

EFFECT OF SUPPLEMENTATION ON PRODUCTION AND QUALITY OF MILK IN CAMEL RAISED IN KUTCH REGION

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ABSTRACT

Camels in Kutch region of India are raised on browse resources by the pastoralists. Availability of browse resources affects nutritional composition of milk from the species. Supplementation could be of advantage during pregnancy and during the lean season. An experiment was planned to monitor the animals under field conditions to study the preference of various species which contributed to the browse ingested, change in body condition score and quality of milk produced by camels raised on available browse with and without concentrate supplement. Pelleted feed concentrate was prepared with admixture of cotton seed extract, rapeseed extract, rice polish, deoiled rice bran, maize, di calcium phosphate, common salt and molasses. Body condition scores improved with the stage of pregnancy however differences with and without supplement were not observed. *Acacia nilotica* a tree species was the most preferred plant species followed by *Zizyphus nummularia* bush, *Acacia tortalis* tree, *Leptodermis reticulata* and *Piper betle* creepers were avidly consumed. Ruminations pattern was observed to be similar in animal's supplemented concentrate. Milk production increased from 3.68 to 4.05 kg/d and production of 4% FCM also improved from 2.43 to 2.66 kg/d which reflected improvement due to supplementation of concentrate feed. Observations suggest improvement in milk production and its fat content could be achieved in Kutchi camels raised under field conditions.

Key words: Browse resources, feed supplementation, Kutch region, milk production, plant species preferred

Kutchhi breed of Camel in the Kutch, Bhuj region of Gujarat state is dependent on plant species along the coastal line which provide important browse materials for survival in the area. Pastoralists in the Kutch region migrate with their herds within the taluka (90.54%) in search of food and water relying on the available range vegetation (Patel *et al*, 2008). Addressing energy and protein deficiencies through supplementation is crucial for boosting milk production. Increasing protein and energy level in the camel diet was associated with an improvement in milk yield and composition. Under field conditions, farmers provide supplements in the form of dry roughages during advance pregnancy to meet nutritional needs, only few provide concentrate supplements.

Inadequate feed resources in quantity and quality during dry season is the major factor affecting milk production in lactating dromedary camels (Lusala *et al*, 2025). Stabling camels had higher milk yield with more protein and less fat compared to grazing camels (Ayadi *et al*, 2019). Supplementing she camels fed on alfalfa with 4 kg/head of feed concentrate improved protein

and mineral levels of milk (Abdelrahman *et al*, 2022). Lactation supplement containing 17% crude protein and 12% metabolism energy when fed at the rate of 2 kg/h/d improved milk by over 50% reflecting significant improvement in production of milk from camel (Hasan *et al*, 2023). Increasing the amount of concentrate feed given to grazing camels from 1kg/head/ day to 4 kg/head/day improved milk yield and composition (El Hatmi *et al*, 2004). Supplementation of concentrate diet at 1, 1.5, 2 kg/h/d to camels during dry season improved milk production, it improved protein and fat content of milk slightly (Lusla *et al*, 2025). Increase in energy content of the diet improved milk yield without affecting milk composition when TDN content was increased from 50% to 60% (Nagpal and Patil, 2012). Similar results were observed when dietary energy was increased on a low protein diet in camel (Al-Saiady *et al*, 2012). Thus improving energy availability is reflected in higher milk yield. Considering lower availability during the winter season, supplementation could be beneficial to mitigate lower nutrient availability to sustain milk production from the available browse in the field.

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However to economise, the present study on lactating camel was planned with the objective to evaluate effect of concentrate supplement on production and quality of milk, body condition score, organo-leptic assessment and aflatoxin residues in milk of kutchi breed camels from human health point of view as camels are raised on natural grazing/ browse resources under field conditions in kutch region.

Materials and Methods

Experimental design: Data regarding number of pregnant animals, their milk production, and stage of pregnancy were collected from the herder. To conduct the experiment, 50 pregnant animals of Kutchi breed were selected from different herds and divided equally into 2 groups with similar production status. A colour band was put on their neck region at the start of experiment to identify animals during movement. Selected camels of both the groups (T1, T2) browsed for 12 hours (6 AM to 6 PM daily). Apart from daily browse, animals under T2 group received one kg pelleted concentrate/h/d during morning milking for a period of 6 weeks. Camel travelled nearly 8-10 kilometres daily ranging from plain to up hills to capture preferred plant species in Kutch region. The route was selected by the pastoralists which had a safe halting point to protect their animals from wild animals during night hours, the route also had a natural water resource to quench thirst of their animals and provide water for cooking which they do at the point of rest; after week to 10 days they shift to a newer place. Browsing behaviour of all the animals under experiment was recorded in which each animal was followed for 10 minutes to observe bites consumed from different plant species during the browse period of 12 hours for two consecutive days. A total of 8700 observations on preference of plant species were recorded to develop preference index of camels in the selected area. Rumination behaviour (bites per bout) was recorded from 10 consecutive observations while at rest in sternal recumbence during early hours of winter months (November-December, between 5-7 AM) from 10 animals each in each group. Observations were recorded in near Ber Moti, Golay, Ganau villages of Mandvi tehsil of Bhuj. Browse materials of animals were collected, pooled, air dried for estimation of protein content (AOAC, 2016).

Flat and hard ground was preferred in the open enclosures/ fields for resting; adults took rest in sternal recumbence while calves were kept loose as they rest with adults during night hours. The animals

were allowed to rest during mid day in the grazing land near water spot without tying for rest during day time.

Evaluation of milk: The animals were milked twice daily during early morning and evening to observe milk production status. Samples of milk were collected at weekly intervals to access compositional quality and analysed for Fat and SNF content with ISmart Milk Analyser. Organo-leptic attributes of milk were assessed to ascertain quality aspects before being pooled (morning and evening) for processing by using BIS Score card and judged by two judges to arrive at final score. The score card evaluated appearance (colour, consistency, freedom from foreign matter), body and texture (uniformity, smoothness, viscosity, absence of watery or curdy feel), flavour and taste (clean, fresh, pleasant, free from off-flavours (oxidised, rancid, sour, metallic etc.), odour (Smell) (Natural, fresh, free from feedy, cooked, or foreign odour), After taste / mouth feel (pleasant, no bitterness or astringency, balanced richness), overall acceptability (general impression considering harmony of all attributes) with maximum scores of 10, 20, 40, 10, 10, 10. Organo-leptic scores given by the judges were pooled over weeks to get final values for each treatment. Milk production data was converted to 4% FCM to observe change among un-supplemented and supplemented groups.

Body condition scores: Body condition scores were recorded to evaluate the amount of fat and muscle reserves on an animal's body which relied on visual observation and tactile palpation of rib, hump, pin, tail as key anatomical landmarks; at the start and end of experiment to observe change.

Composition of feed pellets: Pelleted feed concentrate was prepared at, Kutch's first fully automated, solar energy-operated cattle feed manufacturing unit located in Chandrani, with admixture of cotton seed extract, 5%; rapeseed extract, 30, rice polish, 6; deoiled rice bran, 24%; maize, 30%, di calcium phosphate, 2%; common salt, 1; and molasses 3% with protein content 16% and TDN 70.1% with the objective to provide 10% extra protein and energy to animals. Before initiation of experiment, pelleted feed prepared was assessed for presence of aflatoxin in the in-house facility of dairy unit. Milk samples were also assessed for presence of aflatoxin at the end of feeding period (pooled group wise).

Analysis: Browse materials were collected, Oven dried and analysed for protein content as per

standard technique (AOAC, 2016). The data generated during the experiment was subjected to statistical analysis using by SPSS statistical software (2011) Version 20.0 and the data were statistically analysed using one-way and two-way ANOVA procedures for difference between treatments and periods.

Results and Discussion

Grazing/browsing management is a common practice to raise camels in western arid region of India. Supplementation has been practiced as a beneficial strategy to enhance milk production and improve overall health of lactating and pregnant camels.

Body condition score: Five point scales was used to record body condition scores of animals before and after 6 weeks which revealed (Table 1) that the scores were similar among groups at both the stages.

Table 1. Body condition score of animals.

Group	N	Start of experiment	After VI weeks
Grazing	25	3.05	3.47
Grazing+ Feed supplementation	25	2.96	3.49
SEM		0.004	0.005
P value		0.136	0.799

Browse preference: Study of preference of different plants in the browse area revealed that *Acacia nilotica* a tree species was the most preferred plant (twigs along with pods) followed by *Zizyphus nummularia* bush, *Acacia tortalis* tree, *Leptidinia reticulata* and *Piper betle* creepers were avidly consumed. Other plants were also consumed but with lower preference; choice of different species was jotted to arrive at the preference index (Table 2). Camels usually take a variety of vegetation which presumably provides optimal nutrition. Camels moved from plant to plant and selected browse from different plants, the average bites consumed were 17.4 per minute. It is likely that biomass consumed for 10-12 hours from the available edible browse seemed to be adequate to meet their nutrient needs. Body condition scores in animals used to assess the nutritional status, fat reserves, and overall health of animals.

Milk production starts declining during the third quarter of pregnancy which coincides with the onset of lean season and winter. To meet emerging foetal nutrient requirements, need was felt to supplement she camels as they spend substantial time to select quality browse with more energy from the grazing area. Rumination behaviour in camels

is a critical indicator of normal digestive function, good health, and a positive welfare state (Iqbal and Khan, 2001). Rumination behaviour signifies a state of health, comfort, and good welfare, an active, functioning digestive system. Camels chew their food efficiently to break down coarse desert forage, with peak activity occurring in the early morning and late evening. Ruminations pattern indicated in-significant decrease from 63.9 to 62.5 (chews/bolus) which could be due to supplementation of concentrate/ selection of less fibrous leafy vegetation as per choice of plant species available in the field (Table 3). Studies indicated that each bolus was chewed for an average of 45 s with 68 chews per min (Engelhardt *et al*, 2006) before being swallowed and re-fermented in camels fed hay-based diet. Difference in the numbers reflected fibrous nature of forage ingested as twigs of different plants available in the browse area also contained thorns.

Table 2. Preference index of plant species browsed by camels of Bhuj.

S.No.	Plant name	Percent
1	<i>Acacia nilotica</i>	26.1
2	<i>Zizyphus nummularia</i>	19.3
3	<i>Acacia tortalis</i>	12.9
4	<i>Leptidinia reticulata</i>	9.2
5	<i>Piper betle</i>	7.5
6	<i>Pithecellobium dulce</i>	4.5
7	<i>Solanum xanthocarpum</i>	4.0
8	<i>Prosopis cineraria</i>	3.7
9	<i>Fagonia arabica</i>	3.7
10	<i>Abutilon indicum</i>	3.3
11	<i>Rivea hypocrateformis</i>	1.9
12	<i>Grewia tenax</i>	1.4
13	<i>Prosopis juliflora pod</i>	1.1
14	<i>Salvadora persica</i>	0.9
15	<i>Capparis decidua</i>	0.3
16	<i>Cordia myxa</i>	0.2
Total		100
Bites consumed/ minute		17.4
Bites consumed in 10 hrs of browse		10440
Estimated DMI /bite		0.92g
DMI consumed/day for 600 Kg @1.6% BW		9.6 kg

Aflatoxin content in the feed was observed to be within permissible limit of 15 ppb whereas no aflatoxin was observed in the milk of experimental groups reflecting safe for human use. Farmers were provided weekly quota of the feed to be supplemented. Thus the feed was safe from aflatoxin

point of view. Milk production increased from 3.68 to 4.05 kg/d (Table 4) and production of FCM (4%) also improved from 2.43 to 2.66 kg/d which reflected improvement due to supplementation of concentrate feed (Fig 1). Improvement in milk production was observed in both the groups; however improvement was significant in the supplemented group (T₂) in which improvement in the yield of fat corrected milk was also observed which reflected usefulness for sustainability of production. The browse materials consumed were observed to contain 11.58% CP with an estimated TDN value of 54.75% reflecting energy to protein ration of nearly 4.7 which likely had beneficial nutrient proportion to produce quality milk with higher fat content even with available browse available. It is likely that higher proportion of *Acacia nilotica* in the browse supported better milk yield with higher fat content in the milk as it also contained *Acacia* pods which are a good source of protein, essential for growth, milk production, and overall animal health, especially during dry seasons when pasture quality is low, the pods contain tannins that have anthelmintic properties which help to reduce the parasitic load in grazing animals. Improvement

in milk along with fat content could also be due to production of higher butyrate along with acetate in the rumen (Sawal and Kurar, 1998). Similar results have been observed by Lusala *et al* (2025) wherein supplementation of lactating camels with concentrate during the dry season increased milk production.

Nutritional quality of milk: Higher fat content improved organo-leptic score from 63.5 to 67.8 in the feed supplemented group reflecting preference for high fat milk. Though milk of camels raised on sole browse contained higher milk fat, further improvement in fat content and production was observed due to supplementation with feed containing higher energy: protein ratio. Since protein fraction in the biomass browsed by the animals seemed to be adequate due to preference of ingested plant material, however, it is likely the energy deficit was met either through consumption of pelleted feed with higher energy level or consumption of *Prosopis juliflora* pods which was an excellent source of energy (Sawal *et al*, 2004) available for grazing livestock in Kutch.

Under grazing conditions, animals prefer most digestible components as new sprouts, pods

Table 3. Rumination behaviour of camels (bites/bolus).

Treatment	T ₁	T ₂	Mean	P value		
				Treatment	Observation	Treatment * Observation
Bites	63.86	62.45	63.15	0.368	0.646	0.684

Table 4. Effect of concentrate supplementation on milk production and quality in camel under field conditions.

Week	Morning			Evening			Total Milk (kg)	% FCM kg			Organo-leptic score
	Milk (kg)	Fat	SNF	Milk (kg)	Fat	SNF		M	E	T	
0	1.79	2.84	6.72	1.64	3.09	6.79	3.43	1.14	1.12	2.26	61.3
I	1.79	2.82	6.74	1.61	3.13	6.81	3.40	1.14	1.11	2.25	62.8
II	1.87	3.53	6.60	1.83	4.18	7.09	3.70	1.27	1.35	2.62	61.2
III	1.94	2.39	6.78	1.76	3.39	6.93	3.70	1.14	1.21	2.35	62.7
IV	1.89	3.03	7.06	1.87	3.51	6.92	3.76	1.21	1.27	2.48	63.8
V	2.26	2.71	6.91	1.59	3.66	6.93	3.85	1.31	1.18	2.50	64.5
VI	2.07	2.91	6.87	1.83	3.66	6.95	3.90	1.26	1.28	2.54	68.2
Week	Grazing+ feed supplemented group										
0	1.86	2.66	6.76	1.71	2.99	6.88	3.57	1.14	1.13	2.28	63.8
I	1.96	2.86	6.96	1.78	3.32	7.04	3.75	1.21	1.21	2.43	67.2
II	2.05	3.31	7.22	2.06	3.94	7.41	4.10	1.32	1.41	2.73	63.8
III	2.16	3.62	7.26	1.99	4.14	7.20	4.15	1.41	1.42	2.82	69.5
IV	2.14	3.18	7.02	1.97	3.72	6.96	4.11	1.33	1.34	2.68	66.6
V	2.22	3.00	7.01	2.09	4.46	7.32	4.31	1.34	1.50	2.84	71.0
VI	2.28	3.14	7.27	2.10	3.98	7.30	4.37	1.38	1.44	2.82	72.8
SEM	0.16	0.15	0.19	0.15	0.13	0.19	0.11	0.08	0.07	0.07	0.09
P value	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00

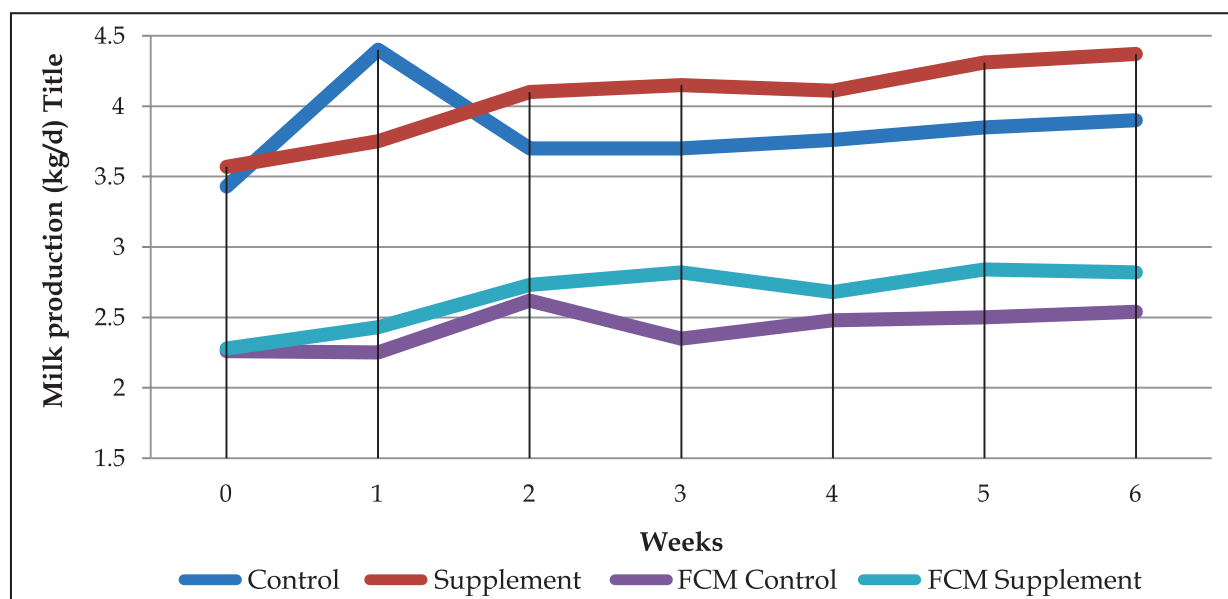


Fig 1. Effect of concentrate supplement on milk production in camel under field conditions.

of different browse species, which are relatively more nutritious. Under field conditions, it supports growth, pregnancy and milk production as well. However, nutrient availability reduces during autumn as pasture matures and senescence reduces availability of quality of biomass. In case of camel this coincides with last quarter of pregnancy as calving occurs usually during January-February. Seasonal fluctuations and poor nutrition during lean seasons reduced productivity which need to be addressed under field conditions to maintain quality of milk value chain. The study supports the view to supplement concentrate to improve nutrient availability and support better health of the camels raised under browsing management which also improved and improve milk production and its quality from value addition point of view which could be utilised for human health purpose.

Beyond developing targeted nutritional feed, this study also opens up possibilities for regular dietary supplementation during periods of feed scarcity or in regions where such shortages occur. This work can be extended to promote feed aimed at imparting specific nutritional and medicinal properties to the milk, such as benefits for diabetes and lactose intolerance, or enhanced protein and vitamin content, while simultaneously preserving and maintaining the organic qualities of camel milk.

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Conflicts of Interest

The authors declare no conflict of interest.

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