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Parity Effects on Milk Production and Composition, Reproductive Performance and Milk Leptin of Lactating Maghrebian She-Camels in Egypt.

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Summary: *Information on package of productivity and reproductive efficiency of Maghrebian She-camels, raised in Egypt, as affected by parity order are rare. This study aimed to evaluate effects of parity order on milk production and reproductive performance of Magrebian She-camels during the 1st four months of lactation period. A total of 21 pregnant Maghrebian She-camels at late pregnancy were divided into three groups (n=7 each) according to parity order: G1 (1-3 parities), G2 (4-6 parities) and G3 (7-9 parities). Result showed that monthly live body weight (LBW) of She-camels tended to increase (P<0.05) by advancing parity during pre- and post-partum months. The LBW of calves at birth and 1st mo of age was higher (P<0.05) in G2 than in G1 and G3. In the 2nd and 3rd month of age, calves were the heaviest (P<0.05) in G2, moderate in G3 and the lowest in G1. Monthly milk yield was higher (P<0.05) in G2 than in G3 and G1. Milk content of G1 showed higher (P<0.05) fat, protein, ash and total solids percentages, while lactose content was not affected by parity. Mineral contents in milk (Na, K and Ca) showed descending (P<0.05) trends with advancement of parity. She-camels of G2 showed the least (P<0.05) number of services per conception (2.86), the highest conception rate (86%), with moderate service period (15.71 d) and gestation period (384.14 days), but G1 did not differ significantly from those in G2. This study indicated that, parity order of camels rather than leptin level in milk serum, had a vital role in productivity and reproduction of Maghrebian She-camels. Breeders of camel herds should put these results in mind for production and reproduction managements to choose camels at appropriate parity orders*.

Keywords: *She-camel, parity, milk yield, minerals, reproduction, leptin.*

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I. Introduction

Arabian camels have no yet a considerable attention from the nutritional, managerial and veterinary points of view. Arabian camels have the potential to minimize the gap of meat and milk at the national level in different Arabian countries, especially in Egypt. Maghrebian camels are distributed in North African area and characterized with medium size and small pointed hump and low milk production (Wilson, 1984).Camels enable to survive under desperate altitude of acrid environments, but several factors are affecting milk yield and composition in camels (Badawy et al., 2008). Marked variations in camel milk production, in particular mineral contents, may be attributed to the effect of season (Yagil and Etzion, 1980), lactation stage (Mostafa et al., 2016), breed, feeding system and stage of lactation (Mehaia et al., 1995) and water intake (Haddadin et al., 2008). Parity order is reported to be one of the major factors that has a marked effect on milk yield of traditional managed camels (Zeleke, 2007), in difficult environments (Raziq et al., 2008) and Saudi camels (Almutairi et al., 2010). Also, recent reports assured that milk contents showed significant differences in camel milk among parities (Dowelmadina et al., 2014; Abdalla et al., 2015; Elhassan et al., 2015). Parity also affected reproductive traits, including number of services per conception (Mostafa, 2007) and gestation period length (Ahmed et al., 2012). However, no effect of parity was reported on milk yield and dam body change postpartum of dromedary camels under farming system in Sudan Mustafa et al. (2015) and on major mineral contents in camel milk (Riyadh et al., 2012). Leptin hormone and its receptors can be utilized as a hereditary marker for improving the efficiency in domesticated animals (Agarwal et al., 2008). In bovine, pronounced changes in leptin profile during postpartum period were reported and are most probably attributed to some energy balance (Block et al., 2001). However, no information is available on leptin profile changes in milk as affected by parity or reproductive status. Based on the foregoing findings, the variation in yield, chemical composition and mineral contents in camel milk as affected by changes in parity order are conflicted in the literature. According to us, data on changes in leptin profile in milk of dromedary camel in Egypt in relation with advancing parity are rare.

Therefore, the objective of the present study was to evaluate the effects of lactation number on live body weight of She-camels and their calves, milk production (yield, chemical composition and mineral contents), reproductive performance, and thermo-regulation of She-camels in relation to leptin concentrations in Maghrabian She-camels during breeding season under the Egyptian conditions.

II. Materials And Methods

This study was carried out at Center of Studies and Development of Camel Production, belonging to Animal Production Research Institute (APRI), Agricultural Research Center, Marsa Matrouh Governorate, Egypt, during the breeding season.

Animals:

A total number of 21 Maghrebian She-camels at about two months of pre-partum period, 420-596 kg live body weight (LBW) and between 1 to 9 parities) was used in this study. Animals were divided based on their parity into three experimental groups, 7 animals in each. She-camels were with 1-3 (G1), 4-6 (G2) and 7-9 (G3) parities the 1^{st}, 2^{nd} and 3^{rd} group, respectively. All experimental She-camels were raised under the same feeding, housing and managerial conditions.

Meteorological parameters:

The meteorological data during the breeding season months were obtained, then temperature humidity index (THI) was calculated from air temperature (AT,°C) and relative humidity (RH%) obtained from Central Laboratory for Agriculture Climate (CLAC) using the equation of **Mader *et al.* (2006)**. Values of THI during the experimental period ranged from 63.65 in January and 74.25 in August. Photoperiod fluctuated between 11 h light and 13 h dark during the breeding season.

Feeding system:

Each animal was fed a daily basal diet consisting of 3.5 kg concentrate feed mixture (CFM), 2.5 kg Egyptian berseem (Trifolium alexandrinum) hay (BH) and about 2-3 kg rice straw (RS). Ingredients of the CFM used in feeding all the experimental animals included 25% wheat bran, 25% yellow corn, 9% uncorticated cotton seed meal, 20% barely, 15% rice brain, 3% molasses, 2% premix and 1% common salt. Feeds were offered twice daily during 6 mo as an experimental period (2 mo pre- and 4 mo post-partum), while drinking water was made available all day time.

Milking:

Born calves were allowed to suckle colostrum from their dams for the first seven days; thereafter all She-camels were hand milked twice daily. Daily milk yield of each animal (morning and evening milking) was recorded. At beginning each lactation month, milk samples of each animal (mixture from morning and evening milking) were taken and stored at -20^{o}C till determination of milk analyses

Experimental procedures:

Live body weight:

Live body weight (LBW) of She-camels was recorded during two months pre-partum and the first four months of post-partum period. LBW of born calves was recorded at 0 (birth), 1, 2 and 3 mo of age. She-camels and their calves were weighed in the morning before feeding using a digital weighing indicator (model jade ver. jwi-586).

Milk yield and chemical analysis:

Daily milk yield of each animal (morning and evening milking) was recorded, and then calculated as monthly milk yield during the 1^{st} four lactation months. Chemical composition in monthly milk samples (fat, protein, lactose and ash) was determined using Milko-Scan (Model 133 B). Chemical analysis of CFM was determined according to Methods of AOAC (1980). In monthly milk samples, contents of Na, K, Ca and Mg were determined using an atomic absorption spectrophotometer (Hitachi U-2000, Tokyo, Japan) according to standard methods (AOAC, 1980), while P concentration was determined using spectrophotometer according to the procedures of Watanabe and Olsen (1965). At Animal Health Research Institute, camel leptin Cat. No: (MBS091173) was assayed using Quantitative Sandwich ELISA kit (MyBioSource.com) in milk serum. The detection range was 0.5-16 ng/ml. The standers curve used in this test include leptin concentration at 0.5, 1, 2, 4, 8 and 16 ng/ml. Sensitivity of the assay was 0.1 πg/ml.

Reproductive measurements:

Reproductive parameters, including LBW of She-camels at first service, number of services per conception, services period length, conception rate and gestation period length were recorded for each group. Camels were diagnosed for pregnancy on day 30 post-mating, using ultrasonographic scanner Vetson-color machine (Kontron Medical, France) with endo-rectal ultrasound multi-frequency probe 5 LV (2-7 MHZ).

Statistical analysis:

Data were statistically analyzed according to the General Linear Model (GLM) procedure of the Statistical Analysis System SAS (1999) using analysis of variance with one way design. Values were given as mean ± standard error. The significant differences were subjected to Duncan's Multiple Range Test (Duncan, 1955) and all significant differences were set at P<0.05).

III. Results And Discussion

Live body weight of She-camels and their calves:

At each month of pre- and post-partum periods, average live body weight (LBW) of She-camels increased by advancing parity of animals, but the differences at each month were not significant. During the 1st month before calving, She-camels in each group showed a marked increment in LBW, and sharply decreased at calving due to losing weight of calf and fetal membranes. After calving, She-camels in all groups indicated again steady increment in LBW up to the 4th month of post-partum period. Calves was the heaviest (P<0.05) in G2 than in G1 and G3 and the lowest in G1 from birth up to the 4th month of post-partum period. This cleared increasing LBW of calves when camel parity increased after the 3rd parity, showing the highest weights for She-camels of 4-6 parities (Table 1). The trend of change in LBW of She-camels during pre- and post-partum periods is in agreement with that reported by Mostafa et al. (2016) on Maghrebian She-camels. However, variety in change of body weight subsequent to calving and during lactation might be due to the level of stress, physiological circumstance and natural state of She-camels and the differences in LBW for hereditary lines expanded with parity (Mustafa et al., 2015),Also, the differences in LBW may due to the negative energy balance at early lactation (Gross et al., 2011). The nutritional status is very important of She-camels in late pregnancy, influencing LBW of calves at birth. This was reflected in increasing LBW of calves at birth and post-partum months in G2 as compared to G1 and G3 was mainly attributed to increasing milk yield with appropriate chemical composition of fat, protein and lactose for camel calves as well as forage availability and supplementary diets (Abdel Fattah and Roushdy, 2016). This finding is matched with increasing milk yield and improving milk fat content of She-camels in G2 in comparing with G1 and G3, which will be shown and discussed (Tables 2 and 3).

Table 1: Live body weight of She-camels at pre- and post-partum months and of their calves at post-partum months as affected by parity order.

Parity group	Pre-partum period		Post-partum period			
	2nd mo	1st mo	1st mo (calving)	2nd mo	3rd mo	4th mo
Live body weight (kg) of She-camels:						
G1	490.1±4.940	515.6±5.42	464.2±14.59	475.0±16.58	484.7±14.71	498.0±16.47
G2	502.1±15.50	522.4±13.42	483.5±12.92	484.3±15.54	495.6±12.75	510.6±13.36
G3	528.3±18.91	548.6±16.03	509.2±16.84	513.3±17.41	526.8±18.09	541.2±16.12
Live body weight (kg) of camel calves:						
G1	-	-	28.86±1.16^{b}	37.71±1.04^{b}	46.86±1.35^{c}	57.29±1.19^{c}
G2	-	-	34.29±0.99^{a}	44.71±0.68^{a}	57.14±1.28^{a}	70.43±1.17^{a}
G3	-	-	30.71±1.23^{b}	39.86±0.40^{b}	50.57±0.72^{b}	62.14±1.26^{b}

Means with different superscripts in the same column for She-camels or calves are significantly different P<0.05.

Milk production in She-camels:

Milk yield:

Average monthly milk yield of She-camels was the highest (P<0.05) in G2, moderate in G3 and the lowest in G1 at each lactation month (Fig. 1) or as overall mean during the 1st four lactation months (Fig. 2). This indicated that milk yield increased (P<0.05) in She-camels with 4-6 parities as compared to those with lower (1-3) or higher (7-9) parities. It is of interest to note that milk yield was higher (P<0.05) for She-camels with 7-9 parities than those with 1-3 parities. It is worth noting that peak of milk production in our study was during the 3rd month in G1 and during the 4th month in G2 and G3 (Table 2). In camels, the lactation peak was reported to be at the 3rd month of lactation (Faye, 2004; Mostafa *et al.,* 2016). Also, Kamoun *et al.* (2012) observed the peak of milk yield in Maghrabian camels occurred between the 3rd and 4th month of postpartum period. However, Bekele *et al.* (2002) reported a peak was empiric earlier, between 9 and 19 wk in one humped camel under pastoral management in semi-arid eastern EthiopiaIn accordance with the present results on Maghrebian camels, Almutairi *et al.* (2010) observed that milk yield of Saudi camels was influenced by parity, calving year and stage of lactation. In this respect, Raziq *et al.* (2008) revealed that She-camels have higher milk production at the 3rd season and longer. Also, Abdelgadir *et al.* (2013) found that the highest milk yield was observed at the 6th and 8th parities and the lowest was at the 1st and 9th parities. Moreover, Ahmad *et al.* (2012) concluded that camels have been accept to be low milk producers by increasing parity of She-camels more than 5 parities. On the other hand, Mustafa *et al.* (2015) found that milk yield was not affected by camel parity but was mostly affected by the stage of lactation.The variation of normal milk yield between all parity groups may be ascribed to the typical physiological development and improvement of the mammary gland. The minimal milk production in camels with primary parities could be explained in the basis that, camels in the primary parities are still growing and nutrients are partitioned for body building purpose and milk production. The reduction in milk yield from earlier as compared to older age groups may be due to wear of teeth, the decrease in the number and potency of milk secreting cells, and accepted weakness due to old age (Zeleke, 2007).

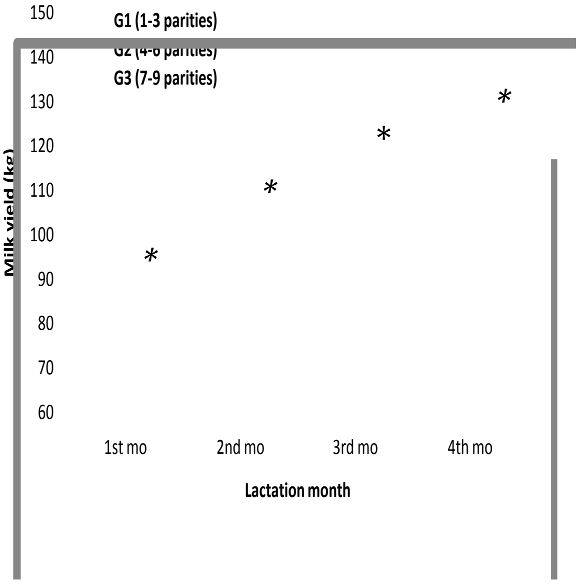

Fig.1. Change in monthly camel milk yield during the 1st four lactation months different parity groups.

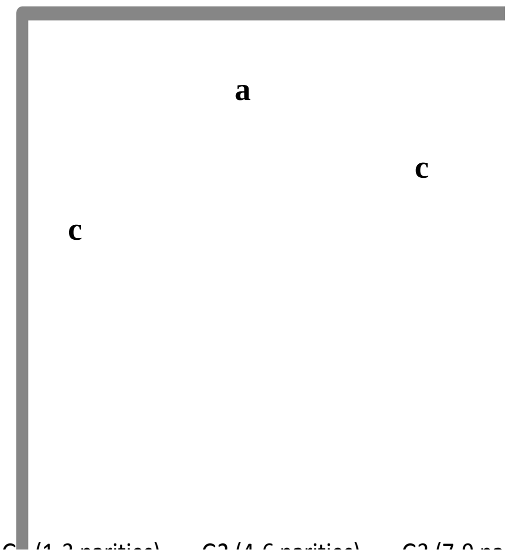

Fig.2.Overall mean of monthly camel milk during the 1st four lactation months in different parity groups.
Means with different superscripts in the same column for She-camels or calves are significantly (P<0.05) different.

Milk composition:

Chemical analysis of camel milk indicated that contents of fat at the 2nd, 3rd and 4th lactation month, and both protein and total solids contents at all months studied were higher (P<0.05) in camel milk of G1 than in G2 and G3 at each lactation month, while both lactose and ash contents were not affected significantly by parity group (Table 2). Also, overall mean of fat, protein and total solids for the four lactation months was the highest (P<0.05) in G1 and the lowest in G3 (Fig. 3). These findings may indicate clearly significant (P<0.05) decrease in fat, protein and total solids in milk by advancing camel parity above the 3rd order, while lactose and ash contents showed slight reduction (P≥0.05) by age advancing. The present values of fat content (2.46-3.73%) are within a range from 1.2 to 6.4% as reported by Konuspayeva *et al.* (2008), while the present values of lactose (3.69-4.36%) and ash (0.81-0.94%) contents in Maghrebian camel milk are within ranges between 2.40 and 5.80% for lactose and 0.6-0.9% for ash as reported by Konuspayeva *et al.* (2009) on dromedary camel milk.

In accordance with the obtained trend of changes in milk contents as affected by camel parity, Dowelmadina *et al.* (2014) reported significant differences in fat content of camel milk with variation in the parity order. In this respect, Abdalla *et al.* (2015) found that percentages of fat, protein, ash in camel milk was highest at the 1st parity and lowest at the 7th parity, but no significant effect of parity was found on total solids content. Also, Al-Sultan and Muhammad (2007) reported that parity had no affect on lactose content.On the other hand, Elhassan *et al.* (2015) reported that total solids content in camel milk increased at the 4th nd 5th parity, while Babiker and El-Zubeir (2014) showed insignificant effect of camel parity on fat content in camel milk.

Table (2): Effect of parity on chemical composition of camel milk during the 1st four months of lactation period.

Milk content (%)	Parity group	Lactation period			
		1st mo	2nd mo	3rd mo	4th mo
Fat	G1	3.73±0.34	3.59±0.26[a]	3.45±0.19[a]	3.38±0.32[a]
	G2	3.14±0.42	2.87±0.20[b]	2.71±0.18[b]	2.53±0.19[b]
	G3	3.06±0.30	2.74±0.23[b]	2.63±0.20[b]	2.46±0.16[b]
Protein	G1	3.82±0.27[a]	3.71±0.31[a]	3.65±0.28[a]	3.56±0.30[a]
	G2	3.01±0.26[b]	2.88±0.30[b]	2.80±0.30[b]	2.69±0.22[b]
	G3	2.74±0.20[b]	2.56±0.17[b]	2.41±0.15[b]	2.37±0.16[b]
Lactose	G1	4.06±0.17	3.91±0.34	4.27±0.24	4.36±0.16
	G2	3.93±0.18	3.77±0.26	4.01±0.28	4.17±0.17
	G3	3.86±0.28	3.69±0.34	3.94±0.36	4.11±0.30
Ash	G1	0.87±0.01	0.89±0.01	0.92±0.01	0.94±0.01
	G2	0.83±0.02	0.86±0.01	0.90±0.01	0.91±0.01
	G3	0.81±0.01	0.83±0.01	0.86±0.01	0.87±0.01
Total solids	G1	12.42±0.35[a]	12.03±0.49[a]	12.23±0.33[a]	12.17±0.58[a]
	G2	10.84±0.45[b]	10.38±0.28[b]	10.42±0.48[b]	10.30±0.36[b]
	G3	10.30±0.43[b]	9.88±0.39[b]	9.91±0.49[b]	9.88±0.50[b]

Means with different superscripts in the same column for each component are significantly different at P<0.05.

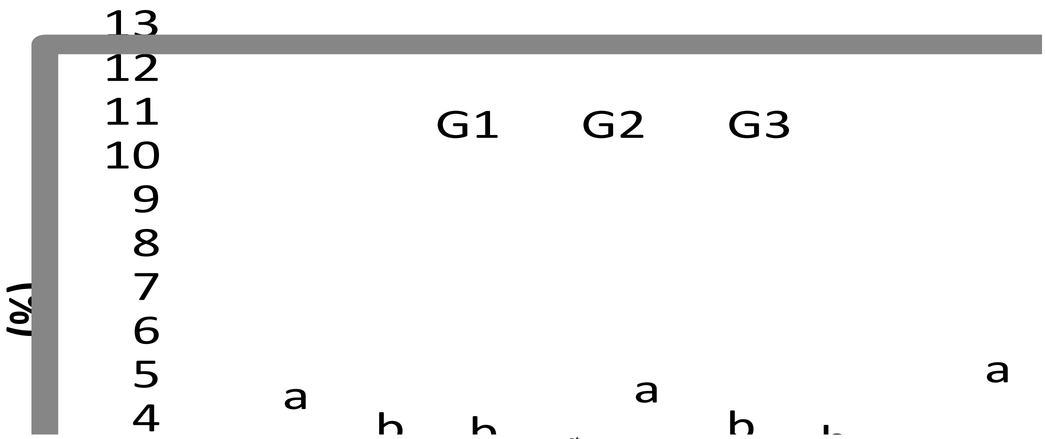

Fig. 3. Overall mean of camel milk composition during the 1st four lactation months in different parity groups.

Major minerals in milk:

During lactation months, there was an increase (P<0.05) in Na content at the 1st and 2nd month and in K content at the 1st month, beside decrease (P<0.05) in Ca content in camel milk by advancing parity order. However, the effect of parity was not significant on Na, K and Ca at other lactation months or on P and Mg contents at all lactation months. Only, overall mean of Na content in camel milk for the four lactation months increased (P<0.05) by increasing parity order up to 7-9 parities (Table 3).

Table (3): Effect of parity on mineral contents in camel milk during the 1st four months of lactation period.

Element (mg/dl)	Parity group	Lactation period				Overall mean
		1st mo	2nd mo	3rd mo	4th mo	
Na	G1	58.29±4.17[b]	55.57±1.99[b]	46.86±4.51	53.71±4.01	53.61±2.43[b]
	G2	64.57±1.60[ab]	61.86±3.28[ab]	51.29±5.43	55.43±4.52	58.29±2.25[ab]
	G3	67.57±1.46[a]	63.85±2.06[a]	56.86±5.24	59.43±2.16	61.93±2.37[a]
K	G1	158.86±1.50[b]	151.29±4.91	155.71±2.07	142.57±4.85	152.11±2.14
	G2	160.86±0.67[ab]	153.43±2.42	156.43±2.38	145.71±5.55	154.11±1.78
	G3	163.71±1.27[a]	157.57±2.22	159.14±2.08	149.43±3.59	157.46±1.10
Ca	G1	45.29±1.95[a]	40.43±2.53	42.57±1.25	39.43±2.06	41.93±1.30
	G2	42.86±1.28[ab]	38.86±1.61	40.43±2.53	38.29±1.36	40.11±1.02
	G3	40.71±0.97[b]	38.86±2.15	39.14±2.02	37.86±1.26	39.14±1.33
P	G1	40.43±1.25	39.29±1.11	37.29±1.49	36.86±1.53	38.47±0.84
	G2	39.29 ±0.71	38.71±0.57	36.14±1.44	35.57±1.89	37.43±0.92
	G3	38.43±0.48	36.86±1.46	35.43±1.27	34.71±1.27	36.36±0.82
Mg	G1	8.19±0.08	8.10±0.07	8.07±0.09	7.99±0.10	8.09±0.05
	G2	8.14±0.19	8.04±0.15	7.90±0.18	7.86±0.13	7.99±0.06
	G3	8.07±0.15	8.03±0.20	7.89±0.10	7.76 ±0.13	7.94±0.07

Means with different superscripts in the same column for each element are significantly different at P<0.05.

In comparable with the present results, Riyadh *et al.* (2012) reported that contents of Na, K and Ca in camel milk were not affected by camel parity. This is in agreement only with the obtained results of mineral contents in camel milk at some lactation especially the 3rd and 4th months. The present variations in the major mineral contents (Na, K, Ca, Mg and P) in camel milk may be attributed to the effect of seasonal change in ambient temperature (Yagil and Etzion, 1980) and water intake (Haddadin *et al.*, 2008). Also, variations of camel milk could be due to breed, feeding system, lactation stage, drought conditions or use of different analytical procedures (Mehaia *et al.,* 1995). The observed trend of reduction in Ca content in camel milk at the 1st month of lactation may be associated with milk yield of each parity group. In this respect, Tsioulpas *et al.* (2007) showed that Ca concentration of milk differed with lactation stage, being the highest immediately after parturition.

Leptin concentration in serum of camel milk:

Effect of parity on leptin concentration in milk during each of the 1st four lactation months was not significant (Table 4). Similar results were obtained on buffalo by Hassan *et al*. (2014), who reported insignificant variation in leptin concentration at early and mid lactation stages. However, Ashmawy (2015) observed a decline in leptin concentration in milk with advancement of lactation period in buffalo. In Friesian cows, Hussein *et al.* (2011) observed that milk serum leptin levels were at high levels at the initial milk samples just after natal, then depressed to nadir at 30 days of lactation then returned to increase, reaching its highest level at 60 days of lactation. However, Rosi *et al.* (2001) concluded that milk leptin seems to be high during early and late stages of lactation and lower during mid-lactation period.

Table (4): Effect of parity on leptin concentration (ng/ml) in camel milk during the 1st four months of lactation period.

Group	Milk leptin concentration (ng/ml) lactation period				Overall mean
	1st mo	2nd mo	3rd mo	4th mo	
G1	5.69±0.28	5.97±0.31	5.83±0.32	5.54±0.38	5.76±0.19
G2	5.91±0.43	5.97±0.44	5.49±0.45	5.23±0.33	5.65±0.24
G3	6.27±0.37	5.83±0.44	5.51±0.45	5.49±0.45	5.78±0.28

In our study, the observed decline in leptin concentration was slight by advancing the 2nd lactation month. Increasing leptin concentrations in milk with time the advancement of lactation could be explained on the basis that leptin is produced by various cell types of the mammary gland, and could act as a paracrine factor on mammary cell proliferation, differentiation and apoptosis via adipose-epithelial and myoepithelial cellular interactions. Secretory epithelial cells may transfer leptin from the blood to attend in milk **(Ashmawy, 2015)**.

Reproductive performance in She-camels:

Reproductive measurements (Table 5), in terms of LBW at the 1st service, number of services per conception (NSC) and gestation period length (GPL) increased (P<0.05) by increasing parity order, being the highest in G3 (camels with 7-9 parities) and the lowest in G1 (camels with 1-3 parities). However, camels in G2 with 4-6 parities showed the best reproductive traits, in terms of the least NSC (3.86 services, P<0.05), shortest service period length (15.71 d, P<0.05), and highest conception rate (86%), with moderate GPL. Animals in G1 showed moderate (P<0.05) SPL and CR (71%). The observed improvement in NSC by advancing camel parity contrasted the results of Mostafa (2007), who reported increasing NSC in the 3rd parity as compared to the 2nd parity in Maghrabian camels. Also conflicted results were obtained on bovine by Hussein (2010), who reported significantly lower NSC at 2-4 parities than in other parities, while, Hammoud *et al*. (2010) found insignificant effect of parity on NSC. Generally, NSC resulted from either failure to conceive at a given service and/or failure to maintain pregnancy thus requiring repeated service. In the present study, GPL of She-camels ranged between 382 and 387 d. However, Ahmed *et al.* (2012) mentioned that the GPL ranged between 365-398 days. The observed variation in GPL may probably due to the production system for farming number of services over the whole time of estrus, number of gestation and sex of the embryo and effects of previous parturition and month of calving. Hammoud *et al.* (2010) reported that the effect of parity on reproductive performance may be due to the changes in managerial systems and environmental conditions among parties. Generally, low reproductive performance could be attributed to older age at puberty, long gestation length, and poor management, environmental factors or other physiological and pathological reasons.

Table (7): Effect of parity on some reproductive traits of She-camels during post-partum period in breeding season

Group	LBW at 1st service (kg)	No of services per conception	Service period length (day)	Gestation period (day)	Conception Rate (%)
G1	457.57±12.54^{b}	3.29±0.29^{b}	18.86±0.51^{b}	382.43±0.72^{b}	71
G2	477.86 ±11.82^{b}	2.86±0.34^{b}	15.71 ±0.75^{c}	384.14±1.10^{b}	86
G3	533.29±6.41^{a}	4.43±0.43^{a}	21.29 ±0.92^{a}	387.57±0.84^{a}	57

Means with different superscripts in the same column are significantly different at P<0.05.

IV. Conclusion

This study indicated that, parity order of camels had a vital role on productivity and reproduction of Maghrebian She-camels. There was gradual increase in live body weight by advancing parity, regardless reproductive status. Milk yield and composition, reproductive performance and LBW of caves were the best at moderate (4-6) as compared to earlier (1-3) or older (7-9) parities. Proper husbandry and health services can play significant roles in the long term improvement of camel production. Therefore, breeders of camel herds should put these results in mind for production and reproduction managements to choose camels at appropriate parity orders.

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