

PRODUCTION AND COMPOSITION OF CAMEL MILK REVIEW

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It has been generally agreed that the camel has the ability to produce more milk of good composition for a longer period of time in an environment of extreme temperature, drought and lack of pasture. In arid zones and drylands, camel has been termed as the goal animal in 21st century. Daily milk yield of camel varies from 3.5 litres (under desert conditions) to 40 litres (under intensive management). Lactation length ranges from 9 to 18 months. Milking frequency in camels varies between two to six times daily. Peak yield is normally attained during second to third month of lactation. Milk yield of bactrian camels, in general, is lower than that of dromedaries. The bactrian milk has high vitamin C content. The range of major constituents of camel milk is: fat 2.9 to 5.5%, protein 2.5 to 4.5%, lactose 2.9 to 5.8%, ash 0.35 to 0.95%, water 86.3 to 88.5% and SNF 8.9 to 14.3%. Its mean specific gravity is 1.03.

Key words: Bactrian camel, lactation length, milk yield and composition

INTRODUCTION

It is widely admitted that dromedary camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture. Yagil and Etzion (1980b) observed that camel has the ability to produce milk of good composition and quantity for human consumption even when water is severely restricted. McDowell (1986) stated that camel's feeding behaviour, tolerance to high salt contents and ability to conserve water, make it the best of ruminants for arid and many semiarid areas. Mohammad (1989) remarked that camel is the most economical and efficient animal in the arid and semiarid rangelands of Pakistan. Yagil (1990) said that with the help of modern science, poor farmers can raise camels for milk and can replace true cows of the desert, which in spite of their adaptability to the area seem to have low potential for milk production compared to the dromedaries. El-Naggar (1998) stated that camel is to be the goal animal in arid zones and drylands in 21st century. The observations of various workers given above tempted the authors to further gather together the information concerning production and composition of camel milk so that a clear picture may emerge, which in turn might provide a spur to the development/improvement of camel as a milk animal.

Milk Yield and Lactation Length: Yasin and Wahid (1957) found that well fed and well managed dromedaries produced 9 to 14 litres milk daily and 2722 to 3629 litres in a lactation period of 16 to 18 months, while under desert conditions the average lactation yield varied from 1134 to 1588 litres milk in 9 months. Knoess (1977) studied milk yield of seven camels milked twice daily in Ethiopia. Mean daily milk yield was 6.6 litres. Field (1979) estimated daily milk yield of camels in northern Kenya at 21 litres in second week of lactation, falling to 4.80 to 2.21 by the sixteenth week of lactation. Depending on management and environmental conditions, the average lactation length in camel is 12 months with a range from 9 to 18 months. Sohail (1983) reported that on average Arabian camels can produce up to 2275 litres of milk per year. Shareha (1985)

reported 3.5 to 6.5 litres of milk daily with an average of 5.04 litres/day when milking half the udder twice a day and 7.26 to 12.20 litres daily when the udder was completely milked. Knoess et al. (1986) collected data on lactation yields of seven dromedaries in Punjab (Pakistan) and found that their mean daily yield was 18.68 litres and their average total yield in 305 days was 5695 litres.

According to Qureshi (1986), on average a camel may produce 8 to 20 litres milk a day, but under intensive management conditions, it may produce from 15 to 40 litres daily. Lactation length in camel was found to vary from 9 to 18 months. Khanna (1986) reported an average daily milk yield varying from 3.5 to 10 litres and 40 litres in exceptionally good camels, while the lactation yield ranged between 2000 and 6000 litres. Gebre-Mariam (1987) stated that average daily milk yield of Somali camels ranged between 5 and 6 litres. A good, a medium and a poor milker can produce 9030, 3185 and 805 litres respectively in 350 days while the average lactation yield was 3570 litres milk (Ibnoaf, 1987). Milk yield of 10 Majaheem camels was recorded during their first lactation for a period of 44 weeks. The milk was obtained from three teats since the fourth was kept for calf feeding and stimulation of milk letdown. The average milk yield was 5.5 ± 1.5 litres with a range from 2.4 to 7.6 litres. Peak yield was attained at 14 weeks which persisted for 12 weeks thereafter (Basmaeil and Bakkar, 1987). Milk yield of five Dankali camels kept on natural pastures in Ethiopia was recorded over a period of 12.14 months. Mean yield per head was 123 litres. The peak yield of 404 litres was obtained at day 56 (Richard and Gerard, 1989). Saudi camels on average produced 16.6 litres milk per day and 5331 litres in a 13 months lactation period (Ismail and Al-Mutairi, 1990). An average of 6 litres milk yield per camel per day under feedlot system was reported by Ibrahim (1990). A study on nine Magrebi camels showed that in 305 days their milk yield varied from 915 to 3900 litres (Kamoun et al., 1990).

Schwartz (1992a) reported that heavy camels of Pakistan and India may produce up to 12,000 litres milk in a lactation ranging from 9 to 18 months, whereas yield of Somalian and Kenyan dromedaries ranges from 1,300 to

2,500 litres, but with good grazing their yield may even exceed 3,000 litres. According to Khanna and Rai (1993), daily milk yield of Indian camels ranged from 3.5 to 10 litres, yearly yield from 1000 to 3500 litres and the peak yield was 20 litres. Farah (1993) reported that daily milk yield varies from 3.5 litres for camels under desert conditions to 18 litres for those on irrigated land. It was further reported that milk yields also vary with breed, feeding management, stage of lactation, sampling procedures and sometimes due to analytical procedures too. Hashi (1993) found that Somalian camels on average produce 4 to 5 litres milk per day with a lactation yield from 800 to 3600 litres during a period varying from 9 to 18 months. El-Badawi (1996) reported that dams maintained on irrigated pasture could yield 15 to 35 litres milk/head per day, while the yield was 3 to 5 litres per day on desert range. Average lactation length was found to be 12 months which may go up to 18 months.

According to Ranjhan (1997), a dromedary may yield 8 to 10 litres of milk daily, which is rich in protein (3.7%) and can sustain calf growth. Simpkin et al. (1997a) compared two traditional camel calf management systems in Kenya involving 42 multiparous lactating Somalian camels to determine their influence on total milk production. The mean daily milk take off over 12 months was significantly higher for camels separated from calves (3.1 ± 0.1 litre) compared to camels that were suckled during the day (2.2 ± 0.4 litre). A longer duration of lactation weeks (66 ± 3 vs. 62 ± 4), combined with the higher estimated total daily yield resulted in significantly increased total lactation yields for camels in the separated group (2956 ± 111 litres) than the control (2441 ± 142 litres). Simpkin et al. (1997b) determined the milk yield of full lactation of eight Somali and six Turkana type primiparous camels in northern Kenya. They found that estimated 24-hr milk yields measured weekly (2.98 ± 1.28 litres) were higher than actual 24-hr milk yields measured monthly (2.75 ± 1.3 litres), but the differences were not significant. Actual and estimated yields had a correlation of 0.62. Jasra and Aujla (1997) conducted a camel survey in Balochistan (Pakistan) and found that milk yield varied from 4 to 12 litres with 22 litres in exceptional cases. Total lactation yield ranged from 1250 to 3650 litres with an average of 1800 litres in a lactation length of about 9 to 18 months.

Araba et al. (1998) conducted a study on Moroccan camels to characterize growth and milk production in camels fed basically shrubs. They reported 935 litres milk yield in 305 days. Sahani and Khanna (1998a) investigated the effect of three milking techniques on milk production in Indian camels. The average daily production under 2-teat, 4-teat and machine milking in Bikaneri camels was 4.19 ± 0.11 , 3.2 ± 0.15 and 2.66 ± 0.16 litres/day, in Jaisalmeri breed in the same order was 3.72 ± 0.17 , 2.17 ± 0.16 and 2.02 ± 0.19 litres/day, and in Kachchi camels with four teat stripping and machine milking was 3.94 ± 0.13 and 3.42 ± 0.4 litres/day respectively. Morning milk yield was about 10 to 27% higher than the evening throughout lactation. El-Naggar (1998) reported that camel can yield about 2700 to

3666 litres milk per lactation (9 to 18 months). Kaufman (1998) analyzed the three different camel husbandry systems of the Rendile, Gabra and Somali pastoralists in northern Kenya. Considering different proportions of poor, average and good yielding camels in the herds, average milk off take per lactation was 1096, 1400 and 1581 litres for the Rendile, Gabra and Somali respectively. According to Iqbal (1999), mean milk yield of camels (in a rolling and rocky range in Punjab, Pakistan) on yearly basis was found to be 4260 litres with an average daily yield of 11.66 ± 0.90 litres. Their peak yield of 13.36 litres was observed in second month of lactation.

Milk Composition: El-Erian (1979) reported that the milk of camels grazing near Riyadh (Saudi Arabia) had fat 2 to 6.10%, lactose 3 to 5.65% and moisture content 85.60 to 89.64% with specific gravity between 1.028 to 1.038. Shalash (1979) found that specific gravity of camel milk was less than that of buffalo, cow or sheep milk. Sohail (1983) analysed camel milk and found 86.94% moisture, 3.67% protein, 5.78% lactose, 0.66% ash and fat 5.76% (1st month), 6.59% (3rd month) and 6.08% in 6th month. He further found that camel milk is rich (58.2 mg/kg) in vitamin C and compares favourably with cow and goat milk. Sawaya et al. (1984) reported 11.7% total solids, 3.0% protein, 3.6% fat and 0.13% acidity in camel milk. Morton (1984) observed that composition of camel milk is similar to the cow and goat milk. Results of camel milk analyses by Knoess et al. (1986) showed a substantial variation in fat percentage (2.1 to 4.7%), while protein varied between 2.20 and 2.59% and lactose between 4.59 and 5.33%. Khanna (1986) reported 12.39 to 14.30% total solids, 3.5 to 5.5% fat and 2.0 to 5.5% protein in camel milk. Abu-Lehia (1987) analysed milk samples of Najdi camels for a period of 3 months during winter/spring season and stated that total solids, total protein, casein, fat, lactose, titratable acidity and ash contents were found to be 11.29 ± 0.57 , 2.78 ± 0.12 , 1.90 ± 0.13 , 3.13 ± 0.15 , 4.67 ± 0.01 , 0.15 ± 0.01 and $0.80 \pm 0.03\%$ respectively. He also examined the colostrum of 10 Saudi camels during first 10 days postpartum. At parturition, total solids, fat, protein, lactose and mineral contents were 20.5, 0.20, 13.0, 2.7 and 1.0% respectively. After three days, solids decreased to 13.6%, protein to 4.7% and mineral content to 0.8%. However, the fat content rose to 1.5% and lactose to 4.4%.

The gross components of camel milk in Turkman Sahara were 12.38% total solids, 2.9% protein, 4.19% fat, 4.52% lactose, 0.77% ash, 0.21% acidity and specific gravity of 1.031 (Karim and Gooklani, 1987). Dromedary milk consisted of 13.6% dry matter, 3.5% protein, 4.9% lactose and 0.7% ash (Meredove, 1989). The water, fat, protein, lactose and ash contents in camel milk were found in the order of 89.1, 4.4, 3.9, 2.8 and 0.8% respectively (Ibrahim, 1990). Yagil (1990) opined that camel milk has more protein and less fat than cow's milk. Proximate analysis of milk samples of 81 camels of Majaheem breed fed normal diets showed 3.15% fat, 2.81% protein, 4.16% lactose, 0.15% acidity, 0.83% ash and 88.33% water (El-Amin and Wilcox, 1992). The milk of Somalian and Kenyan

dromedaries contained 2.7 to 4.5% protein, 2.9 to 5.2% fat and up to 5.5% lactose (Schwartz, 1992a). The physical and chemical characteristics of milk of Indian camels are: mean specific gravity 1.03, freezing point 0.57°C, SNF 8.9 to 14.3%, fat 2.9 to 5.5%, protein 2.5 to 4.5%, lactose 2.9 to 5.8%, ash 0.35 to 0.95% and water 86.3 to 88.5% (Khanna and Rai, 1993). Composition of camel milk was found comparable to cow milk in terms of fat, protein, pH and density (Araba et al., 1998). Camel milk was reported to have high viscosity, sweet in taste, and has high vitamin C and fat contents (2.9 to 5.5%) (El-Naggar, 1998). The composition of camel milk was studied at different phases of production viz. I (1 to 3 months), II (4 to 7 months) and III (8 to 12 months). It was observed that ash, fat and water contents showed an increasing trend towards the end of lactation, while protein, lactose and total solids showed a decreasing trend (Zia-ur-Rehman et al., 1998). Percentage protein, fat, solids-not-fat and total solids contents in camel milk were 2.74, 3.82, 8.58, 12.26 respectively and the specific gravity was 1.03 (Iqbal, 1999).

Ratio of Milk Yield to Body Weight: Knoess (1977) found that the ratio of average daily milk yield to camel's body weight was 1.86%. Shalash (1979) reported that the ratio of fat to total solids in camel milk ranged from 20 to 43% with a mean of 31.16% which is near to that of cow milk (32.1 %), but definitely lower than that of buffalo milk (40.91%). Knoess (1979) observed that daily milk production of the dromedary may range from 15 to 40 litres, which represents 3.3 to 8.9% of body weight.. Knoess et al. (1986) stated that mean daily milk yield (18.68 litres) of seven dromedaries constituted 3.26% of body weight.. Khanna (1986) observed that average daily milk yield during different stages of lactation in camel ranged between 1.9 and 2.5% of body weight.. The ratio of fat to total solids ranged from 20 to 43%.

Milking Frequency: Milking frequency of camels was found to be six to eight times a day (Knoess, 1977). It was reported that milking frequency in camels varies between two to six times daily depending on season, stage of lactation and milk yield (Dioli et al., 1992).

Water Restriction: Yagil et al. (1979) found that Israeli camels, with some supplements, continued to produce 6 litres milk per day during the hot summer with watering once in a week. Yagil and Etzion (1980b) determined the camel milk yield in hot summer. The camels were subjected to water restriction once per week for two hours. They produced a steady amount of 6 litres per day/camel..

Bactrian Camel: A bactrian camel may yield up to 5000 litres milk per lactation ranging from 6 to 18 months, however, average production is only 800 to 1200 litres. Milk fat contents vary from 5.8 to 6.6% (Kulaeva, 1964). It was reported that in addition to suckling of the calf, Chinese bactrian camel may yield 0.5 to 2.0 litres of milk per day in areas of China where camels are milked. In these camels, lactation lasts 14 to 16 months and peak yield reaches during third or fourth month after parturition (Wei, 1979). The highest milk yield was observed in the third month (Cherepanova and Belokobylenko, 1986) or between

the third and fourth month of lactation (Xhao, 1994). Milk yield of bactrians, in general, is lower than that of dromedaries. The total lactation yield varies between 500 and 1254 litres. The lactation period ranges from 14 to 18 months. The protein content varies from 3 to 5% and moisture from 86 to 91%. Amino acid content declines with increasing milk yield. The bactrian milk has a high vitamin C content (5.7 to 9.8 mg/ml) which is considered important for the people living in arid areas. The vitamin B₂ content varies between 2.30 and 3.90 µg/ml, while vitamin A and carotene contents are 7.57 µg/ml and 9.40 µg/ml respectively (Gahlot, 2000).

General: A great variation in camel milk production may be attributed to the methods employed to determine yield, high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, age of animal, persistency of lactation, lactation number and stage of lactation. The milking frequency largely depends on supply of and demand for milk, season, quantity of milk produced per animal, the number of milking animals present, availability of other food for the herder's household and the sex, age and the health of calves. Probably, frequent milking increases overall daily milk yield (Knoess, 1979). The amount of milk which the calf drinks varies with its size, age and health, however, the amount of browsing material and water availability to the camel also determine the quantity suckled and the total quantity produced (Yagil, 1982). The mean suckling duration in camels is 210 ± 52 seconds. A significant decline in suckling frequency takes place over the duration of lactation or as the age of the calf advances. It was further suggested that the duration of suckling and the vigour of butting or extracting milk by the calf from the gland can influence the strength of milk ejection reflex and affect milk secretion rate independently of suckling frequency (Sambraus, 1995).

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