Punjab University Journal of Zoology

OPEN ACCESS

38(1): 43-51 (2023)
https://dx.doi.org/10.17582/journal.pujz/2023.38.1.43.51

Check for updates

Research Article

Milk Profile of Marecha Camel (*Camelus dromedarius*) Affected by Stage of Lactation and Pregnancy

Asim Faraz[1*], Nasir Ali Tauqir[2], Hafiz Muhammad Ishaq[1], Muhammad Arslan Akbar[3], Muhammad Abubakar Sufyan[1], Abdul Waheed[1], Muhammad Usman Saleem[4], Muhammad Shahid Nabeel[5], Morteza Bitaraf Sani[6], Amal AlKharusi[7], Samira Jebahi[8] and Ayman Balla Mustafa[9]

[1]*Department of Livestock and Poultry Production, Bahauddin Zakariya University, Multan, Pakistan*
[2]*Department of Animal Nutrition, The Islamia University of Bahawalpur, Pakistan*
[3]*Department of Breeding and Genetics, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan*
[4]*Department of Bio Sciences, Bahauddin Zakariya University Multan Pakistan*
[5]*Livestock and Dairy Development Department, Punjab, Pakistan*
[6]*Animal Science Research Department, Yazd Agricultural and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization (AREEO), Yazd, Iran*
[7]*Ministry of Agriculture and Fisheries and Water Resource, Sultanate of Oman*
[8]*TechnologiesNucléaires (CNSTN), 2020, Sidi Thabet-Tunisia*
[9]*Therapeutic Nutrition Department, Faculty of Nursing and Health Sciences, Misurata University, Misurata, Libya*

Article History
Received: May 21, 2022
Revised: October 15, 2022
Accepted: November 09, 2022
Published: April 03, 2023

Authors' Contributions
AF conducted trial and wrote the paper. MSN helped in conduct of trial, NAT, HMI, MAA, MAS and MUS, helped in write-up. AW helped in analysis, MBS and AAK helped in structuring manuscript. SJ and ABM reviewed the paper.

Keywords
Camel, Production, Composition, Milk, physiological condition

Abstract | The current research was conducted to investigate the outcome of lactation stage and pregnancy on milk composition and production of Marecha dromedary camel at Camel Breeding and Research Station (CBRS), Rakh Mahni, district Bhakkar of Punjab province, Pakistan. Two comparable groups of she-camels were formed and each group had ten she-camels; one group was selected from early lactation stage (1-3 months) with no pregnancy (G1) and the second group (G2) with end lactation stage (11-14 months) with pregnancy (2-4). Milk yield was recorded in liters. By using Milky Lab Analyzer, the estimated values of milk composition were determined including protein, total solids, fat, density, lactose, and solids not fat (SNF). The difference between composition of milk, and yield was found to be significantly ($P<0.05$) high. Solids not fat (SNF), protein, and total solids in milk were found to be highly significant ($P<0.05$) in early lactating and non-pregnant females while milk density and lactose were studied to be highly significant in mid-end lactating and pregnant she-camels. A significant reduction in milk fat, protein, and SNF total solids was studied as the stage of lactation proceed. The results showed that physiological condition like the lactation stage and pregnancy has great significant effects on milk composition and yield.

Novelty Statement | Camel is a chief source of food security especially for the arid and semi-arid areas of Pakistan, where the pastorals mainly rely on this natural resource for their food and day to day activities. The major product of camel is milk in this area, while this study especially deals with two important factors i.e. lactation stage and pregnancy effects on milk profile of Marecha dromedary camel in desert adobes. This study will make the primary database of country for related future studies and will pave a way for further investigations in camel science.

To cite this article: Faraz, A., Tauqir, N.A., Ishaq, H.M., Akbar, M.A., Sufyan, M.A., Waheed, A., Saleem, M.U., Nabeel, M.S., Sani, M.B., Al-Kharusi, A., Jebahi, S., and Mustafa, A.B., 2023. Milk profile of marecha camel (*Camelus dromedarius*) affected by stage of lactation and pregnancy. *Punjab Univ. J. Zool.*, **38**(1): 43-51. https://dx.doi.org/10.17582/journal.pujz/2023.38.1.43.51

Introduction

Camel has an integral part in the sustenance of livelihood of rural population of the various eco-zones ranging from central Asia to the horn of Africa (Faraz *et al*., 2019a; Faraz, 2020). The purpose of camel domestication was mainly for milk production and they are said to be a good milk producer and a chief source of livelihood, particularly for population of arid, semi-arid, and deserted areas (Faraz *et al*., 2019b). Vitamin C is higher in camel milk (Konuspayeva *et al*., 2011) and in pastoral community, it has importance as source of food (Mohamed *et al*., 2005; Saini *et al*., 2007).

For pastoralists and agro-pastoralists, camel has great importance over other domestic livestock which is adapted to semi-arid or arid conditions because during drought conditions it produces a satisfying volume of milk for a longer period (Faraz *et al*., 2019c, 2021). Camels have excellent genetic potential for milk production and their lactation period is much longer (390 days) than small as well as large ruminants. The fodder necessities are also relatively lesser than other dairy animals, the only source of milk are camels, especially in desert areas (Faraz *et al*., 2019b).

Camel has the great production capacity of extra milk per kg of body weight as compared with other dairy animals (Knoess *et al*., 1986). In same conditions, camel lactation period is longer than other domestic species as compared to their feed intake which is moderate (Wilson, 1998). Camels can survive in harsh and hostile places where greenish fodder is available seasonally only due to unpredictable rainfalls (Knoess, 1977; Yagil, 1994).

Pakistan has a good number of camels population of 1.1 million heads (GOP, 2021-22), so it is enough population to make to help Pakistanis understand our tasks to multi-purpose domestication of camel specie. Urbanization is speedier in the country, the camel population is maintained and has no descending tendency so that details can be clearly mentions the worth of the one-humped camel in different areas of Pakistan (Faraz *et al*., 2019c). Therefore, there is a need of reconnoitering its production potential affected by several physiological conditions under its natural habitat. Under the routine regional pastoral managing system, milk production by camels is enough than any other type of species of domesticated animals when they are raised in the similar environment (Raziq *et al*., 2010).

It exemplifies that the camel has an excessive potential as a dairy animal in its usual environment. Milk production differs with the age, breed of animal, managemental conditions, feeding, and lactation stage. By following the above debate, the plan of the present research was desired to assess the influence of lactation stage and pregnancy on composition and yield of milk in the natural environment of Marecha dromedary camel (Thal desert).

Materials and Methods

Study area

The CBRS (Camel Breeding and Research Station) Rakh Mahni is located in the Thal desert region and this area is considered as the agro-ecological zone-III. Sandy storms come and contain dunes and thin strips of sandy crests. The climatic conditions change between the semi-arid and arid regions and the average temperature of midwinter falls from 5.5 to 1.3 and the average temperature during summer days reaches up to 45.6 ˚C. From south to north average rain fall increases and range of average annual rainfall is from 150-350mm (Rahim *et al*., 2011).

Allocation and management of experimental animals

The experiment was conducted at CBRS Rakh Mahni Bhakkar Punjab, Pakistan during 2015-16. Twenty she-camels of Marecha breed were divided into two comparable groups each with ten animals, one group (G1) was selected from the early lactation stage (1-3 months) with no pregnancy and the second group (G2) was at the end lactation stage (11-14 months) with pregnancy (2-4). At the start of the current trial, all animals in the current experiment were carefully observed. Healthy she-camels were only included in the trial physically. Deworming of animals was completed after every 3 months by using an injection of ivermectin (1%) @ 1ml/50 kg body weight. A spray of ecofleece solution was also used on the animals and shed @ 1cc/liter and 2cc/liter of water, respectively. Vaccination against trypnosomiasis disease was done using a 1 g sachet for 4 adult camels of injection of trypamedium (Samorine) after every three months.

Feeding management

The same quantity of ration was provided to all animals with similar trial conditions. All animals were offered with @ 2-3 kg per day concentrate. Browsing/grazing was practiced for the animals for 3-4 hours daily in the jungle. Animals were provided *Cicer arientinum* (gram straw) *adlib* for the rest of the time as manager feeding. Water was offered two times daily. Salt knobs were provided to managers and dicalcium phosphate powder was fed @ 100g/animal daily. The composition of concentrate, its chemical and constituents is stated in Table 1 and gram straw was used for the proximate analysis and different browsing/grazing animals in the experimental area are given in Table 3.

Corresponding authors: Asim Faraz
drasimfaraz@bzu.edu.pk

Table 1: Ingredients of experimental ration(a), chemical composition of experimental ration (b).

(a) Ingredients (%)	Exp ration	(b) Parameters (%)	Exp ration
Wheat bran	24	CP	18.06
Molasses	14	ME (Mcal/kg DM)	2.41
Maize grain	9	DM	90.32
Rape seed cake	6	ADF	14.41
Cotton seed cake	25	NDF	29.09
Corn gluten 30%	20	TDN	70
Salt	1		
DCP	1		

Table 2: Mean milk yield, composition and acidity of Marecha She-camel at CBRS Rakh Mahni Bhakkar, Punjab.

Parameters	Early lactating and non pregnant	End Lactating and pregnant
Milk yield (liters)	7.06±0.2[a]	6.33±0.25[b]
Fat (%)	4.28±0.08[a]	3.66±0.09[b]
Protein (%)	3.58±0.07[a]	3.42±0.08[b]
Lactose (%)	4.89±0.06[a]	5.22±0.08[b]
SNF (%)	9.36±0.07[a]	8.77±0.08[b]
Total Solids (%)	13.62±0.18[a]	12.54±0.16[b]
Density (%)	1.25±0.07[a]	1.42±0.06[b]

Means having different superscript are significantly different (P≤0.05).

Milk sampling and laboratory analysis

Milk yield (morning and evening) was recorded and measured in liters while samples of milk were composed one time during a week and from which were composed for a month. All composed samples were examined in duplicated form. Hygienic bottles made up of plastic used for sample collection to transport them into the dairy lab; CBRS (Camel Breeding and Research Station) at Rakh Mahni and for analysis. The determination of milk composition included protein, lactose, fat, solids not fat (SNF), total solids, and acidity were assessed by means of Milky Lab Analyzer.

Different type of forage plants used for browsing/ grazing include kikar, beri, phulai, siras, khagal, jand, dhaman, bhakra, kali bui, khawi, persain, kari, karir, phog, laana, and khar laana. The gram straw and forage species available for grazing/browsing were studied for percent ether extract, dry matter, crude fiber, crude, ash and protein (AOAC, 1997). Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were also calculated (Van Soest *et al*., 1991).

Statistical analysis

Data were compiled in Microsoft Excel and it was the 2010 version of Microsoft Office. Then data was prepared for statistical analysis to the analysis of variance by using SPSS software. Tukey's test will be used at 0.05 significance level for comparing the variances among the treatment means (Steel *et al*., 1997).

Results and Discussion

Milk yield

The mean value of milk yield remained to be 7.06±0.2 and 6.33±0.25 in early lactating with non-pregnant (G1) and end lactating with pregnant (G2) group animals (Table 2). The difference between the values between G1 and G2 was found to be significant (P<0.05).

Table 3: Proximate analysis (%) of crop residue and different grazing/browsing species.

Feed/ Forage species	DM	EE	CP	NDF	CF	Crude ash	ADF
Phulai (*Acacia modesta*)	53.40	02.21	13.23	46.60	35.40	06.94	28.78
Gram Straw (*Cicer arientinum*)	93.53	02.60	09.72	68.70	44.40	07.83	47.60
Beri leaves (*Ziziphus mauritiana*)	40.20	05.77	15.52	48.30	28.02	08.48	26.90
Kikar (*Acacia nilotica*)	28.50	01.79	16.71	55.40	25.08	05.94	25.40
Jand (*Prosopis cineraria*)	46.15	06.52	16.86	47.50	19.14	04.95	29.00
Siras (*Albizia labbek*)	37.30	06.58	16.17	43.00	27.25	16.33	29.00
Khagal (*Tamarix aphylla*)	31.90	03.25	12.81	42.40	17.32	13.03	31.60
Dhaman (*Cenchrus ciliaris*)	31.90	03.94	14.69	38.53	26.51	15.71	18.15
Persain (*Suaeda fruticosa*)	30.30	05.52	10.57	48.70	33.14	07.54	27.60
Khawi (*Cymbopogon schoenanthus*)	34.60	02.01	09.53	62.10	35.67	07.14	43.50
Kari (*Capparis spinosa*)	36.70	17.84	17.84	01.18	30.75	51.80	33.50
Kali Bui (*Kochia indica*)	33.78	04.91	10.80	58.6	27.61	13.32	39.76
Phog (*Calligonam polygonoides*)	34.70	08.95	8.95	4.82	23.42	49.60	31.90
Bhakra (*Tribulus terrestris*)	32.10	08.76	8.76	4.58	32.63	46.70	35.40
Laana (*Haloxylon salincornicum*)	34.20	15.85	15.85	3.09	32.33	51.34	37.50
Khar Laana (*Haloxylon recurvum*)	47.90	12.36	12.36	3.32	24.95	49.20	31.30
Karir (*Capparis decidua*)	49.40	16.75	16.75	1.52	24.64	53.60	37.80

DM, dry matter; EE, ether extract; CP, crude protein; NDF, neutral detergent fiber; CF, crude fiber; ADF, acid detergent fiber (Adapted from

Faraz, 2021).

Different experiments showed that lactation stages, farm, and range conditions influence milk production. Sahani *et al.* (1998) showed in their results that during the 6th month of lactation, the milk yield of camels was at its peak in a farm environment and the maximum production was noted in range conditions during the 5th month of lactation (Field, 1979). Raziq *et al.* (2010) reported that the milk production and yield potential of the white Kohi dromedary camel of Balochistan, Pakistan was affected by age and parity. Low milk yield in 1st parity is logical when the camel is at the growing stage and the high nutrients were required for body development while reduction of yield in subsequent parities may be due to a reduction in the quantity as well as the power of milk secreting cells, and overall weakness at an older age of the animal.

Present study results are similar with the outcomes of Kebebew and Baars (1998), Gedlu (1996), and Tezera (1998) who described in Eastern African camels, the range of milk/day from 4.5-7.5 liters in early to the mid-lactation stage with 3rd to 5th parity in pregnant/non-pregnant females although in divergence through the conclusions of Zeleke and Bekele (2001) as they described the range in early to mid-stage of lactation with or without pregnancy as 1.5-3.1 liter/d underneath wide management situations in Ethiopian camels.

Bekele *et al.* (2002) and Melaku and Fesha (2001) studied the early-mid stage of lactation and 4.14±0.04 kg and 2.5 liters daily milk yield under wide situations in Ethiopian camels. Eisa and Mustafa (2011) studied that 5-10 kg/day is the range for milk in many parities and various stages of lactation in Sudanese camels as. Kamoun and Jemmali (2012) reported the daily milk yield and reported the mean values as 6.72±2.46 liters/day of milk production in different stages of lactation in Tunisian camels. Nagy *et al.* (2013) studied the milk production under intensive management of dromedary camels in the United Arab Emirates and their results showed mean values of 6.0±0.12 kg of daily milk yield in different lactation stages of animals.

In a comprehensive review of the literature, Khan and Iqbal (2001) reported that a varied range of milk production from 3.50-40 kg/day was at different lactational stages and parity numbers in several breeds of camel in Pakistan. Ali *et al.* (2009), Ahmad *et al.* (2010), Farah and Fisher (2004), described the range as 3-10 kg in different parity numbers and stages of lactation for daily milk production of Pakistani camel and this endorsed the outcomes of the current study. Raziq *et al.* (2010) reported that milk production was affected by the parity number and age of Kohi dromedary camel inhabitants in mountainous areas of Balochistan and their study presented that the average daily milk production was 10.20±0.43 kg. Their study results showed that the daily milk production in 1st parity of 3 camels group was 6 liters with 4.5 years average age, 2nd parity milk production in 9 camels group was 8.8 liters with 7.3 years average age, 3rd parity in 6 camels group of 8.8 years average age was 11.1 liters, in group of 10 camels milk production was 11 liters with 11.4 years average age, 11.7 liters milk production was in 4 camels group with 13.5 years mean age and 11 liters milk production was in 8 camels group with 17.4 years average age raised under extensive managemental situations.

In the current research, Faraz *et al.* (2020) examined the composition and yield of milk of Barela dromedary camel reared under an extensive management system in Thal area of Punjab, Pakistan, and reported daily milk yield in 3rd to 5th parity was 7.38 liters at initial and mid-stages of lactation. Camels were raised in a traditional pastoral management system and showed a longer lactation period. In another research conducted by Faraz *et al.* (2018) reported the milk production was 5.62 kg/day of Marecha she-camel in an extensive managemental conditions inhabitant at Thal area of Punjab, Pakistan. These Marecha camels inhabitants at Mankera Tahsil of District Bhakkar were at 3rd to 5th parity as well as at early and mid-lactation stages, and reared under pastoral managemental conditions.

Milk composition

Milk composition and quality were changed for several reasons including genetic, managemental, physiological (body weight, age, stage of lactation), and methods of animal milking (Bencini and Pulina, 1997; Antunac and Havranek, 1999). The milk composition was highly affected by the different lactation stages (Gonzalo *et al.*, 1994; Fuertes *et al.*, 1998; Fenyvessy and Javor, 1999). It is well documented in the literature that milk composition markedly changes all over the year, the consequence of lactation stages on milk value.

Milk ingredients in early lactation and non-pregnant females were notably significant ($P<0.05$) high as related to end lactation and pregnant she-camels. Rodriguez *et al.* (1985) reported similar observations as well as in studies by El-Amin (1979). However, these findings are controversial to Auldist *et al.* (1998), who observed that protein and fat contents were present to be significant and had different effects on the availability of forage in lactating cows. Lucey and Fox (1992) detected poor quality milk in late lactation. These significant changes in milk composition in different lactation stages and pregnancy may be due to season and light to dark ratio (Maria-Levrino and Gabina, 1990). These changes may be a result secretion of prolactin in of greater amount, as its plasma concentration was more in the summer season as compared with the winter season (Tucker, 1989).

Milk composition changes in pregnancy may be because of hormonal variations (Sevi *et al*., 1999; Hassan, 1995). In the current research, milk density and percentage of lactose were noted to be increased during end-lactating pregnant female camels as compared to non-pregnant females with early lactation. The noticeable decrease of casein contents and milk protein in the late lactation stage might be understood by way of the result of deteriorating health of the udder and also in the light of lactose and fat levels (Sevi *et al*., 1999).

Fat and protein

Mean values of percentages of milk protein and fat were found to remain 4.28±0.08, 3.66±0.09 and 3.58±0.07, 3.42±0.08 in G1 and G2, respectively (Table 2). The values started to remain highly significant (P<0.05) in different groups. Findings of current research are in line with the results of Khaskheli *et al*. (2005) and Kappeler *et al*. (1998) who stated the percentage ranges of protein and fat as 2.40-4.50% and 2.50-5.50%, respectively. These animals were raised under extensive environmental conditions with different parity numbers and stages of lactation. Present findings are dissimilar to the findings of Elamin and Wilcox (1992) as they stated 2.81% protein and 3.15% fat in Majaheem camels milk ininhabitantst Saudi Arabia where they were reared on usual feeding conditions and they were in various lactation stages.

Moreover, Mehaia *et al*. (1995) stated protein and fat percentages in the milk of Wadah, Majaheim, and Hamra she-camels as 2.91, 3.22; 2.36, 2.46; and 2.52, 2.85, at their mid-lactation. The study of Konuspayeva *et al*. (2009) included 82 reports as a reference and described the milk protein and fat in camel milk as 3.4±0.62 and 3.8±1.08, respectively. Comprehensive review from 1980 to 2009 of Al-Haj and Al-Kanhal (2010) on dromedary camel and reported averages of protein and fat as 3.1 and 3.5%, respectively. Another scientist, Meiloud *et al*. (2011) reported protein and fat percentages as 2.5 and 2.9% at different lactation stages on natural grazing of Mauritanian camel milk. Nagy *et al*. (2013) reported milk production of the dromedary camel breed reared in an intensive managemental environment of United Arab Emirates and their study showed that mean protein and fat concentrations as 2.6±0.01% and 2.5±0.03%, respectively.

Current results are similar to the results of Iqbal *et al*. (2001) as they described the ranges of protein and fat percentage as 2.50-5.50 in extensive conditions of, she-camels in Pakistan and at various stages of parity and lactation stage. Raziq *et al*. (2011) reported in their studies collected the milk samples for the composition of 6 female camels in the early and late-stage of lactation of Kohi camel in Balochistan, Pakistan; they sampled in an extensive environment and reported fat and protein percentages as 2.63 and 4.01, respectively. Mal *et al*. (2006, 2007) described the range in Indian camel's milk for the percentage of protein and fat as 3.8-3.9 and 2.5-3.3, respectively. Mal and Pathak (2010) described the milk of Indian Bactrian she-camel protein and fat percentages as 5.5 and 3.87%, respectively. Thus, the data that was presented seems to be a comparison with the higher fat and protein values of Marecha and Barela she-camel milk, particularly concerning contents of fat.

Current research of Faraz *et al*. (2020) studied the milk composition and production of camel breed, Barela dromedary in Thal area of Punjab, Pakistan under extensive management conditions and reported almost the same values of protein and fat percentages as 3.62 and 4.26, respectively in its initial and mid-lactation stages in parities of 3rd to 5th of animals. In another research, Faraz *et al*. (2018) studied the composition of milk raised under extensive managemental conditions in Marecha female camel in Thal area of Punjab, Pakistan, and described milk protein and fat percentages as 3.42 and 4.44, respectively at initial and mid-stage lactation yield in 3rd, 4th and 5th parities of she-camels.

Milk lactose and density

Mean values of milk lactose and density percentages were found to be 4.89±0.06, 5.22±0.08 and 1.25±0.07, 1.42±0.06 in group 1 and group 2, respectively as shown in Table 2 and difference in the values was significant (P<0.05) in different groups. Present study results are similar with Guliye *et al*. (2000) who studied the Bedouin camels that a very similar lactose percentage of 4.81 under extensive managemental conditions. Konuspayeva *et al*. (2009) showed in 82 references from literature data that lactose percentage was 4.46±1.03 in camels. Al-Haj and Al-Kanhal (2010) described the averages of lactose which was 4.4% on dromedary camels from 1980-2009 in their comprehensive review.

The averages for the lactose percentage were calculated as 4.9±0.6% at different lactation stages grazed on natural resources in the milk of Mauritanian camel (Meiloud *et al*., 2011). Nagy *et al*. (2013) described that the mean value of the concentration of lactose was 4.03±0.03 in the milk of dromedary she-camels reared in intensive managemental environment in United Arab Emirates. The percentage of milk lactose was calculated as 4.16% at different stages of lactation and these animals were reared on regular feed in Majaheem camels in Saudi Arabia (Elamin and Wilcox, 1992). The lactose percentage in the milk was 4.46% in Hamra, 4.43% in Majaheem, and 4.44% in Wadah, respectively, mainly at a mid-lactation stage in Saudi Arabia (Mehaia *et al*., 1995). Lactose percentage was reported by Yagil and Etzion (1980) as 4.6 in dehydrated camels.

Iqbal *et al*. (2001) and Khan and Iqbal (2001) described

in their study results as the lactose percentage for milk ranged from 3.0 to 5.50% in different stages of parity and lactation in semi-intensive and extensive managemental conditions in dromedary camels of Pakistan. In a very recent study about milk production and composition under extensive managemental conditions of Barela dromedary she-camel in Thal area of Punjab, Pakistan by Faraz *et al.* (2020) reported that the percentage of lactose remained almost the same at 4.84 during the 3-5 parity in initial and mid stage of lactation in animals.

While in another study, Faraz *et al.* (2018) described the lactose percentage as 4.8%, a very close value to the milk of Marecha camel during 3-5 parity and its early and mid-lactation stages of animals that were reared under extensive managemental conditions in Thal area of Punjab, Pakistan. Thus, compared to protein and fat contents, the variations in components of lactose in camel milk during various conditions seem inferior. Furthermore, variations during lactation stages are not as significant as for protein and fat (Musaad *et al.*, 2013).

Total solids and solids not fat

The averages of milk total solids, and SNF percentages were noted as 9.36±0.07, 8.77±0.08 and 13.62±0.18, 12.54±0.16 in G1 and G2, respectively (Table 2). The values significantly ($P<0.05$) differed among all groups of animals. Elamin and Wilcox (1992) reported in 81 milk samples of Majaheem camel that the lesser values with 10.95% total solids and 7.8% SNF and animals were fed with a usual diet calculated at several lactation stages in Saudi Arabia. Mehaia *et al.* (1995) reported that percentages of total solids and SNF in camel's milk were 11.35% and 8.13% in Majaheem, 10.07% and 7.61% in Wadah, 10.63% and 7.78% in Hamra, respectively throughout the mid-lactation stage in Saudi Arabia. The average value of total solids was 11.9% in the complete review described by Al-Haj and Al-Kanhal (2010).

Aljumah *et al.* (2012) described the Physico-chemical superiority in the milk yield of camel and their results showed that the range for SNF and total solids were 5.56-8.29g and 7.76-12.13 /100gm. Meiloud *et al.* (2011) showed in their results that average values for total solids and SNF as 11.80 ± 1.00 and 8.88 ± 0.08 at several lactation stages on usual browsing in the milk of Mauritanian camel. Nagy *et al.* (2013) reported milk yield under intensive managemental conditions of dromedary camels in United Arab Emirates and their reports showed that the mean values of concentrations of solids not fat and total solids as 7.56±0.03 and 9.98±0.03%, respectively.

The outcomes of the current research are in line with the results of Iqbal *et al.* (2001) and Khan and Iqbal (2001) whose reports showed the range for total solids and SNF in the milk of camels was 11.5-17.8% and 8.9-14.3%, respectively. In very fresh research, Faraz *et al.* (2020) observed the milk composition and yield of Barela dromedary she-camel reared under general managemental environment in Thal area of Punjab, Pakistan and their report showed at 3rd to 5th parity of milking animals that almost the same values of percentages for total solids and SNF as 13.28 and 9.02, respectively during early and mid-lactation stages. While another study was conducted on Marecha camel breed's milk, total solids and SNF were 13.38 and 8.96 percent with 3-5 parity animals in Thal area at initial and mid stage lactation (Faraz *et al.*, 2018). Mal *et al.* (2006, 2007) conducted a study on Indian camel's milk and the results showed that the ranges of percentages for total solids and SNF as 9.85-11.45 and 7.25-8.25, respectively in different parity numbers and lactation stages. Percentages of total solids and SNF were found to be 14.68%, and 9.18% respectively in the milk of Indian Bactrian she-camel as reported by (Mal and Pathak, 2010).

Conclusions and Recommendations

The Marecha camels are good milk producers in their natural habitat and their milk value assessed in the present research is verified to be outstanding, containing higher amount of fat, protein, and lactose. The result showed that physiological conditions like the stage of lactation and pregnancy have a weighty effect on milk composition and production. The milk production was considered to be higher in non-pregnant and early lactating females than in end lactating and pregnant females. This might be due to a decrease in potency and number of milk secreting cells, and overall weaker because of advancement in pregnancy as the nutritional requirements and availability may compromise with the fetal extra nutritional needs. So, it is recommended that optimum feeding supplementation should be provided for the lactating and pregnant females which is mostly not done in the field conditions. The outcomes of current research about the milk yield and quality prove that these might be used in superior food animals which might be a key part of the food safety and countrywide livelihood of the country population.

Acknowledgments

The financial help extended by Higher Education Commission (HEC) of Pakistan under NRPU Project No. 9977 is gratefully acknowledged.

Conflict of interest

The authors have declared no conflict of interest

References

Ahmad, S., Yaqoob, M., Hashmi, N., Ahmad, S., Zaman, M.A. and Tariq, M., 2010. Economic importance of

camel: A unique alternative under crises. *Pak. Vet. J.*, **30**: 191-197.

Al-Haj,O.A.andAl-Kanhal,H.A.,2010.Compositional, technological and nutritional aspects of dromedary camel milk. *Int. Dairy J.*, **20**: 811-821. https://doi.org/10.1016/j.idairyj.2010.04.003

Ali, I., Chaudhry, M.S. and Farooq, U., 2009. Camel rearing in Cholistan desert of Pakistan. *Pak. Vet. J.*, **29**: 85-92.

Aljumaah, R.S., Almutairi, F.F., Ismail, E., Alshaikh, M.A., Sami, A. and Ayadi, M., 2012. Effects of production system, breed, parity and stage of lactation on milk composition of dromedary camels in Saudi Arabia. *J. Anim. Vet. Adv.*, **11**: 141-147. https://doi.org/10.3923/javaa.2012.141.147

Antunac, N. and Havranek, L.J., 1999. Proizvodnja, sastav i osobine ovčjeg mlijeka. (Production, composition and properties of sheep's milk). *Mljekarstvo*, **49**: 241-254.

AOAC, 1997. *Official methods of analysis of the association of official analytical chemists*. Washington, D.C. U.S.A.

Auldist, M.J., Walsh, B.J., Thomson, N.A., 1998. Seasonal and lactational influences on bovine milk composition in New Zealand. *J. Dairy Sci.*, **65**: 401-411. https://doi.org/10.1017/S0022029998002970

Bekele, T., Zeleke, M. and Baars, R.M.T., 2002. Milk production performance of the one humped camel (*Camelus dromedarius*) under pastoral management in semi-arid eastern Ethiopia. *Livest. Prod. Sci.*, **76**: 37-44. https://doi.org/10.1016/S0301-6226(01)00333-5

Bencini, R. and Pulina, G., 1997. The quality of sheep milk: A review. *Aust. J. Exp. Agric.*, **37**: 485-504. https://doi.org/10.1071/EA96014

Eisa, M.O. and Mustafa, A.B., 2011. Production systems and dairy production of Sudan camel (*Camelus dromedarius*): A review. *Middle-East J. Sci. Res.*, **7**: 132-135.

El-Amin, F.M., 1979. *The dromedary camel of Sudan*. In: Roc. Workshop on Camels. Int. Found. Sci., Stockholm, Sweden. pp. 35

Elamin, F.M. and Wilcox, C.J., 1992. Milk composition of Majaheem camels. *J. Dairy Sci.*, **75**: 3155-3157. https://doi.org/10.3168/jds.S0022-0302(92)78079-5

Farah, Z. and Fisher, A., 2004. *The camel* (Camelus dromedarius) *as a meat and milk animal: Hand book on product and processing*, Vdf Hochschulverlag, www.camelgate.com.

Faraz, A., 2020. Food security and socio-economic uplift of camel herders in Southern Punjab, Pakistan. *Land Sci.*, **2**: 8-11. https://doi.org/10.30560/ls.v2n2p8

Faraz A., Waheed, A., Tauqir, N.A., Mirza, R.H., Ishaq, H.M., and Nabeel, M.S., 2021. Effect of pregnancy on blood biochemical profile of semi-intensive kept Marecha (*Camelus dromedarius*) camel. *Int. J. Agric. Biol.*, **25**: 241-248.

Faraz, A., Waheed, A., Mirza, R.H. and Ishaq, H.M., 2019a. The camel a short communication on classification and attributes. *J. Fisheries Livest. Prod.*, **7**: 289.

Faraz, A., Waheed, A., Mirza, R.H., Ishaq, H.M. and Tariq, M.M., 2019b. Socio economic status and associated constraints of camel production in desert Thal Punjab, Pakistan. *J. Fisheries Livest. Prod.*, **7**: 288.

Faraz, A., Waheed, A., Mirza, R.H. and Ishaq, H.M., 2019c. Role of camel in food security: A perspective aspect. *J. Fisheries Livest. Prod.*, **7**: 290.

Faraz, A., 2021. Blood biochemical and hair mineral profile of camel calves reared under different management systems. Pakistan J. Zool., 53(1): 55-61. https://doi.org/10.17582/journal.pjz/20190430140425

Faraz, A., Waheed, A., Mirza, R.H., Nabeel, M.S. and Ishaq, H.M., 2020. Milk yield and composition of Barela dromedary camel in Thal desert Punjab. *Pakistan. Pakistan J. Zool.*, **52**: 1221-1224. https://doi.org/10.17582/journal.pjz/20190212070204

Faraz, A., Waheed, A., Nazir, M.M. and Mirza, R.H., 2018. Milk production potential of Marecha dromedary camel in desert Thal Punjab, Pakistan. *J. Fisheries Livest. Prod.*, **6**: 1000280. https://doi.org/10.4172/2332-2608.1000280

Fenyvessy, J. and Javor, A., 1999. Milk composition of different sheep genotypes. In: *Milking and milk production of dairy sheep and goats*. Proceedings of the sixth international symposium on the milking of small ruminants. *Proc. Int. Symp. EAAP Publ.*, **95**: 430-433.

Field, C.R., 1979. *Preliminary report on ecology and management of camels, sheep and goats in northern Kenya*. Integrated Project in Arid Land (IPAL) Technical Report. IPAL.

Fuertes, J.A., Gonzalo, C., Carriedo, J.A. and Primitivo, F.S., 1998. Parameters of test day milk yield and milk components for dairy ewes. *J. Dairy Sci.*, **81**: 1300-1307. https://doi.org/10.3168/jds.S0022-0302(98)75692-9

Gedlu, M., 1996. *Camel productivity in Jijiga Zone*. Southeastern Range Land project, Report, pp. 20.

Gonzalo, C., Carriedo, J.A., Baro, J.A., and San Primitivo, F., 1994. Factors influencing variation of test day milk yield, somatic cell count, fat, and protein in dairy sheep. *J. Dairy Sci.*, **77**: 1537–1542. https://doi.org/10.3168/jds.S0022-0302(94)77094-6

GOP, 2021-22. *Economic advisor's wing*. Ministry of Finance, Government of Pakistan Islamabad, Pakistan.

Guliye, A.Y., Yagil, R., Deb F.D. and Hovell, 2000.

Milk composition of Bedouin camels under semi-nomadic production system. *J. Camel Pract. Res.*, **7**: 209-212.

Hassan, S.H., 1995. Effects of crossing and environmental factors on production and some constituents of milk in Ossimi and Saidi sheep and their crosses with Chios. *Small Ruminant Res.*, **18**: 165-172. https://doi.org/10.1016/0921-4488(95)00684-D

Iqbal, A., Gill, R.A. and Younas, M., 2001. Milk composition of Pakistani camel (*Camelus dromedaries*) kept under station/farmer's conditions. *Emir. J. Agric. Sci.*, **13**: 7-10. https://doi.org/10.9755/ejfa.v12i1.5197

Kamoun, M. and Jemmali, B., 2012. Milk yield and characteristics of Tunisian camel. *J. Anim. Sci.*, **1**: 12-13.

Kappeler, S., Farah, Z. and Puhan, Z., 1998. Sequence analysis of *Camelus dromadarius* milk caseins. *J. Dairy Res.*, **65**: 209-222. https://doi.org/10.1017/S0022029997002847

Kebebew, T. and Baars, R.M.T., 1998. *Milk production performance of pastorally managed camels in Eastern Ethiopia*. Proc. 6th Annual Conference Ethiopian Society of Animal Production, May 14-15, Ethiopia, pp. 184-193.

Khan, B.B., and Iqbal, A., 2001. Production and composition of camel milk. A review. *Pak. J. Agric. Sci.*, **38**: 64-68.

Khaskheli, M., Arain, M.A., Chaudhry, S., Soomro, A.H. and Qureshi, T.A., 2005. Physico-chemical quality of camel milk. *J. Agric. Soc. Sci.*, **1**: 164-166.

Knoess, K.H., 1977. The camel as a meat and milk animal. *World Anim. Rev.*, **22**: 39-44.

Knoess, K.H., Machudum, K.A., Rafiq, M. and Hafeez, M., 1986. Milk production potential of the dromedary, with special reference to the province of Punjab, Pakistan. *World Anim. Rev.*, **87**: 11-21.

Konuspayeva, G., Faye, B. and Loiseau, G., 2009. The composition of camel milk: A meta-analysis of the literature data. *J. Fd. Compos. Anal.*, **22**: 95-101. https://doi.org/10.1016/j.jfca.2008.09.008

Konuspayeva, G., Faye, B. and Loiseau, G., 2011. Variability of vitamin C content in camel milk from Kazakhstan. *J. Camelid Sci.*, **4**: 63-69.

Lucey, J.A. and Fox, P.F., 1992. Rennet coagulation properties of late-lactation milk. Effect of pH adjustment, addition of CaCl2, variation in rennet level and blending with mid-lactation milk. *Ir. J. Agric. Fd. Res.*, **31**: 173-184.

Mal, G., and Pathak, K.M.L., 2010. *Camel milk and milk products*. Natl. Res. Centre Camel, P.B. No. 07, Bikaner, Rajasthan 334001 India.

Mal, G., Suchitra, S.D. and Sahani, M.S., 2007. Changes in chemical and macro-minerals content of dromedary milk during lactation. *J. Camel Prac. Res.*, **14**: 195-197.

Mal, G., Suchitra, S.D., Jain, V.K. and Sahani, M.S., 2006. Therapeutic value of camel milk as a nutritional supplement for multiple drug resistant (MDR) tuberculosis patients. *Israel J. Vet. Med.*, **61**: 88-94.

Maria-Levrino, G. and Gabina, D., 1990. Environmental effects on milk production of milking sheep. *J. Dairy Sci.*, **73**(**Suppl. 1**): 1251.

Mehaia, M.A., Hablas, M.A., Abdel-Rahman, K.M. and El-Mougy, S.A., 1995. Milk composition of Majaheem, Wadah and Hamra camels in Saudi Arabia. *Fd. Chem.*, **52**: 115-122. https://doi.org/10.1016/0308-8146(94)P4189-M

Meiloud, G.M., Bouraya, I.N.O., Samb, A. and Houmeida, A., 2011. Composition of Mauritanian camel milk: Results of first study. *Int. J. Agric. Biol.*, **13**: 145-147.

Melaku, T. and Fesha, G., 2001. A study on the productivity and diseases of camels in eastern Ethiopia. *Springer Sci.*, **33**: 265-274.

Mohamed, H., Mousa, H. and Beynen, A., 2005. Ascorbic acid concentrations in milk from Sudanese camels. *J. Anim. Physiol. Anim. Nutr.*, **89**: 35-37. https://doi.org/10.1111/j.1439-0396.2004.00507.x

Musaad, A., Faye, B. and Abu-Nikhela, A., 2013. Lactation curve of dairy camels in an intensive system. *Trop. Anim. Hlth. Prod.*, **45**: 1039-1046. https://doi.org/10.1007/s11250-012-0331-x

Nagy, P., Thomas, S., Marko, O. and Juhasz, J., 2013. Milk production, raw milk quality and fertility of dromedary camels (*Camelus dromedarius*) under intensive management. *Acta Vet. Hung.*, **61**: 71-84. https://doi.org/10.1556/avet.2012.051

Rahim, S.M.A., Hasnain, S. and Farkhanda, J., 2011. Effect of calcium, magnesium, sodium and potassium on farm plantations of various agroecological zones of Punjab, Pakistan. *Afr. J. Pl. Sci.*, **5**: 450-459. https://doi.org/10.5897/AJPS11.070

Raziq, A., Verdier, K., Younas, M., Khan, S., Iqbal, A. and Khan, M.S., 2011. Milk composition in the Kohi camel of mountainous Balochistan, *Pakistan. J. Camelid Sci.*, **4**: 49-62.

Raziq, A., Younas, M., Khan, M.S. and Iqbal, A., 2010. Milk production potential as affected by parity and age in the Kohi dromedary camel. *J. Camel Prac. Res.*, **17**: 1-4.

Rodriguez, L.A., Mekonnen, G., Wilcox, C.J., Martin, F.G. and Krienke, W.A., 1985. Effects of relative humidify, maximum and minimum temperature, preg- nancy, and stage of lactation on milk composition and yield. *J. Dairy Sci.*, **68**: 973. https://doi.org/10.3168/jds.S0022-0302(85)80917-6

Sahani, M.S., Rahinasabapathy, M., Gorokhmal and Khanna, N.D., 1998. Effect of milking techniques

on milk production potential in Indian camel breeds under farm condition. *Proc. 3rd Ann. Meet. Anim. Prod. Arid Cond. UAE Univ.*, **1**: 52-58.

Saini, N., Bhati, A., Singh, N. and Tuteja, F., 2007. Trace mineral and vitamin C content of camel milk: A comparative study. *Vet. Pract.*, **8**: 20-21.

Sevi, A., Albenzio, M., Taibi, L., Dantone, D., Massa, S., Annicchiarico, G., 1999. Changes of somatic cell count through lactation and their effects on nutritional renneting and bacteriological characteristics of ewe's milk. *Adv. Fd. Sci.*, **21**: 122-127.

SPSS, 2008. Inc. Released 2008. *SPSS Statistics for Windows, Version 17.0*. Chicago: SPSS Inc.

Steel, R.G.D., Torrie, J.H. and Dicky, D.A., 1997. *Principles and procedures of statistics*. A biometric approach 3rd Ed. McGraw Hill Book Co., New York, USA.

Tezera, G., 1998. *Characterization of camel husbandry practice and camel milk and meat utilization in Shinille and Jijiga Zone of Somali National Regional State*. MSc thesis, Alemaya Univ. Agric. Dire Dawa, Ethiopia.

Tucker, H.A., 1989. Photoperiod affects intake, growth, and milk production of cattle. *Feedstuffs*, **61**: 15-16.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A., 1991. Method for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, **74**: 3583-3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

Wilson, R.T., 1998. *Camels*. The tropical agriculturalist. A book by McMillan Education Ltd. London, UK.

Yagil, R. and Etzion, Z., 1980. Effect of drought condition on the quality of camel milk. *J. Dairy Res.*, **2**: 159-166. https://doi.org/10.1017/S0022029900021026

Yagil, R., 1994. *The camel in today's world*. Gifrid, Bonn, Germany.

Zeleke, M. and Bekele, T., 2001. Effects of season on the productivity of camels (*Camelus dromedarius*) and the prevalence of their major parasites in Eastern Ethiopia. *Trop. Anim. Hlth. Prod.*, **33**: 321-329.