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Milk Production And Composition in Maghrebi She-Camel Under Different Management System In Egypt

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Abstract: *This study aimed to determine the effect of management systems (farming and traditional pastoral system) and parity order on milk yield and composition of lactating Maghrebi camel. Total of forty lactating she-camels (Camelus dromedarius), (aging 5–12 years, weighing 370-590 kg, and between the first and eighth parities) were divided into two system groups (Farming and pastoral, 20 in each). Each of farming or pastoral group was divided into four sub groups according to their parity, including 1-2, 3-4, 5-6 and 7-8parities, 5 animals in each. The obtained results revealed that overall mean of udder depth and circumference were higher (P<0.05) in farm than pastoral system. Udder length showed (P<0.05) an opposite trend, but udder width was not affected by management system. Overall mean of all udder measurements showed increase (P<0.05) by advancing parity. Effect of interaction between management system and animal parity on all udder measurements was not significant. Effect of management system on all teat measurements and milk vein diameter was not significant. However, these measurements increased (P<0.05) by advancing parity. Effect of interaction between management system and animal parity on all teat measurements and milk vein diameter was not significant. Overall mean of IgG, IgM, and IgA concentrations in colostrum of camels did not differ significantly (P<0.05) under both management systems. Concentration of IgG and IgA increased (P<0.05), while IgM insignificantly increased by advancing parity. Effect of interaction between management system and parity on immunoglobulin concentrations was not significant. Daily or total milk yield was higher (P<0.001) under farming more than pastoral system by about 26.12 and 13.41%, respectively. Fat, protein, lactose, total solids and solids not-fat contents attained significantly higher values in milk of farming than in pastoral system. However, ash content showed an opposite (P<0.001) trend. Daily and total milk yield and its composition significantly increased by advancing parity. The interaction between management system and parity was not significant on milk yields and milk composition. Under pastoral system milk showed significantly higher contents of Na and K and significantly lower P and Mg than farm system. Milk Ca and chlorine contents were not affected by management system. By advancing animal parity, Ca and P contents increased (P<0.05) up to 7-8 parities, while Na and K increased (P<0.05) up to 5-6 and 3-4 parities, respectively. Yet, Mg and chlorine contents were not affected significantly by parity. The interaction between management and parity was highly significant (P<0.001) only on K and P, reflecting different trend of change in K and P contents in camels under farm and pastoral system by advancing parity.*
This study could be recommended to increase awareness of the nomads about the importance of the effect of feeding system and parity on yield and nutritive value of camel milk produce for human consumption or suckling their newborns

Keywords: *Maghrebi camel, management system, parity, milk production.*

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I. Introduction

In many countries, dromedary camels are considered the strategic stockpile of food security, play an important role as a milk source and meat **(El-Bahrawy *et al*., 2015)**. Increasing human population challenge food security and evoke the need to explore new resources of food, such as camel products (**Faye and Konuspayeva, 2012)**. Camel milk has an important role in human nutrition in many regions (**Mal *et al*., 2006**) and also widely exploited for medication and human health such as anti-cancer **(Magjeed, 2005),** anti-diabetic (**Agrawal *et al*., 2011**) and hypo-allergic properties (**Shabo *et al*., 2005).** Camel sustains its productivity in difficult conditions and comparatively less affected by the adverse factors like feed and water shortage and water. Several factors, such as type of food, are expected to affect the quality and composition of camel milk **(Mustafa et al., 2015)**. The information on the milk off take of camels varies according to the management of camels in their natural environment or under improved condition **(Yagil, 1980).** However, geographical origin and seasonal variations were found to be the most effective factors in camel milk composition **(Konuspayeva *et***

***al*., 2009**). Milk yield in the dromedary camels ranged between 3.5 and 20 kg **(Jianlin, 2005)**, varies greatly depending on the region **(Kamoun and Jemmali, 2012)**. Camel milk contained all the essential nutrients found in bovine milk **(Narmuratova *et al*., 2006).** Milk yield and composition in camels are influenced by environmental conditions, and time and number of milking (**Aljumaah *et al*., 2011).**

Camel management systems are different from region to another, and very rare references on various quantitative traits of milk under different productive systems are available **(Eha *et al*., 2016)**. **Musaad *et al*. (2013)** concluded that camel milk composition showed a wide variability in its constituents depending on the physiological, genetic and environmental factors. Milk yield of Maghrebi she-camels under traditional extensive conditions averages 2.0 l/d though, under more favorable conditions, it ranges between 6 and 12 l/d (**Ayadi *et al*., 2009**), which suggest that the milk yield potential of this breed is greater than that recoded under the traditional extensive conditions. Variations observed in camel milk composition could be attributed to several factors such as feeding conditions **(Khaskheli *et al*., 2005)** and production systems **(Bakheit *et al*., 2008; Aljumaah *et al*., 2012).**

The objective of this study is to evaluate the effect of different management system and parity order on yield, composition and bacteriological examination of Maghrebi camel milk under Egyptian conditions.

II. Materials And Methods

This study was carried out in the Marsa Matrouh Governorate (Northwest Egypt, 500 km from Cairo during the period from November to Joule.

Animals and experimental design:

Total of forty dairy Maghrebi she-camels (Camelus dromedarius), (aging 5–12 years, weighing 370-590 kg, and between the first and eighth parities) without history of diseases, were divided into two groups (G1 and G2). Twenty camels were chosen from a dairy farming system (Center of Studies and Development of Camel Production), belonging to the Animal Production Research Institute, Marsa Matrouh Governorate and twenty camels from a traditional pastoral herd in the desert areas inhabited by pastoral tribes (Bedouins) followed the same area (Marsa Matrouh Governorate). Each of farming or pastoral group was divided into four sub groups according to their parity, including 1-2, 3-4, 5-6 and 7-8parities, 5 animals in each. Camels in the first group (G1, n=20) were managed under farming system, all animals were kept in the experimental farm during the day, housed in semi-open barns all times and offered ration consisted of 4.5 kg DM of a forage mixture (Berseem hay and rice straw) and 3.5 kg DM of a commercial feed concentrate mixture composed of 25% wheat bran, 25% yellow corn, 9% uncorticated cotton seed meal, 20% barely, 15% rice brain,3% molasses, 2% premix and 1% common salt (Table 1). Feeds were offered to animals twice daily. Free access to clean water was provided at all times by a water tanks.

Camels in the second group (G2, n=20) were managed under traditional pastoral system; animals were brought to graze and browse the available plants and agricultural residues. The dominant vegetations of the natural pasture are Leucaena (30% CF and 20% CP), Atriplex (20% CF and 15% CP), Mesquite (25% CF and 23.5% CP), Kochia indica (14% CF and 23% CP) and Alphalpha (20% CF and 17% CP).

Climatic conditions, including ambient temperature (Max. and Min.) and relative humidity as well as calculated temperature-humidity index all over the year were 25.6 and 16.7 ^{o}C, 64.6 and 58.1%), respectively. However, photoperiod fluctuate between 11 h of light and 13 h of dark during this period.

Udder measurements:

Udder and teat measurements were taken just before morning milking which coincided with approximately 16 h milking interval. Each measurement in the present study was taken twice and the average of the two readings was then adopted as the base of calculations. The following udder and teat measurements were taken; udder depth: the distance between the udder attachment and the base of the teats, udder height**:** the distance from the ground to the base of the teats, and was measured as the distance from the ground to udder floor at the points directly in front of the fore and rear teats, teat length: the distance between the bases of the teat to the tip of the teat, by stretching the tape along the teat, teat diameter: with a vernier caliper at the middle point of the teat, and the distance between both fore, rear, right or left teats. Also, milk vein diameter was measured with a vernier caliper.

Milking and milk samples:

All camels were handly milked twice a day. Milk yield was measured after the born calves were allowed to suckle colostrum from their dams for the first seven days. After each milking, milk was weighed on limited day for each week and then monthly milk yield was calculated for the lactation period.

Milk composition:

Milk Samples (30 ml) were collected from each lactating camel at milking time in clean glass bottles. Monthly sample of each camel were mixed from morning and evening milking, and taken for the determination of composition and physical characteristics of milk all over the lactation period. Whole milk samples were stored frozen at−20◦C without adding preservatives then the samples were heated to 40°C in a water bath and held at this temperature for 15 min for detection of protein, fat, lactose, total solids, solid not fat and ash using Lactoscan (-Ultasonic Milk Analyzer, Bulgaria).

Colostrum analysis:

Colostrum samples were collected within one hour of parturition (first milking) from each dam on the 1st, 2nd and 3rd day postpartum for immunoglobulin studies. Determination of immunoglobulins, including IgA, IgM and IgG in colostrum was applied by Bovine radial immune-diffusion (RID) kit according to the procedure outlined by the manufacturer (The Binding Site Ltd, Birmingham, UK). The principle of the technique was derived from the work of **Mancini *et al*. (1965)** and **Fahey and McKelvey (1965).**

Mineral content in milk:

Contents of Ca, K, Na, and Cl in milk samples were determined with an atomic absorption spectrophotometer (Hitachi U-2000, Tokyo, Japan) according to standard methods of **AOAC (1980).** Phosphorus content was determined spectro-photometrically using the procedure of **Watanabe and Olsen (1965)**.

Statistical analysis

Statistical analysis was carried out using the General Linear Model Program (GLM) of **SAS (2002).** Data were analyzed using the following model:

$\mathbf{Y_{ijK}= \mu+ T_i + D_K+ e_{ijK}}$, where µ = overall mean, T_i = fixed effect of management, D_K= fixed effect of parity and eij_k = Error. The significant differences among means of parity groups were set at P<0.05 using multiple range test of **Duncan (1955)**.

III. Results And Discussion

Udder measurements:

Data showed that overall mean of udder depth and circumference were significantly (P<0.05) higher in camels of farm than pastoral system. However, udder length showed significantly (P<0.05) an opposite trend, but udder width was not affected by management system (Table 2).

It is worth noting that overall mean of all udder measurements showed significantly (P<0.05) gradual increase by advancing animal parity, being the lowest at 1-2 parities and the highest at 7-8 parities. On the other hand, the effect of interaction between management system and animal parity on all udder measurements was not significant, reflecting similar trend of changes in all measurements by advancing parity order udder both management system (Table 2).

Teat measurements:

Effect of management system on all teat measurements and milk vein diameter (Table 3) was not significant. However, these measurements significantly (P<0.05) increased by advancing parity of camels, being with the highest values in camels with 7-8 parities. Also, the effect of interaction between management system and animal parity on all teat measurements and milk vein diameter was not significant, showing the same trend of increase in all measurements by advancing parity for camels in farm and pastoral systems (Table 2).

In lactating camels, **Zayeed *et al*. (1991)** mentioned to a highly variations due to many factors such as breed, lactation stage, parity number and disease which can be influence on the size and length of udder and teats. Similarly, **Abdallah and Faye (2012)** observed a clear variability in teats and udder length in 12 breeds of camels in Saudi Arabia, while some of the udder morphometric measurements of Lahween dromedary camel in Sudan have proved to possess an impact on their milk yield **(Eisa *et al*., 2010).** In addition, lactating camels are characterized by the development of the udder and milk veins **(Wardeh and Al-Mustafa, 1990).**

Our results were less than that reported by **Ayadi *et al*. (2013)** for udder measurements (cm). **Ayadi *et al*. (2013)**, also found positive relationships were detected between milk yield and udder morphology traits of dairy camels. Udder height measured was similar to values reported by **Eisa *et al*. (2010**). However, udder length and depth values were greater than the results previously reported by **Abdallah and Faye (2012**) in dromedary camels.

In accordance with the present results in this study, **Ayadi *et al*. (2013)** and **Abdallah and Faye (2012**) found that teat length showed similar values in different breeds of camel in Saudi Arabia. Meanwhile, the distance between teats was greater than the results previously reported by **Eisa *et al*. (2010)** on camel. The well developed milk vein observed in our study may reflect a high yield milk secretion potential. In agreement with the present results regarding the effect of parity on udder measurements, **Osman (2006)** found marked trend of increase in all uder and teat measurements as well as in diameter and length of milk vein by advancing parity, stage of lactations and age of camel.

Immunoglobulin concentration in camel colostrum:

Table (4) showed that overall mean of IgG, IgM, and IgA concentrations in colostrum of camels did not differ significantly ($P<0.05$) under both management systems.) However, concentration of IgG and IgA significantly ($P<0.05$) increased, while IgM insignificantly increased by advancing animal parity. Meanwhile, the effect of interaction between management system and parity on immunoglobulin concentrations was not significant.

Concentration of IgG in camel milk is 1.64 mg/ml as compared to 0.70, 0.67, 0.55, 0.63 and 0.86 mg/ml for goat, cow, sheep, buffalo and human milk, respectively (**El-Agamy and Nawar, 2000)**. In spite of the higher mean IgG concentration in the Dromedary camels, **Konuspayeva *et al.* (2007)** found that mean IgG concentration in raw camel milk was 0.718 ± 0.330 mg/m, but IgG concentration differed for region. They also found seasonal change in IgG content, being higher in winter than in summer. Concentration of IgG decreased regularly ($P<0.001$) throughout the year, with the highest value in January and the lowest in July.

It is highly required to investigate colostrum under farming and traditional systems to evaluate the impact of this variable on neonatal viability rate. In this respect, **Bernabucci *et al.* (2013)** mentioned that multiple factors influence the production and the composition of colostrum, including the species, breed, health status of the mammal, feeding practices, and time collected post-parturition. However, **El-Hatmi *et al.* (2006)** found that concentration of IgG at first milking in Tunisian camels dropped abruptly in the subsequent milkings. **Fahmy and Maha (2010)** found that the concentration of IgG1 decreased by 94% within the whole period of lactation in dromedary camel (Camelus dromedarius) reared in Marsa Matroh governorate during the first season of lactation. **Mackle *et al.* (1999)** showed that a pasture supplementing with maize grain and silage led to slightly decreasing of IgG content. Also, In bovin, **Król *et al.* (2012)** reported that feeding system has the major impact on the milk yield and its chemical composition. Milk of cows grazing the pasture was characterized by a higher content of IgG. **Osman (2014)** mentioned that individual animals showed a wide range of colostrum composition which suggests a prominent role of animal individuality. The chemical characteristics of colostrum were greatly affected by colostral days and slightly by lactation number.

Milk yield and composition:

Data in Table (5) showed that daily or total milk yield was significantly ($P<0.001$) higher for she-camels under farming systems more than those under traditional pastoral system by about 26.12 and 13.41%, respectively. Also, camel milk composition showed significant differences between both management systems. Fat, protein, lactose, total solids and solids not-fat contents attained significantly higher values in milk of farming system as compared with the traditional pastoral system. However, ash content showed significantly ($P<0.001$) an opposite trend. As affected by animal parity, data in Table (5) cleared that significant increase in daily and total milk yield and its composition by advancing parity. The interaction between management system and parity was not significant on milk yields and milk composition.

It is worth noting that increasing milk yield of camels under farm system was associated with significant increase in depth and circumference of udder with insignificant changes in teat characteristics as compared to pastoral camels. Also, increasing milk yield by advancing camel parity, regardless management system, was related to developmental changes in udder and teat measurements by age progress. These results indicated significant effects of camel management system on yield and composition of milk. Remarkable variation in feeding system was achieved in camel farms or during grazing. In this study, camels were under good feeding system in the farm, while camels under pastoral system were under poor feeding of fry and wet shrubs and desert shrubs and insufficient in drinking water (thirst). The most important factor in camel milk for peoples living in dry zone is its water content **(Wilson, 1998).**

In similarity with the present results, **Bakheit *et al.* (2015)** found that average daily milk yield was 6.85±1.32 and 3.14±0.66 liter for semi-intensive and traditional system, respectively with highly significant ($P<0.001$) differences. The increase in average daily milk yield amounted to 53% under semi-intensive system compared to those under traditional system. The present values of milk composition are in agreement with the results of **Abdalla *et al.* (2015)**, who reported that milk of Maghrebi she-camels under normal condition contained 3.01, 3.06, 0.69, 4.33, and 11.06%for protein, fat, ash, lactose and total solids contents, respectively. Also, **Obied and Hakem (2014)** found a wide range of variation in the chemical composition of milk among different management systems especially under uncontrolled environmental condition as is mostly the case locally and the significant effect between the mean values of the two milk groups at ($P<0.05$) were found to be in water, lactose, ash and total solids. In this respect, **Shuiep *et al.* (2014)** revealed that, camel milk under semi intensive system showed significantly (P<0.05) higher total protein, solids not-fat and lactose contents. Whereas, fat was significantly (P<0.05) higher in milk samples collected from traditional nomadic system. Several authors reported that camel milk composition was influenced by regional differences including feeding conditions **(Konuspayeva *et al*., 2009; Al-Haj and Al-Kanhal, 2010; Babiker and El Zubeir, 2014),** or management system, season, stage of lactation and calving number **(Riyadh *et al*., 2012),** and geographical locations or feeding conditions **(Bekele *et al*., 2011).** On the other hand, **Dowelmadina *et al*. (2014)** found that the highest percentages of fat, protein, lactose, total solids and solids not fat were recorded for the camel in the traditional nomadic system, followed by the semi intensive system. Finally, **Mustafa *et al*. (2014)** found that mean values of solid non-fat; crude fat; crude protein and lactose were (9.13 and 8.42%); (5.39 and 1.71%); (4.94 and 4.57%) and (3.64 and 3.24%) in milk of camels kept under traditional pastoral and farming system, respectively.

Mineral content in milk:

Results in Table (6) revealed that camels reared under traditional pastoral system showed significantly higher contents of Na and K and significantly lower inorganic P and Mg than those reared under farm system. However, milk Ca and chlorine contents were not affected by management system. These trends may be due to the differences of the feeding and water intake.

By advancing animal parity, Ca and P contents significantly (P<0.05) increased up to 7-8 parities, while Na and K significantly (P<0.05) increased up to 5-6 and 3-4 parities, respectively. Yet, Mg and chlorine contents were not affected significantly by parity. The interaction between management and parity was highly significant (P<0.001) only on K and P, reflecting different trend of change in K and P contents in camels under farm and pastoral system by advancing camel parity (Table 6).

It was reported that the major mineral contents (Ca, P, Na, and K) of dromedary camel milk showed a large variation among different studies due to breed, feeding, stage of lactation, drought conditions, or analytical procedures **(Mehaia *et al*., 1995; Gorban and Izzeldin, 1997)**. In agreement with this study, **Obied and Hakem (2014)** found that the desert camel bulk milk had significantly higher amount of Ca, Na and K than in farm camel milk. **Shawket and Ibrahem (2012)** found increased (P<0.05) content of macro-elements (Na, K and Ca %) in milk of camels fed ad lib. on fresh Atriplex halimus due to higher Na, K and Ca contents in Atriplex than in berseem hay.

On the other hand, **Elnour and Bakheit (2012)** indicated that mineral contents in camel milk were affected by parity. Contents of P, Na and K markedly increased with increasing parity number. Content of P in milk of camels at one and three parities were 1.13 and 1.4%, respectively, increased to 1.8% at advanced perities. Content of Na (0.65- 0.95%) and K (3.37-4.1%) increased, while Ca content (5.2-1.55%) markedly decreased (5.2 and 1.55%) by increasing camel parity.

IV. Conclusion

Based on the foregoing results, both parity order and management system play an important role in productive performance of Maghrebi lactating camels, in terms of remarkable increase in milk yield and production of good quality milk of Maghrebi camel under farm system as compared to pastoral system and by advancing parity order, without obvious effect was found on level of immunoglobulins in milk. On the basis of the obtained results, this study could be recommended to increase awareness of the nomads about the importance of the effect of feeding system and parity on yield and nutritive value of camel milk produce for human consumption or suckling their newborns.

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Table (1): Chemical composition of different feedstuffs used in feeding camels.

Item	CFM	BH	RS
DM (%)	89.44	88.91	88.46
Chemical analysis (%):			
OM	92.43	82.92	82.24
CF	8.85	24.91	35.69
CP	12.24	13.85	2.53
EE	4.64	1.14	1.52
NFE	66.70	43.02	40.50
Ash	7.57	17.08	19.76

CFM: Concentrate feed mixture. BH: Berseem hay. RS: Rice straw.

Table 2. Effect of management system and parity on udder measurements (cm) in Maghrebi she camels.

Treatment	Udder measurement (cm)			
	Depth	**Length**	**Width**	**Circumference**
Effect of management system:				
Farm (F)	22.75±0.64^{a}	21.00±1.01^{b}	19.75±0.91	55.25±3.58^{a}
Pastoral (P)	21.25±1.13^{b}	22.75±0.72^{a}	19.55±0.81	50.25±3.43^{b}
Significance	*	*	NS	**
Effect of parity:				
1-2 parities	16.00±1.01^{c}	17.00±0.94^{c}	14.50±0.62^{c}	34.00±1.75^{d}
3-4 parities	21.50±0.56^{b}	21.00±0.65^{b}	20.00±0.58^{b}	45.00±2.13^{c}
5-6 parities	24.50±0.73^{a}	24.50±0.78^{a}	20.00±0.70^{b}	60.50±2.02^{b}
7-8 parities	26.00±0.67^{a}	25.00±0.56^{a}	23.50±0.72^{a}	71.50±1.61^{a}
Significance	***	***	***	***
Interaction between management system and parity:				
F x 1-2 parities	18.00±1.38	15.00±0.14	15.00±1.05	35.00±2.00
F x 3-4 parities	22.00±0.71	20.00±0.55	19.00±0.89	48.00±2.10
F x 5-6 parities	25.00±0.95	24.00±1.14	20.00±0.95	64.00±2.28
F x 7-8 parities	26.00±1.10	25.00±0.95	25.00±0.55	74.00±2.59
P x 1-2 parities	14.00±0.84	19.00±0.84	14.00±0.71	33.00±3.05
P x 3-4 parities	21.00±0.89	22.00±1.05	21.00±0.45	42.00±3.39
P x 5-6 parities	24.00±1.18	25.00±1.14	20.00±1.14	57.00±3.24
P x 7-8 parities	26.00±0.89	25.00±0.71	22.00±0.95	69.00±1.34
Significance	NS	NS	NS	NS

NS = Insignificant, * P<0.05, ** P<0.01 and *** P<0.001.

Means denoted within the same column for each factor with different superscripts are significantly different at P<0.05.

Table 3. Effect of management system and parity on teat measurements (cm) in Maghrebi she camels**.**

Variable	Fore teats				Rear teats				Distance between lateral teats	Milk vein diameter (MVD)
	Length	**Circum-ferenc**	**Height**	**Distance in-between**	**Length**	**Circum-ferenc**	**Height**	**Distance in-between**		
Effect of management system:										
Farm (F)	3.75±0.43	2.42±0.21	93.10±2.20	12.85±0.73	5.55±0.50	11.75±1.01	91.65±2.15	13.50±0.73	3.90±0.22	3.01±0.25
Pastoral (P)	4.05±0.45	2.32±0.22	94.90±1.95	12.55± 0.71	5.70±0.52	11.90±0.96	93.55±1.96	13.35±0.68	4.35±0.25	3.05±0.28
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Effect of parity:										
1-2 parities	1.90±0.23^{d}	1.39±0.09^{d}	81.10±1.68^{c}	9.10±0.56^{b}	3.00±0.21^{d}	6.90±0.43^{d}	79.80±1.77^{c}	9.30±0.42^{c}	3.30±0.33^{b}	1.59±0.12^{c}
3-4 parities	3.00±0.21^{c}	1.99±0.10^{c}	93.80±1.84^{b}	12.90±0.65^{a}	4.40±0.30^{c}	9.50±0.45^{c}	92.70±1.93^{b}	13.90±0.62^{b}	4.10±0.23^{ab}	2.45±0.12^{b}

5-6 parities	4.30±0.42^{b}	2.43±0.18^{b}	100.20±1.38^{a}	13.70±0.70^{a}	7.00±0.42^{b}	13.70±0.70^{b}	98.60±1.24^{a}	14.70±0.78^{ab}	4.50±0.22^{a}	3.88±0.22^{a}
7-8 parities	6.40±0.37^{a}	3.65±0.18^{a}	100.90±0.80^{a}	15.10±0.97^{a}	8.10±0.27^{a}	17.20±0.4^{8}	99.30±0.74^{a}	15.80±0.55^{a}	4.60±0.40^{a}	4.19±0.14^{a}
Significance	***	***	***	***	***	***	***	***	*	***
Interaction between management system and parity:										
F x 1-2 parities	2.00±0.31	1.46±0.13	79.40±1.65	9.20±0.860	3.00±0.31	6.40±0.67	78.00±1.51	9.00±70	3.20±0.48	1.72±0.1
F x 3-4 parities	2.80±0.20	2.08±0.08	91.60±2.06	13.00±0.94	4.60±0.50	9.20±0.58	90.60±2.15	14.40±0.87	4.20±0.37	2.40±0.1
F x 5-6 parities	3.60±0.40	2.32±0.22	99.80±2.74	14.20±1.20	6.60±0.74	14.80±1.01	98.00±2.40	15.40±1.07	4.20±0.37	3.80±0.35
F x 7-8 parities	6.60±0.50	3.80±0.22	101.60±1.02	15.0±1.48	8.00±0.44	16.60±0.81	100.00±0.89	15.20±0.96	4.00±0.44	4.10±0.24
F x 1-2 parities	1.80±0.37	1.32±0.14	82.80±2.98	9.00±0.83	3.00±0.31	7.400±0.50	81.60±3.18	9.60±0.50	3.40±0.50	1.46±0.18
F x 3-4 parities	3.20±0.37	1.90±0.18	96.00±2.93	12.80±1.01	4.20± 0.37	9.80±0.73	94.80±3.15	13.40±0.92	4.00±0.31	2.50±0.19
F x 5-6 parities	5.00±0.63	2.54±0.30	100.60±0.97	13.20±0.80	7.40±0.40	12.60±1.20	99.20± 1.01	14.00±1.18	4.80±0.20	3.96±0.31
F x 7-8 parities	6.20±0.58	3.50±0.302	100.20±1.28	15.20±1.42	8.20±0.37	17.80±0.48	98.60±1.20	16.40±0.50	5.20±0.58	4.28±0.18
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = Insignificant, * P<0.05 and *** P<0.001.

Means denoted within the same column for each factor with different superscripts are significantly different at P<0.05.

Table 4. Effect of management system and parity on immunoglobulin concentration in colostrum in Maghrebi she camels.

Variable	IgG (g/dl)	IgM (g/dl)	IgA (g/dl)
Effect of management system:			
Farm system (F)	33.69±2.31	4.93±0.20	2.92±0.24
Pastoral system (P)	32.0±2.09	4.98±0.21	3.11±0.20
Significance	NS	NS	NS
Effect of parity:			
1-2 parities	20.54±0.79^{d}	4.49±0.32	2.49±0.27^{b}
3-4 parities	28.99±0.89^{c}	5.43±0.24	2.73±0.25^{b}
5-6 parities	36.96±1.56^{b}	4.88±0.15	3.60±0.30^{a}
7-8 parities	44.89±0.91^{a}	5.02±0.34	3.23±0.33^{ab}
Significance	***	NS	*
Interaction between breeding system and parity			
F x 1-2 parities	20.28±1.21	4.36±0.48	2.14±0.28
F x 3-4 parities	29.36±1.24	5.20±0.35	2.48±0.26
F x 5-6 parities	39.64±1.78	5.02± 0.25	4.10±0.50
F x 7-8 parities	45.48±1.34	5.14 ±0.50	2.94±0.41
P x 1-2 parities	20.80±1.14	4.62±0.50	2.84±0.44
P x 3-4 parities	28.62±1.40	5.66±0.32	2.98±0.41
P x 5-6 parities	34.28±2.06	4.74±0.19	3.10±0.16
P x 7-8 parities	44.30±1.34	4.90±0.53	3.52±0.53
Significance	NS	NS	NS

NS = Insignificant, * P<0.05 and *** P<0.001.

Means denoted within the same column for each factor with different superscripts are significantly different at P<0.05.

Table 5. Milk yield and chemical composition of Maghrebi she camels as affected by management system, camel parity and their interaction.

Variable	Milk yield (kg)		Milk composition (%)					
	Daily	Total	Fat	Protein	Lactose	Ash	Total solids	Solid not-fat
Effect of management system:								
Farm system (F)	7.29±0.39^{a}	496.0±26.18^{a}	2.52±0.11^{a}	3.08±0.15^{a}	5.77±0.17^{a}	0.80±0.04^{b}	12.17±0.38^{a}	9.64±0.32^{a}
Pastoral system (P)	5.78±0.26^{b}	437.4±33.04^{b}	1.87±0.05^{b}	2.64±0.11^{b}	5.30±0.24^{b}	1.004±0.03^{a}	10.81±0.35^{b}	8.94±0.34^{b}
Significance	***	**	***	***	*	***	***	**
Effect of parity:								
1-2 parities	4.86^{c}±0.26c	282.7±27.76^{c}	1.94±0.15^{c}	2.28±0.07^{d}	4.34±0.23^{b}	0.75±0.06^{b}	9.32±0.21^{c}	7.37±0.25^{c}
3-4 parities	6.22^{b}±0.37b	478.6±26.60^{b}	2.04±0.07^{bc}	2.59±0.11^{c}	5.60±0.25^{a}	0.88±0.06^{a}	11.12±0.34^{b}	9.08±0.29^{b}
5-6 parities	6.90^{b}±0.51b	508.3±19.68^{b}	2.33±0.16^{ab}	3.00±0.14^{b}	6.09±0.17^{a}	0.97±0.03^{a}	12.41±0.35^{a}	10.07±0.27^{a}
7-8 parities	8.15^{a}±0.28a	597.3±12.32^{a}	2.46±0.18^{a}	3.55±0.17^{a}	6.08±0.14^{a}	0.99±0.04^{a}	13.09±0.36^{a}	10.63±0.22^{a}
Significance	***	***	**	***	***	***	***	***
Interaction between management system and parity:								

F x 1-2 parities	4.94±0.51	351.2±31.77	2.18±0.23	2.26±0.14	4.66±0.27	0.66±0.12	9.76±0.17	7.58±0.33
F x 3-4 parities	7.14±0.39	505.0±44.11	2.24±0.04	2.88±0.09	5.95±0.14	0.76±0.07	11.83±0.14	9.59±0.18
F x 5-6 parities	8.26±0.44	515.0±33.90	2.72±0.19	3.20±0.11	6.35±0.22	0.89±0.01	13.17±0.33	10.45±0.24
F x 7-8 parities	8.82^{a}±0.25	613.0±11.79	2.95±0.19	3.97±0.18	6.11±0.08	0.89±0.03	13.91±0.34	10.96±0.21
P x 1-2 parities	4.78±0.22	214.2±10.61	1.71±0.16	2.31±0.07	4.02±0.36	0.84±0.04	8.88±0.30	7.17±0.41
P x 3-4 parities	5.30±0.25	452.2±29.85	1.84±0.04	2.31±0.09	5.25±0.46	1.01±0.08	10.42±0.51	8.58±0.49
P x 5-6 parities	5.54±0.28	501.6±23.92	1.94±0.11	2.80±0.26	5.85±0.25	1.07±0.03	11.66±0.40	9.71±0.47
P x 7-8 parities	7.48±0.28	581.6±20.52	1.98±0.07	3.15±0.16	6.05±0.30	1.11±0.04	12.28±0.40	10.30±0.36
Significance	**	NS	NS	NS	NS	NS	NS	NS

NS = Insignificant and *** P<0.001.

Means denoted within the same column for each factor with different superscripts are significantly different at P<0.05.

Table 6. Mineral content in milk of Maghrebi camels affected by management system, camel parity and their interaction.

Variable	Mineral content (mg/dl)					
	Calcium	**Sodium**	**Potassium**	**Inorganic phosphors**	**Magnesium**	**Chlorine**
Effect of management system:						
Farm system (F)	188.27±4.34	75.38±2.97^{b}	87.83±1.49^{b}	117.74±3.07^{b}	11.80±0.34^{a}	100.24±0.54
Pastoral system (P)	190.77±3.61	81.98±3.31^{a}	92.22±3.06^{a}	102.47±1.79^{a}	7.38±0.17^{b}	101.38±0.42
Significance	NS	**	*	***	***	NS
Effect of parity						
1-2 parities	167.55±4.68^{c}	65.30±2.10^{b}	75.43±2.05^{b}	104.07±2.21^{c}	9.53±0.96	99.80±0.49
3-4 parities	190.25±4.44^{b}	68.45±2.70^{b}	94.36±2.35^{a}	103.62±2.26^{c}	9.51±0.66	101.07±0.65
5-6 parities	197.61±3.17^{ab}	88.39±2.12^{a}	93.26±2.35^{a}	111.20±4.72^{b}	9.64±0.95	100.28±0.81
7-8 parities	202.66±1.81^{a}	92.58±2.91^{a}	97.05±1.80^{a}	121.55±4.84^{a}	9.66±0.71	102.09±0.66
Significance	***	***	***	***	NS	NS
Interaction between management system and parity:						
F x 1-2 parities	158.48±3.32^{d}	62.22±2.68	79.55±1.37^{e}	106.53±2.47^{bc}	12.02±0.97	99.94±0.93
F x 3-4 parities	196.88±5.79^{ab}	66.23±3.98	90.51±2.32^{cd}	106.97±1.82^{bc}	11.36±0.48	100.52±1.23
F x 5-6 parities	198.66±3.71^{a}	86.40±2.82	88.97±3.06^{d}	124.34±3.16^{a}	12.23±0.85	99.56±1.41
F x 7-8 parities	199.06±1.75^{a}	86.65±3.13	92.29±1.13^{bcd}	133.14±5.39^{a}	11.58±0.44	100.94±0.95
P x 1-2 parities	176.64±6.82^{c}	68.38±2.82	71.32±2.93^{f}	101.61±3.59^{bc}	7.04±0.32	99.66±0.48
P x 3-4 parities	183.62±5.76^{bc}	70.67±3.82	98.21±3.49^{ab}	100.27±3.77^{bc}	7.67±0.18	101.62±0.50
P x 5-6 parities	196.56±5.57^{ab}	90.39±3.22	97.56±2.54^{abc}	98.07±2.02^{c}	7.05±0.08	101.0±0.87
P x 7-8 parities	206.26±2.30^{a}	98.50±3.30	101.80±1.42^{a}	109.95±3.09^{b}	7.76±0.54	103.24±0.67
Significance	*	NS	**	**	NS	NS

NS = Insignificant, * P<0.05, ** P<0.01 and *** P<0.001.

Means denoted within the same column for each factor with different superscripts are significantly different at P<0.05.

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