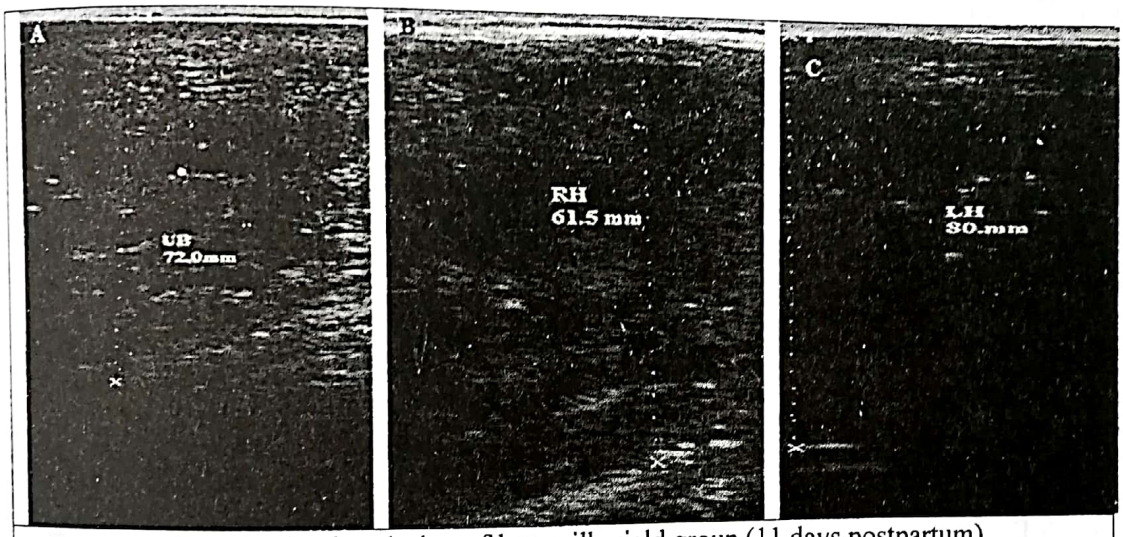

Fig. 4 Uterine involution of low milk yield group (11 days postpartum)
UB: uterine body; LH: left horn; RH: right horn.

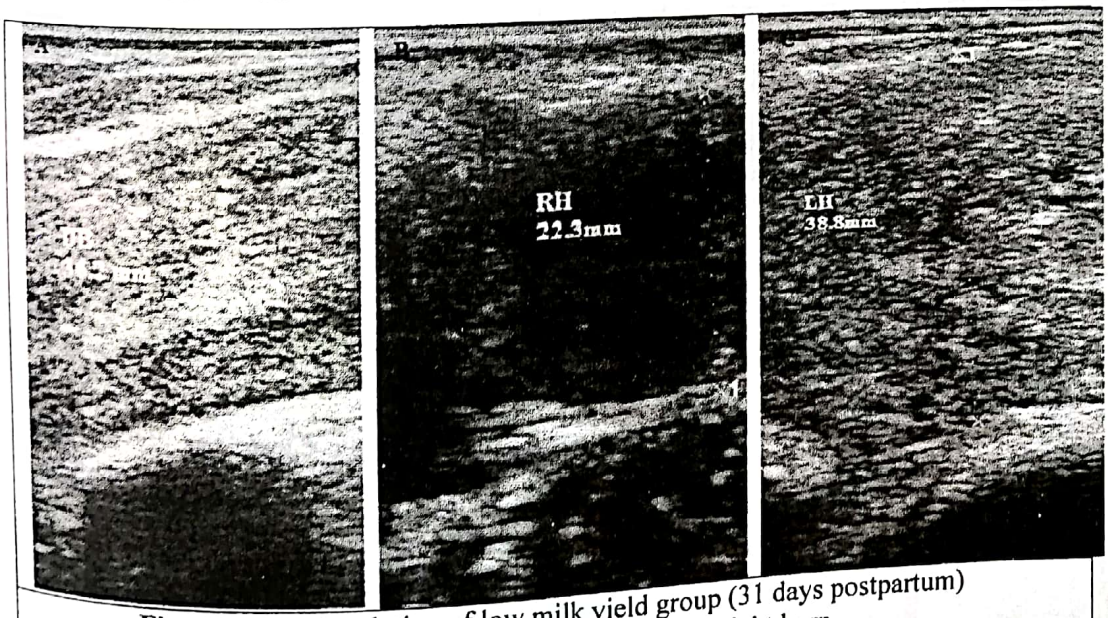

Fig. 5 Uterine involution of low milk yield group (31 days postpartum)
UB: uterine body; LH: left horn; RH: right horn.

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3.5. Ovarian (Follicular) activity

In high milk yield camels, periodic examination of the ovaries revealed that one camel (14.2%) was observed to have a follicle of ovulating size (diameter ≥1.1 cm) by the end of the first week (No.1) the second week (No.7) and during the seventh week (No. 4) while, (28.5%) two camels were observed to have a follicle of ovulating size by the end of the fifth week (No.5, 6). Small follicles (≥0.8 cm in diam.) were observed in only one camel (14.2%) at the seventh week (No 3). Estrus was detected in 6/7 camels, but ovulation occurred in 3/7 camels (42.8%) after mating **(Fig.6)**.

In low milk yield camels, ultrasound examination of the ovaries showed that, one camel (14.2%) had a follicle of ovulating size (diameter ≥1.1 cm) by the end of the second week (No.11), the fourth week (No.10), during the fifth week small follicles (≥0.8 cm in diam.) were observed in two camels (28.5 %) at the end of the second week (No. 12, 13) and seventh weeks (No 9). Estrus was detected in 4/7 camels and ovulation did not occur after mating **(Fig.7)**.

Fig. 6: Sonographic monitoring of follicular growth in high milk yield camels during 8 weeks postpartum. R=Right ovary and L= Left ovary. SO = Smooth ovary; SF = Small follicle; CL= Corpus luteum; F = Follicle; The diameters of follicles (F) are shown.

	Animal No	Week / Ovary	1	2	3	4	5	6	7	8
High milk yield	1	R	F 5 m F 5 m	SF	SO	SO	SO	SO	SO	SO
		L	F 11 m	F 7 m	SO	SO	SO	SO	SO	SO
	2	R	SO	SO	SO	F 4 m F 3 m F 4.2 m	SO	SO	SO	SO
		L	SO	SO	SO	F 9 m F 7 m	SO	SF	SO	SO
	3	R	SO	SO	SO	SF	SO	SF	SO	SO
		L	SO	SO	SO	SF	SF	SF	F 8.5 m	SO
	4	R	SO	SO	SO	SF	SO		SF	SO
		L	SO	SO	SO	F 6.5 m	SO	SF	F 18 m	CL 20 m
	5	R	SO	SO	SO		SO	SF	SF	F 8.5 m
		L	SO	SO	SF	SF	F 15 m	CL 20 m	CL 25 m	CL 25 m
	6	R	SO	SO	SO	SO	SO	SO	SO	F 15 m
		L	SO	SO	F 6 m	SO	F 8.5 m	CL 20 m	CL 25 m	CL 25 m
	7	R	SO	F 8 m	F 5 m F 5 m	F 12 m	SF	F 6 m	SO	F 15 m
		L	SO	F 12 m	F 12 m	F 10 m	SF	F 14 m	SF	SF

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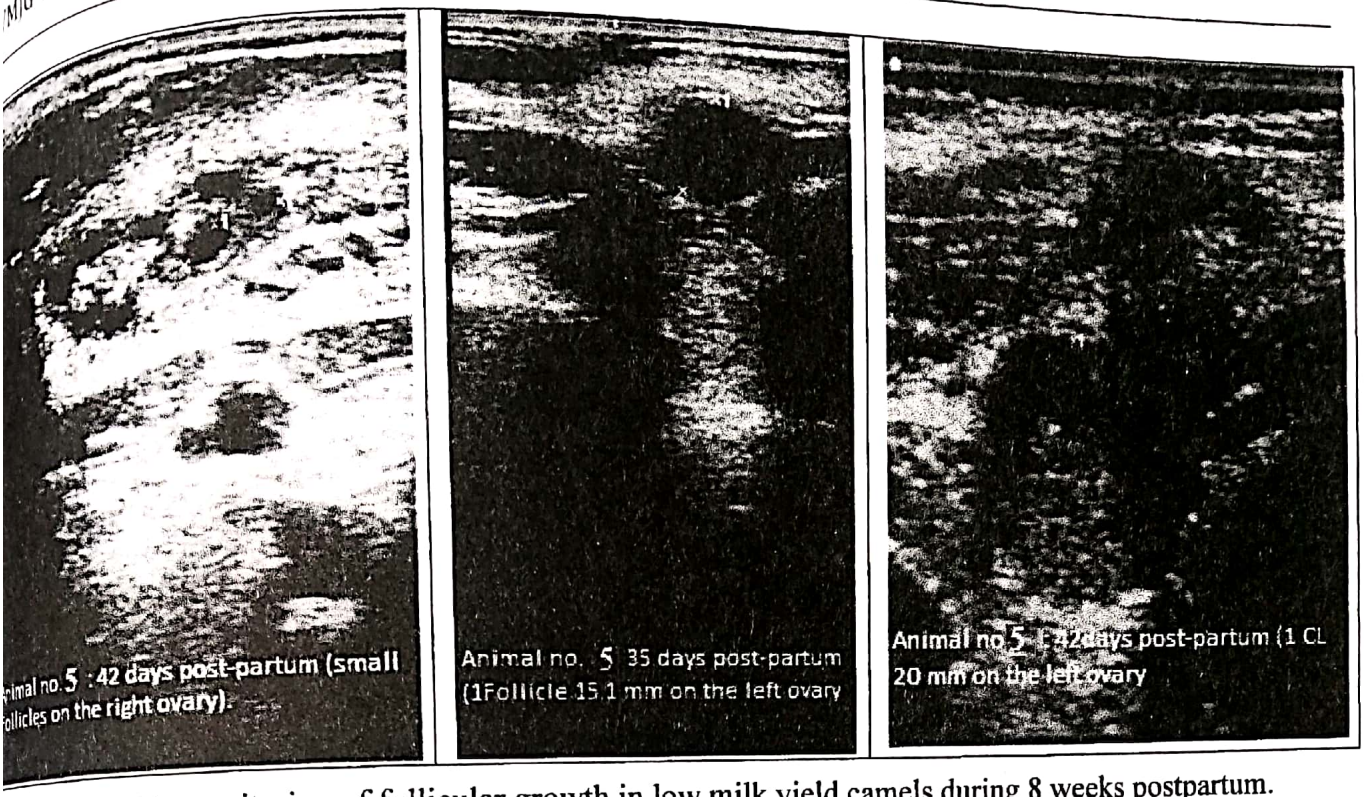

ig.7 Sonographic monitoring of follicular growth in low milk yield camels during 8 weeks postpartum. =Right ovary and L= Left ovary. SO = Smooth ovary; SF = Small follicle; CL= Corpus luteum; F = ollicle; The diameters of follicles (F) are shown

Animal No	Week / Ovary	1	2	3	4	5	6	7	8
8	R	SO	SO	SO	SO	SO	SO	SO	SF
	L	SO	SO	SO	SO	SO	SO	SO	F 10 m F 4,5 m
9	R	SO	SO	SO	SO	SO	SO	SF	SF
	L	SO	SO	F 6 m	SO	SO	SF	F 5 m	SF
10	R	SO	SO	F 6 m	SF	SO	SF	F 7 m	SO
	L	SO	F 2.5 m	F 9 m F 10 m	F 12 m F 21 m	SF	SF	F 12 m	SO
11	R	SO	SF	SO	SO	SO	SO	SO	SO
	L	SO	F 11 m	F 15 m	SO	SO	SO	SO	SO
12	R	SO	SO	SO	SO	SO	SO	SO	SO
	L	SO	SO	SO	SO	F 12 m F 14 M	F 18 m	Cystic F 28 M	F 12 m
13	R	SO	SF	F 4.5 M	SO	F 4.5 M	SO	SO	SF
	L	SO	SF	F 8.5 m	SO	SO	SO	SO	SF
14	R	SO	SO	SO	SF	SO	SO	SO	SO
	L	SF	SO	SO	SO	SO	SO	SO	SO

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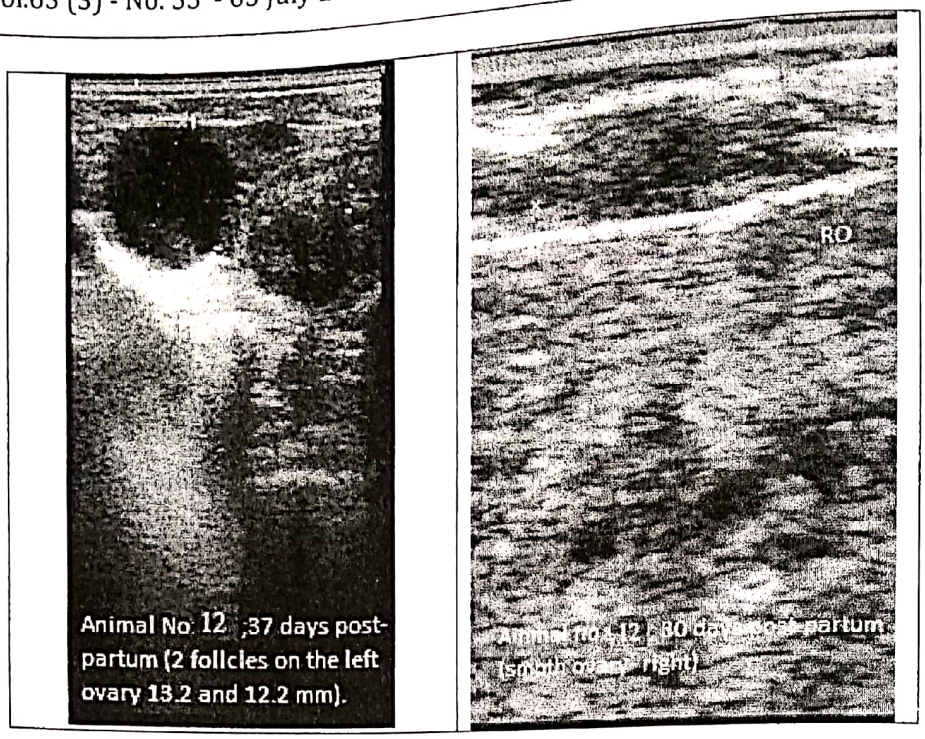

Discussion

In the present study, average daily milk yield in high milk group is consistent with the report of **(Simenew et al., 2013)** who obtained a daily average of 5kg milk production per camel, but was lower than **(Ishag and Ahmed, 2011).** The dissimilarities of milk production in the present study may be due to variation of nutrition, age of animals, management and environmental factors. Milk production also decreases with the increasing of animal's age. The average total milk yield was less than the findings of **(Bekele et al., 2001)** who reported an average of 1422±74kg and 1694±185kg per lactation. The variations of total milk yield are due to length of lactation period, green fodder, health condition and age of animals.

The onset of the first postpartum estrus in camels is controversial, early postpartum estrus of 23 days was reported by **Qureshi, 1986; and Fazal et al., 2017** which is less than the present study, while other research workers have reported that the first postpartum heat was delayed until the next breeding season **(Musa and Makawi, 1985).**

Serum progesterone concentrations of the non-pregnant postpartum camels were varying between 0 ng/ml and 0.41 ng/ml, but raised after a successful mating. Lactating status have a significant effect on serum progesterone level comparing non lactating females. Also the serum progesterone value was affected significantly and tended to increase with age in younger she-camels **(Kamoun and Jemmali, 2014).**

Pregnancy diagnosis by ultrasound was confirmed by progesterone assay which indicates that the serum progesterone levels in the pregnant camels remain higher than 1.0 ng/mL. These results are in agreement with previous findings in the dromedary camel **(Marie and Anouassi, 1986; Skidmore et al., 1996).**

The changes in the ovarian follicular dynamics in dromedary camels are described as a "follicular wave pattern". Each follicular wave is divided into four phases namely: recruitment phase, growth phase, mature phase and regression phase **(Skidmore et al., 1996 and Tibary and Anouassi, 1997).** Behavioral (estrus) signs that made distinguishable females with a dominant follicle on their ovaries from other females are rarely displayed in camels. Consequently the monitoring of ovarian activity became an essential step for the reproductive management of this species **(Skidmore et al., 1996).** It is worth mentioning that the signs of estrus in camels do not always correlate with ovarian follicular status.

These behavioral signs of estrus are, therefore, difficult to relate to follicular activity in the ovaries and cannot be used reliably to decide timing for breeding in camels **(Skidmore, 2011).** In comparison with other species, camels have a relatively short luteal lifespan in the absence of pregnancy **(Skidmore, 2011; Marie and Anouassi, 1986).**

Pregnancy has a strong negative effect on milk production, as milk yield starts declining within 1 month of conception and animals stop lactating by 4 month of gestation. Such a

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decrease is a major economic loss in a camel dairy operation. As there are few data on the endocrinology of pregnancy and lactation in dromedary camels, further research is essential to understand the underlying mechanisms.

Ultrasound examination revealed the absence of corpus luteum in low milk yield group, while corpus luteum was observed in three camels only which were considered pregnant in high milk yield group. This result revealed variation of post-partum ovarian activity of she-camel and conception rate at first month postpartum were not found to be affected by milk yield. Result of the second month, however, revealed that there is a positive tendency between milk production and conception rates (**Fig.7**).

The present study revealed that, since high and low milk yield groups were in the transition period hence recognizable size follicles were absent or fewer and the small follicles did not progress in growth in most animal during the first and the second week, the follicle growth observed during transition period revealed that the follicular growth progressed very slowly during this period and required up to five weeks till reaching the ovulatory size especially in high milk group camels.

Results of the present study are, somewhat, consistent with the results of **(Derar et al., 2014)** that ovarian activity resumed between days 14 and 17 postpartum and different follicular populations were monitored once the ovaries were accessible. In well-fed camels, ovarian activity, as assessed by ultrasonography, is evident in some females by 30 days postpartum **(Skidmore, 2004)**.

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Also, after the weaning or loss of their offspring, the majority of females showed a mature follicle within 10-12 days **(Skidmore, 2011)**.

In the current study, uterine involution was rapid between days 3 and 17 postpartum and slowed thereafter. Uterine involution is generally rapid in female Camelidae due to the diffuse nature of the placentation, which does not cause a great loss of uterine tissue **(Tibary and Anouassi, 1997; Derar et al., 2014)**. The physiological process of uterine involution is quite complicated and the different mechanisms regulating it are not completely understood. Uterine contractility remains strongly active for about 48 h after fetal expulsion. Nutrition, postpartum hormonal milieu and lactation are detrimental factors in the process of uterine involution and ovarian resumption in camelide **(Merkt et al., 1990; Derar et al., 2014; Monaco, et al., 2015)**.

Fertility during the postpartum period is important for species in which gestation is long. In dromedaries, it has been reported that four out of nine conceived between days 34 and 70 postpartum, after mating and hCG treatment to improve ovulation **(Vyas and Sahani, 2000)**. In well fed dromedaries, ovarian activity is evident in 70-80% of animals by 30 days postpartum and at 45days, the conception rate was normal **(Tibary and Anouassi, 1997)**.

Conclusion

It is conclude that the calving interval of dromedaries could be decreased by early breeding during mid-lactation, where, high milk yield did not negatively affect postpartum reproductive performance. Proper management can play significant role in the long term improvement of camel reproduction and productivity.

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الملخص العربي

الاداء التناسلي بعد الولادة للنوق عالية ومنخفضة الإنتاجية من اللبن

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الهدف من هذه الدراسة هو دراسة العلاقة بين مستوى إنتاج اللبن خلال فترة الـ 21 أسبوع الأولى من الرضاعة والأداء التناسلى للنوق بعد الولادة. تم تقسيم عدد 14 ناقة إلى مجموعتين متساويتين وفقا لمستوى إنتاجهم من اللبن فى المواسم الانتاجية السابقة كالتالي: عالية الانتاج (>4 كجم حليب يوميا) ومنخفضة الانتاج (<4 كجم اللبن يوميا). تم فحص النوق عن طريق الموجات فوق الصوتية أسبوعيا بعد الولادة. جمعت عينات الدم لتقدير هرمون البروجسترون بعد التلقيح. أظهرت النتائج أن متوسط إنتاج اللبن اليومي كان (5.53 ± 0.1 كجم مقابل 3.32 ± 0.1 كجم) لمجموعات اللبن العالية والمنخفضة على التوالي. الفترة الزمنية من الولادة إلى أول دورة شياع كانت متشابه قليلا في كلتا المجموعتين بمتوسط ايام للدورة (29.8 يوما). زادت مجموعة اللبن المنخفضة زيادة معنوية في فترة الشبق لدورة الشياع الأولى والثانية بعد الولادة (42.4±3.3 و 54.0±2.44ساعة) مقارنة مع مجموعة اللبن العالية (23.9±1.0 و 37.1± 3.4ساعة). كان متوسط فترة عودة الرحم لوضعه الطبيعى تقريبا هو نفسه في كلا المجموعتين العالية والمنخفضة بمتوسط قدرة (30.6 يوم). كان مستوى هرمون البروجسترون في السيرم بعد التلقيح قاعدى في المجموعة منخفضة الإنتاج ، في حين ارتفع في ثلاثة نوق من المجموعة عالية الإنتاج. فحص المبيض بالموجات فوق الصوتية خلال ثمانية أسابيع بعد الولادة اظهر نموا حويصلى في المجموعة عالية اللبن ، وحدوث الشبق في 7/6 النوق وحدوث التبويض في 7/3 من النوق (43٪) من الإبل الملقحة . في حين أظهرت المجموعة المنخفضة اللبن نموا حويصلى أقل ، وحدوث الشبق في 4 نوق، ولكن مع غياب الجسم الأصفر. وخلصت الدراسة إلى أن نشاط المبيض والأداء التناسلى بعد الولادة لم يتأثر سلبيا بالانتاج المرتفع من اللبن.