



Milk Production Potential of Marecha Camel (*Camelus dromedarius*) in Extensive and Semi-intensive Management Systems

Asim Faraz^{1*}, Abdul Waheed¹, Ayman Balla Mustafa², Nasir Ali Tauqir³, Riaz Hussain Mirza¹, Hafiz Muhammad Ishaq¹, Rana Muhammad Bilal⁴ and Muhammad Shahid Nabeel⁵

¹Department of Livestock and Poultry Production, Bahauddin Zakariya University Multan, Pakistan

²Therapeutic Nutrition Department, Faculty of Nursing and Health Sciences, Misurata University, P.O. Box: 2478, Misurata, Libya

³Department of Animal Science, University of Sargodha, Sargodha, Pakistan

⁴University College of Veterinary and Animal Science, The Islamia University of Bahawalpur, Bahawalpur, Pakistan

⁵Camel Breeding and Research Station Rakh Mahni, Livestock and Dairy Development Department, Punjab, Pakistan

ABSTRACT

Camel is an integral part of livestock as Pakistan ranks 8th in the world regarding its population. Mainly the camel production is in remote areas as pastoral system in desert ecosystem of Pakistan. Due to the urbanization, this husbandry system is changed and the cameleers are moving towards urban/peri-urban areas of arid and semi-arid environment. This study was planned to check its production potential in extensive management system (EMS) and semi-intensive management system (SIMS). The mean milk yield and range of Marecha she-camel was found to be 5.6±0.3, 6.1±0.2 and 3-8, 5-9 kg under EMS and SIMS, respectively. The fat, protein, lactose, SNF and total solids percentage was found to be 4.44, 4.40; 3.42, 3.38; 4.82, 4.76; 8.96, 8.93 and 13.38; 13.33, respectively under EMS and SIMS. The results could be used for future intensive camel production in Pakistan.

Article Information

Received 27 February 2020

Revised 04 April 2020

Accepted 23 April 2020

Available online 17 July 2020

Authors' Contribution

AF conducted research and wrote the paper. MSN helped in conduct of research. AW and RHM analyzed the data. ABM and NAT helped in write-up. HMI and RMB reviewed the article.

Key words

Camel, Milk production, Milk composition, Desert

INTRODUCTION

Camels were mainly domesticated for the purpose of milk production (Epstein, 1971). The great importance for pastoralists and agro-pastoralists is of camel as it produces more milk during drought conditions for longer periods than any other domestic animal species adapted to arid and semi-arid habitats (Faraz *et al.*, 2019a). The udder of she-camel has four quarters, having one teat per quarter with two strip canals to three strip canals per teat. Mostly the milk let-down of she-camels is usually stimulated by a suckling calf which is of very short duration (30-90 seconds). Once the milk let down is firmly established, the calf is quickly removed and the she-camel milked by two milkers simultaneously on both sides of the animal.

Milk yield varies with the parity, breed, management conditions, feeding and stage of lactation. Under pastoral

conditions it is difficult to estimate the daily milk yield of camel. Since the calves suckle their dams throughout the lactation period, variation in the milking frequencies among various pastoral groups and seasonality of available fodder are also complicating factors affecting the lactations. Under traditional pastoral management system camel produces more milk than any other type of domestic animal species reared in the same environment *i.e.* in arid and semi-arid areas (Faraz *et al.*, 2019b). The Marecha camel breed is used as a loading carrier, transport provider, racing/dancing purpose, milk and meat. Marecha she-camel can produce up to 10 liters milk per day in intensive conditions with an average annual milk yield of 4179 liters while lactation length varies from 270-540 days having the total milk yield as 1300-4200 kg (Yaqoob and Nawaz, 2007; Ali *et al.*, 2009; Faraz *et al.*, 2019c). In current study the milk production and composition of Marecha she-camel was determined in extensive management system (EMS) and in a herd maintained at Camel Breeding and Research Station, Rakh Mahni which was reared under semi-intensive management system (SIMS).

* Corresponding author: drasimfaraz@bzu.edu.pk
0030-9923/2021/0001-0001 \$ 9.00/0
Copyright 2021 Zoological Society of Pakistan

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

Feed/Forage species	DM	CP	EE	CF	NDF	ADF	Crude ash
Gram straw (<i>Cicer arietinum</i>)	93.53	9.72	2.60	44.4	68.7	47.6	7.83
Kikar (<i>Acacia nilotica</i>)	28.5	16.71	1.79	25.08	55.4	25.4	5.94
Phulai (<i>Acacia modesta</i>)	53.4	13.23	2.21	35.40	46.6	28.78	6.94
Beri leaves (<i>Ziziphus mauritiana</i>)	40.2	15.52	5.77	28.02	48.3	26.9	8.48
Siras (<i>Albizia labbek</i>)	37.3	16.17	6.58	27.25	43	29	16.33
Jand (<i>Prosopis cineraria</i>)	46.15	16.86	6.52	19.14	47.5	29	4.95
Khagal (<i>Tamarix aphylla</i>)	31.9	12.81	3.25	17.32	42.4	31.6	13.03
Dhaman (<i>Cenchrus ciliaris</i>)	31.9	14.69	3.94	26.51	38.53	18.15	15.71
Persain (<i>Suaeda fruticosa</i>)	30.3	10.57	5.52	33.14	48.7	27.6	7.54
Khawi (<i>Cymbopogon schoenanthus</i>)	34.6	9.53	2.01	35.67	62.1	43.5	7.14
Kali bui (<i>Kochia indica</i>)	33.78	10.80	4.91	27.61	58.6	39.76	13.32
Bhakra (<i>Tribulus terrestris</i>)	32.1	8.76	4.58	32.63	46.7	35.4	9.64
Kari (<i>Capparis spinosa</i>)	36.7	17.84	1.18	30.75	51.8	33.5	6.97
Laana (<i>Haloxylon salicornicum</i>)	34.2	15.85	3.09	32.33	51.34	37.5	11.93
Phog (<i>Calligonum polygonoides</i>)	34.7	8.95	4.82	23.42	49.6	31.9	8.76
Karir (<i>Capparis decidua</i>)	49.4	16.75	1.52	24.64	53.6	37.8	14.76
Khar laana (<i>Haloxylon recurvum</i>)	47.9	12.36	3.32	24.95	49.2	31.3	12.15

DM, Dry matter; CP, Crude protein; EE, Ether extract; CF, Crude fiber; NDF, Neutral detergent fiber; ADF, Acid detergent fiber.

MATERIALS AND METHODS

Camel Breeding and Research Station (CBRS) Rakh Mahni is situated in Thal desert which comes under the agro ecological zone-III. Sandy deserts having narrow strips of sand ridges and dunes while the climate is arid to semi-arid with mean summer temperature goes up to 45.6°C and in winter it falls from 5.5 to 1.3°C. Mean annual rainfall ranges from 150-350 mm, increasing from south to north (Rahim *et al.*, 2011). In EMS, A total of 100 households, who owned adult she-camels were selected using purposive sampling technique. All animals were carefully examined physically before the start of milk recording and those were found physically healthy were included in the study. The animals of 3rd to 5th parity in early and mid-stage lactation (1-12 months) were selected. All animals were milked twice daily on equal time intervals. The animals suckled by their calves so one right side was offered to calf and left side was milked then multiplied by 2 to get the morning/evening milk production. The animals were allowed grazing/browsing daily for 10 hours without their calves. While in SIMS, the same pattern was adopted to she-camels for their milking and recording. The herd which was maintained at CBRS from there 20 she-camels were used for this purpose. The animals were allowed grazing daily for 8 hours without their calves while supplemented with gram crop residues in rest

of the time *adlib*. The animals were watered twice a day in both the systems. The proximate analysis of available grazing/browsing species and gram straw was performed by using standard methods (AOAC, 1997; Van Soest *et al.*, 1991) (Table I). Data was presented to analysis of variance for statistical analysis (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

In present study the mean milk yield and range of Marecha she-camel was found to be 5.6±0.3, 6.1±0.2 and 3-8, 5-9 kg under EMS and SIMS, respectively (Table II). Knoess *et al.* (1986) studied the milk production potential of the dromedary, with special reference to the province of Punjab, Pakistan and reported that camel produces more milk per unit body weight than other dairy animals. It can survive in those hot areas where green fodder is only seasonally available due to some erratic rainfall and can thrive well on horny and thorny plants (Knoess, 1977). Faraz *et al.* (2018) reported 5.62 kg daily milk yield of Marecha she-camel in Thal desert Punjab, in traditional management system. These Marecha she camels were in early and mid-lactation stage (1-12 months), in 3-5 parity numbers. A wide range of 3.5-40 kg daily milk yield was reported by Khan and Iqbal (2001) in various breeds of Pakistani camel in different stages of lactation and parity.

Farah and Fisher (2004), Ali *et al.* (2009) and Ahmad *et al.* (2010) reported 3-10 kg daily milk yield of Pakistani camels in different stages of lactation and parity. Raziq *et al.* (2010) studied milk production of Kohi dromedary camel as affected by age and parity in mountainous areas of Balochistan and reported mean daily milk yield as 10.2 ± 0.43 kg. They reported 6 liters daily milk yield in 1st parity with 4.5 years average age in group of 3 camels, 8.8 liters in 2nd parity with 7.3 years mean age in group of 9 camels, 11.1 liters in 3rd parity with 8.8 years mean age in group of 6 camels, 11 liters with 11.4 years mean age in group of 10 camels, 11.7 liters with 13.5 years mean age in group of 4 camels and 11 liters with 17.4 years mean age in group of 8 camels reared under extensive conditions. Milk production and lactation length of Pakistani camels is summarized in Table III.

Table II. Milk yield (kg) and composition (%) of Marecha she-camels in EMS and SIMS.

Parameters	EMS	SIMS
	Average (Range)	Average (Range)
Milk yield	5.6±0.3 (3-8)	6.1±0.2 (5-9)
Fat	4.44±0.26 (3.88-4.70)	4.40±0.26 (3.9-4.68)
Protein	3.42±0.06 (2.66-4.02)	3.38±0.06 (2.76-4.1)
Lactose	4.82±0.08 (3.67-5.04)	4.76±0.08 (3.71-4.98)
SNF	8.96±0.09 (7.62-9.87)	8.93±0.09 (7.73-9.82)
Total solids	13.38±0.06 (12.22-14.65)	13.33±0.06 (12.32-14.64)

SNF, Solids not fat; EMS, Extensive management system; SIMS, Semi-intensive management system

Wernery *et al.* (2004) reported that camels can be kept well in a closed farm and managed to be milked with an automatic portable milking machine. In their study, the total daily milk yield of she-camel was 21.96 kg with an average of 4.8 kg where n=16. Melaku and Fesha (2001) and Bekele *et al.* (2002) reported 2.5 liters and 4.14 ± 0.04 kg daily milk yield in Ethiopian camels in extensive conditions. Eisa and Mustafa (2011) reported range for milk in Sudanese camel as 5-10 kg/day in different stage of lactation and parity numbers. Kamoun and Jemmali (2012) studied milk yield of Tunisian camel and reported average daily milk production as 6.72 ± 2.46 liters. Nagy *et al.* (2013) studied milk production of dromedary camels under intensive management in United Arab Emirates and reported average daily milk yield as 6 ± 0.12 kg.

Table III. Milk production and lactation length of Pakistani camels.

Source	Average daily yield (Liters)	Lactation length (Months)	Lactation yield (Liters)
Sial (1950)	-	-	6688
Yasin and Wahid (1957)	10-15	16-18	2721-3629
Knoess (1977)	35	-	-
Knoess <i>et al.</i> (1986)	18.7	-	6688
Qureshi (1986)	8-10	-	-
Aujla <i>et al.</i> (1998)	4-12	9-18	1250-3650
Iqbal (1999)	11.66	12	4260
Baloch (2001)	4.25	15	1894.93
Khan and Iqbal (2001)	3.5-40	9-18	-
Raziq <i>et al.</i> (2008)	15-20	18	-
Raziq <i>et al.</i> (2010)	6-11.7	8	-
Ahmad <i>et al.</i> (2012)	8.17	-	-
Current study	5.6 (EMS)	18	-
	6.1 (SIMS)	9-18	2373-3120

In north Kenya Wangoh *et al.* (1998) estimated the daily milk yield of dromedary camels as 21 liter in the 2nd week of lactation and drops to 4.8-2.2 in the 16th week of lactation. Camels that calved in the long dry season give milk for a longer period and have a higher milk yield than those of calved in the short rainy season. Camels that calved in the long wet season showed the highest daily peak off take in between 9-19 weeks of lactation. During the long wet and short dry seasons, the daily off take was above the annual mean off take (Bekele *et al.*, 2002). Reported milk production of eastern African camels was to be 5-6 liter/d (Hussien, 1986), 5 kg/d (Gedlu, 1996), 4.5 kg/d (Tezera, 1998), 7.5 liter/d (Kebebew and Baars, 1998), 8-10 kg/d (Abebe, 1991), 10-15 kg/d (Knoess, 1980; Yagil, 1982), 12-20 liter/d, (FAO, 1993) and 1.5-3.1 liter/d in eastern Ethiopian camels under extensive management conditions (Zelege and Bekele, 2001).

Camel milk is the best nourishment source available to humans during droughts as camels continue to lactate during the dry seasons. Breeds of camel with high milk production potential do exist. The main aim of pastoral dairy management is to obtain an animal with extended lactation that enables to rear a calf with a good body condition and to conceive again. Sustained milk output is more important rather than high yield and the lactation length in camels is about 18 months. Highest daily milk yield was showed between 9-19 weeks of lactation in the

camels that calved in the long wet season (Hashi, 1988). Sahani *et al.* (1998) reported that the milk production from she-camels was on its peak at farm conditions during 6th month of lactation while under range conditions, peak production was observed during the 5th month of lactation (Field, 1979; Wilson, 1998; Bakheit *et al.*, 2008).

Finally, compared to the available literature data, Marecha camel breed appeared as a good dairy camel with a relatively good milk production potential (Faraz *et al.*, 2018). Moreover, the available publications give some results as daily average quantities, total lactation yield or year yield, herd average, after camel calf suckling or not. Therefore, the comparisons between authors are not easy (Faye, 2004), and must be accepted with caution. Average milk yield of camel reported from various countries is summarized in Table IV (Farah, 1993).

Table IV. Average milk yield of camel from various countries.

Country	Daily milk yield (kg)	Lactation length (Months)
Egypt	3.5-4.5	9
Ethiopia	5-13	12-18
India	7-18	15
Kenya	2-12	11-16
Pakistan	8-10	12
Somalia	3-9	9-18
Sudan	5-10	10-12
Tunisia	4	12

Source: Farah, 1993.

Milk composition

Bakheit *et al.* (2008), Raziq (2008), Raziq *et al.* (2010) and Faraz *et al.* (2013) concluded that camel milk composition is a reflection of parity and seasonal variations. Milk fat, protein, lactose and ash contents were all significantly affected by season. Fat, protein and ash contents were higher in hot summer and decreased in winter and rainy seasons. However, lactose contents showed an opposite trend being higher in rainy season and decreased in the summer season. The highest milk protein contents were recorded in primiparus camels. Moreover, parity has no effect on milk fat contents while total solids were not significantly affected by parity and season.

Fat and protein

Milk fat and protein percentage of Marecha she-camel were found to be 4.44 ± 0.26 , 4.40 ± 0.26 and 3.42 ± 0.06 , 3.38 ± 0.06 , respectively in extensive and semi-intensive management systems (Table II). These findings are in accordance with the findings of Iqbal *et al.* (2001) who

reported range of fat and protein percentage as 2.5-5.5 in Pakistani camels in traditional management system and at different stages of lactation and parity. Raziq *et al.* (2011) studied milk composition of Kohi camel in Balochistan, Pakistan; they sampled 6 she-camels in initial and late stage of lactation in extensive conditions and reported fat and protein percentages as 2.63 and 4.01, respectively. In a very recent study, Faraz *et al.* (2018) investigated milk composition of Marecha she-camel reared under traditional management system in Thal desert, Punjab Pakistan and reported milk fat and protein percentage as 4.44 and 3.42, respectively during early and mid-lactation stage in 3-5 parity animals.

Mal *et al.* (2006, 2007) reported ranges for fat and protein percentages as 2.50-3.30 and 3.75-3.92, respectively in Indian camel's milk. Kappeler *et al.* (1998) and Khaskheli *et al.* (2005) reported range of fat and protein percentages as 2.5-5.5 and 2.4-4.5 percent, respectively in camels reared under extensive conditions with different stage of lactation and parity. Present findings are in contrast with the findings of Elamin and Wilcox (1992) who reported 3.15% fat and 2.81% protein in milk of Majaheem camels in Saudi Arabia who were raised on normal diet and were in different stages of lactation. Furthermore, Mehaia *et al.* (1995) reported fat and protein percentage as 3.22, 2.91; 2.46, 2.36 and 2.85, 2.52 in milk of Majaheim, Wodah and Hamra camels during mid-stage lactation.

Konuspayeva *et al.* (2009) summarized 82 reports and stated the milk fat and protein in camel milk as 3.82 ± 1.08 and 3.35 ± 0.62 , respectively. Al-Haj and Al-Kanhal (2010) in their comprehensive review on dromedary camel from 1980-2009 reported mean values of fat and protein as 3.5% and 3.1%, respectively. Meiloud *et al.* (2011) reported fat and protein percentage as 2.92 and 2.50 in Mauritanian camel milk at various stages of lactation on natural grazing. Nagy *et al.* (2013) studied milk production of dromedary camels under intensive management in United Arab Emirates and reported average fat and protein concentrations as 2.51 ± 0.03 and $2.60 \pm 0.01\%$, respectively.

Lactose

Milk lactose percentage of Marecha camel was found to be 4.82 ± 0.08 and 4.76 ± 0.08 under EMS and SIMS, respectively in present study (Table II). Khan and Iqbal (2001) and Iqbal *et al.* (2001) reported range for milk lactose percentage as 3-5.5% in Pakistani dromedary camels in different stage of lactation and parity in extensive and semi-intensive management systems. Faraz *et al.* (2018) reported very close percentage range of lactose as 3.87-5.10 in milk of Marecha camel in Thal desert during early and mid-stage of lactation in 3-5 parity animals

reared under traditional management system.

Current findings are in agreement with Guliye (2000) who reported very close lactose percentage as 4.81 in Bedouin camels under extensive management system. Konuspayeva *et al.* (2009) reported lactose percentage in camel as 4.46 ± 1.03 in 82 references from literature data. Al-Haj and Al-Kanhal (2010) in their comprehensive review on dromedary camel from 1980-2009 reported mean value of lactose as 4.4%. Reported mean value for percentage of lactose was to be $4.91 \pm 0.61\%$ in Mauritanian camel's milk at various stages of lactation on natural grazing (Meiloud *et al.*, 2011). Nagy *et al.* (2013) studied milk production of dromedary camels under intensive management in United Arab Emirates and reported average lactose concentration as 4.03 ± 0.03 .

Milk lactose percentage was found to be 4.16% in Majaheem camels in Saudi Arabia which were raised on normal diet and of different stages of lactation (Elamin and Wilcox, 1992). Mehaia *et al.* (1995) reported 4.43% lactose in Majaheem, 4.46% in Hamra and 4.44% in Wadah camel's milk, respectively during mid-stage lactation in Saudi Arabia. Lactose percentage was found to be 4.6 in dehydrated camels as reported by Yagil and Etzion (1980). Thus, contrary to fat and protein content, the variability in lactose content of camel milk in different conditions appears lower. Moreover, its change throughout lactation is not so important than for fat and protein (Musaad *et al.*, 2013).

SNF and total solids

Regarding milk SNF and total solid's percentage the values found were 8.96 ± 0.09 , 8.93 ± 0.09 and 13.38 ± 0.06 , 13.33 ± 0.06 in extensive and semi-intensive management systems, respectively (Table II) in Marecha she camels in early and mid stage lactation with 3-5 parity. These findings agree with the findings of Khan and Iqbal (2001) and Iqbal *et al.* (2001) who reported range for SNF and total solids in camel's milk as 8.9-14.3% and 11.5-17.8%, respectively. Recently, Faraz *et al.* (2018) reported range as 7.42-9.47 and 12.32-14.35 percent SNF and total solids in milk of Marecha she camel reared under traditional management system in desert Thal in early and mid-stage lactation with 3-5 parity animals. Mal *et al.* (2006, 2007) reported ranges for SNF and total solids percentages as 7.25-8.25 and 9.85-11.45, respectively in Indian camel's milk in different stage of lactation and parity numbers.

Elamin and Wilcox (1992) reported lower values with 7.8% SNF and 10.95% total solids in 81 milk samples of Majaheem camel fed with normal diet and at various stages of lactation in Saudi Arabia. Reported SNF and total solids percentages were 8.13% and 11.35% in Majaheem, 7.78% and 10.63% in Hamra and 7.61% and 10.07% in Wadah camel's milk, respectively during mid-stage lactation in

Saudi Arabia (Mehaia *et al.*, 1995). Al-Haj and Al-Kanhal (2010) in their comprehensive review reported mean value of total solids as 11.9%.

Aljumah *et al.* (2012) studied physico-chemical quality of camel milk and reported range for total solids and solids-not-fat as 7.76-12.13 and 5.56-8.29 g/100g. Meiloud *et al.* (2011) reported mean values for SNF and total solids as 8.88 ± 0.08 and 11.80 ± 1.0 in Mauritanian camel's milk at various stages of lactation on natural grazing. Nagy *et al.* (2013) studied milk production of dromedary camels under intensive management in United Arab Emirates and reported average total solids and solids-not-fat concentrations as 9.98 ± 0.03 and $7.56 \pm 0.03\%$, respectively.

CONCLUSION

The Marecha camel has good milk production potential under extensive and semi-intensive management systems. Camel husbandry system is in a state of flux as pastoralists are moving from one place to another so makes it favorable if the camel is managed in semi-intensive and intensive management system as it has a great potential to produce milk economically in these systems. The extensive review of literature and the results of present study proves that Marecha camel could be a future food animal which definitely will play a pivotal role in the food security. It will be a useful addition to the food chain in developing countries that may help to recover the conditions like kwashiorkor and Marasmus.

ACKNOWLEDGEMENTS

A special thanks to camel herders for their willingness to participate in the study. The financial assistance by Higher Education Commission (HEC) Islamabad, Pakistan and the kind support of management of Camel Breeding and Research Station (CBRS) Rakh Mahni is gratefully acknowledged.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

- Abebe, W., 1991. Traditional husbandry practices and major health problems of camels in the Ogaden. *Nomadic People*, **29**: 21-30.
- Ahmad, S., Yaqoob, M., Bilal, M.Q., Khan, M.K., Muhammad, G., Yang, L.G. and Tariq, M., 2012. Factors affecting yield and composition of camel milk kept under desert conditions of central Punjab,

- Pakistan. *Trop. Anim. Hlth. Prod.*, **44**: 1403-1410.. <https://doi.org/10.1007/s11250-012-0079-3>
- 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. and Al-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>
- AOAC, 1997. *Official methods of analysis of the association of official analytical chemists*. Washington, D.C. U.S.A.
- Aujla, K.M., Jasra, A.W. and Munir, M., 1998. *Socio-economic profile of camel herders in South-western mountainous areas of Pakistan*. Proc. III Annu. Meet. Anim. Prod. under Arid Conditions, **2**: 154-174.
- Bakheit, S.A., Majid, A.M.A. and Nikhala, A.M.M.A., 2008. Camels (*Camelus dromedarius*) under pastoral systems in North Kordofan, Sudan: seasonal and parity effects on milk composition. *J. Camel. Sci.*, **1**: 32-36.
- Baloch, M.N., 2001. *Documentation and characterization of camel breeds of Pakistan*. PhD dissertation, Sindh Agric. Univ., Tandojam. Doctoral library, HEC, H-9 Islamabad, Pakistan.
- 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](https://doi.org/10.1016/S0301-6226(01)00333-5)
- 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.
- Elamin, F.M. and Wilcox, C.J., 1992. Milk composition of Majaaheem camels. *J. Dairy Sci.*, **75**: 3155-3157. [https://doi.org/10.3168/jds.S0022-0302\(92\)78079-5](https://doi.org/10.3168/jds.S0022-0302(92)78079-5)
- Epstein, H., 1971. *The origin of the domestic animals of Africa*. Vol. 2. New York. Africana Publ. Corp. Leipzig, Germany.
- FAO., 1993. *Animal health year book*. Rome. Italy.
- 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.
- Farah, Z., 1993. Composition and characteristics of camel milk. *J. Dairy Res.*, **60**: 603-626. <https://doi.org/10.1017/S0022029900027953>
- Farah, Z., Rettenmaier, R. and Atkins, D., 1992. Vitamin content of camel milk. *Int. J. Vit. Nutr. Res.*, **62**: 30-33.
- Faraz A., Mustafa, M.I., Lateef, M., Yaqoob, M. and Younas, M., 2013. Production potential of camel and its prospects in Pakistan. *Punjab Univ. J. Zool.*, **28**: 89-95.
- Faraz, A., Waheed, A., Mirza, R.H. and Ishaq, H.M., 2019a. The camel, a short communication on classification and attributes. *J. Fish. Livest. Prod.*, **7**: 289.
- Faraz, A., Waheed, A., Mirza, R.H. and Ishaq, H.M., 2019c. Role of camel in food security: A perspective aspect. *J. Fish. Livest. Prod.*, **7**: 290.
- 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. Fish. Livest. Prod.*, **7**: 288.
- 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. Fish. Livest. Prod.*, **6**: 1000280. <https://doi.org/10.4172/2332-2608.1000280>
- Faye, B., 2004. *Dairy productivity potential of camels*. In: Proc. of the 34th meeting FAO/ICAR (International Committee for Animal Recording). Session on camelids. 28 mai-3 juin 2004, Sousse (Tunisie). pp. 93-105.
- Field, C.R., 1979. *Ecology and management of camels, sheep and goats in northern Kenya*. UNESCO, Nairobi, Kenya.
- Gedlu, M., 1996. *Camel productivity in Jijiga Zone*. Southeastern Range Land project, Report, Dairy productivity potential of camels pp. 20.
- 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.
- Hashi, A.M., 1988. *The role of camel production in dry lands with reference to Somalia*. Camel forum working Paper No. 25, Somali Academy of Science and Art. pp. 98.
- Hussien, M.A., 1986. *Husbandry and management of*

- camels in Somali, Ethiopia, Kenya and Djibouti. *Options Mediterraneennes-Serie Seminaires*, 2: 37-44.
- Iqbal, A., 1999. *Studies on some of the productive, reproductive and behavioral aspects of camel in Pakistan*. Doctoral thesis, Department of Livestock Management, University of Agriculture, Faisalabad, Pakistan.
- Iqbal, A., Gill, R.A. and Younas, M., 2001. Milk composition of Pakistani camel (*Camelus dromedarius*) 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 dromedarius* 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 Conf. 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. *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. FAO Rome, Italy. **22**: 39-42.
- Knoess, K.H., 1980. Milk production of the dromedary. *Prov. Rep. Int. Found. Sci.*, **6**: 201-214.
- Knoess, K.H., Makhudum, A.J., Rafiq, M. and Hafeez, M., 1986. Milk production potential of the dromedary, with special reference to the province of the Punjab, Pakistan. *World Anim. Rev.*, **57**: 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>
- Mal, G., Suchitra, S.D. and Sahani, M.S., 2007. Changes in chemical and macro-minerals content of dromedary milk during lactation. *J. Camel Pract. 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.
- 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](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. <https://doi.org/10.1023/A:1010580416485>
- Musaad, A., Faye, B. and Nikhela, A.A., 2013. Lactation curves 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>
- Qureshi, M.H., 1986. *The camel: A paper presented at a seminar on the camel, Kuwait*. Oct. 20-23, FAO, Rome. pp. 1-35.
- 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. Camel. Sci.*, **4**: 49-62.
- Raziq, A., Younas, M. and Kakar, M.A., 2008. Camel-A potential dairy animal in difficult environments. *Pak. J. agric. Sci.*, **4**: 263-267.
- 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 Pract. Res.*, **17**: 1-4.
- Sahani, M.S., Rahinasabapathy, M., Gorokhmal, Khanna, N.D., 1998. *Effect of milking techniques on milk production potential in Indian camel breeds under farm condition*. Proc. Third Annual Meeting for Anim. Prod. under Arid Condition, United Arab Emir. Univ., pp. 52-58.
- Sial, K.U.H., 1950. Part-I. *Investigation into the*

- production of milk and camels and the uses of which it is being put in the Punjab, including the local practice of management of camels. Part-II. Making of ghee from camel's milk by different methods and determination of its properties.* M.Sc. (Agri.) thesis, University of the Punjab, Lahore.
- 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.
- 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](https://doi.org/10.3168/jds.S0022-0302(91)78551-2)
- Wangoh, J., Farah, Z. and Puhan, Z., 1998. Composition of milk from three camel (*Camelus dromedarius*) breeds in Kenya during lactation. *Milchwissenschaft-Milk Sci. Int.*, **53**: 136-39.
- Wernery, U., Juhasz, J. and Nagy, P., 2004. Milk yield performance of dromedaries with an automatic bucket milking machine. *J. Camel Pract. Res.*, **11**: 51-57.
- 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., 1982. *Camels and camel milk.* Paper No. 26. Animal health and production, FAO, Rome, Italy.
- Yaqoob, M., Nawaz, H., 2007. Potential of Pakistani camel for dairy and other uses. *Anim. Sci. J.*, **78**: 467-475. <https://doi.org/10.1111/j.1740-0929.2007.00464.x>
- Yasin, S.A. and Wahid, A., 1957. Pakistan camels: A preliminary survey. *Pakistan Agric.*, **8**: 289-297.
- 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.

Online First Article