

STATUS, MORPHOMETRIC CHARACTERISTICS, MILK PRODUCTION AND QUALITY OF JALORI BREED CAMEL

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ABSTRACT

The Jalori breed of camel is one among the 9 registered camel breeds of the country. The breeding tract encompasses the Jalore and Sirohi districts of Rajasthan. In order to know the status of the breed, 3187 camels belonging to 188 camel breeders of 75 villages in the Jalore and Sirohi districts of Rajasthan were covered in the study. The population of Jalori camels in the breeding tract was estimated to be 7323 heads. The extent of crossbreeding was estimated to be 14.42%. The ratio of breedable male to female was estimated to be 1:1.8. In order to define the phenotype of the breed, the morphometric measurements were recorded for 628 adult camels, and on average the adult Jalori male and female camels measured 199.12 ± 1.73 and 199.12 ± 0.60 cm height at withers, 205.72 ± 2.12 and 207.58 ± 0.66 cm heart girth, and 155.01 ± 1.38 and 154.90 ± 0.40 cm body length, respectively. The average body weight of adult Jalori camels of 4 years of age was recorded as 452.50 ± 24.98 kg, and that of ≥ 5 years was recorded as 510.67 ± 17.71 kg. In order to record the milk production potential, 37 female camels were recorded continuously at the farmer's doorstep, and the average per day milk production from a female was recorded as 4858.52 ± 26.671 ml and the percent fat in the milk was estimated to be 3.70 ± 0.02 . The Open Nucleus Breeding programme with its nucleus at the government research centre and associated herds with the camel owners may lead to significant improvement in the milk production potential of the animals. Continuous policy support and awareness programmes will not only help the camel owners in maintaining the Jalori camel with diverse livestock species under optimum production but will also boost their morale and bring happiness in them.

Key words: Characterisation, conservation, Jalori camel, milk production, milk quality

The nodal agency for the registration of domestic animal biodiversity in the country is the ICAR-National Bureau of Animal Genetic Resources, Karnal. The Bureau has registered 9 breeds of camel in the country *viz.* Bikaneri, Jaisalmeri, Kutchi, Mewari, Marwari, Jalori, Malvi, Mewati and Kharai. The Jalori breed of camel has been registered by the Bureau with the Accession No. INDIA_CAMEL_1700_JALORI_02004. The Domestic Animal Diversity Information System (DAD-IS) of the Food and Agriculture Organisation of the United Nations has also included the Jalori breed of camel among the 11 breeds of dromedary listed for the country. In spite of all these, the breed's phenotype and production potential remain undocumented. The population of livestock cannot sustain unless it has some utility to the stakeholders, which may be through the draught power or the production of meat, milk, hair, dung, urine etc. Recently, the production and properties of non-bovine milk has attracted the attention of researchers and the policy makers (Faye and Konuspayeva, 2012; Bekhit *et al*,

2022). Hence, in order to know the current status of the Jalori breed, it has become essential to characterise them at the phenotypic level as well as at molecular level. The molecular characterisation of this breed using microsatellite markers (Sharma *et al*, 2018) and hair production and quality of breed (Mehta and Dahiya, 2021) has already been reported. This paper highlights the morphometric characteristics, population status, milk production potential and milk quality of Jalori camels maintained under extensive system of management by the farmers in the breeding tract.

Materials and Methods

Survey of the breeding tract

In order to know the present status of the breed with its production potential and associated parameters, a total of 3187 camels belonging to 75 villages of Ahore (12), Jalore (12), Sayala (2), Sanchore (10), Raniwara (7), Bhinmal (11) tehsils of Jalore district and Sirohi (3) and Pindwara (18) tehsils of

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Sirohi districts of Rajasthan were covered in the study (Fig 1). Individual animals of each herd were meticulously judged for the typical features. The phenotype of important body parts was described. Body measurements of 14 body parameters were recorded for 628 adult camels with measuring tape. The body weight was taken for a total of 45 camels utilising commercial weigh bridge. Only healthy camels were measured. Pregnant females were not included in the study and body weight was taken in the morning before the animals were allowed to go for grazing. These animals were reared under extensive system of management.

Milk production

Thirty-seven (37) she-camels were continuously recorded in the field area for their milk production potential. Weekly recording of milk yield was carried out at the farmers door step. No special feed was given. Health was monitored throughout the lactation and milk production of only healthy animals was recorded. A few animals were dropped in the process. As per the practice adopted in the breeding tract, the farmers allowed the calves to suckle in the evening and thereafter the legs of the female were tied and thus disallowing further suckling. In the morning, the camel owners milked the animals. Later the calves were allowed to be with them for few hours and then calves were separated and taken for grazing. The morning milk production was measured and this is estimated to be about a half of the milk the animal produce. The analysis of milk quality was carried out using MilkoScan (FOSS) at the ICAR-National Research Centre on Camel, Bikaner (Rajasthan). However, the monthly fat estimation was carried out at the village level by utilising the Electronic Milk Tester (REIL) available at the milk cooperative societies following the standard protocol defined by the company.

Statistical Analysis

The statistical analysis was carried out by utilising SPSS version 26 (IBM Corp., 2019). The population data of the breed were extrapolated by utilising the percent availability of pure-bred animals of the breed in respective district and the total population of camels in the district as per latest livestock census (Livestock Census, 2019).

Results and Discussion

Origin and distribution of Jalori camel

The Jalori camel derives its name from the place of rearing, i.e. Jalore district of Rajasthan.

The three districts surrounding Jalore, i.e. Barmer, Jodhpur and Pali constitutes a major portion of the Thar Desert in the country. Thus, spreading of camel from the Thar Desert to the Jalore and Sirohi appears natural extension to cater the human needs of baggage and transport in the region. The Jalore region is generally plain but has scattered hills, rocks and at some places it is dotted with sand dunes and ridges. Thus, geographically the hard land of Jalore and Sirohi districts has Thar desert in north, hills in the southeast and Rann of Kachchh in the southwest direction. Owing to adaptation and interbreeding, probably the Jalori camel has originated. The Jalori camels are reared mainly by the Dewasi community located in the region.

The geographical distribution of the breed encompasses chiefly the Jalore and Sirohi districts of Rajasthan. The breeding tract extends in east from 72°58' to 71°3' longitude and in north from 24°22' to 25°22' latitude with fair vegetation and average annual rainfall ranging from 40 to 58 cm. Average elevation of the breeding tract from main sea level ranges from about 268 metres to 321 metres. The breeding tract of Jalori camel in northwest is closely placed with the breeding tract of Jaisalmeri camel and in the northeast with the breeding tract of Marwari camel. The Rann of Kachchh, which is known for the Kachchhi breed of camel is attached with the breeding tract in the southwest. The town Sanchore is like a junction point between the Rajasthan and Gujarat in the extreme western part of the country (Fig 1).

Status of Jalori Camel

The status of a particular breed with respect to its age-wise and sex-wise distribution in different zones of the breeding tract is very important. As per the Livestock Census 2019 (GoI), the total population of the camel in the entire breeding tract is 8551, out of which about 44% population belonging to 188 households was covered in the present survey (Table 1). The morphometric traits were recorded for 628 adult camels. Individual camel was judged for the breed characteristics (Fig 2 and 3) and it was observed that in the Jalore district, Jalori camels were 86.08 % and in Sirohi district, the Jalori camels were 85.03 %. The majority of the crossbreds were showing the features of Bikaneri breed which is preferred because of better look and physique (Mehta and Sahani, 2006). The overall population of Jalori camels in the breeding tract was estimated to be 7323. Relatively smaller population figure of 5023 for the breed has been mentioned by the breed-wise report of livestock and Poultry (2019). The difference in the two figures could



Fig 1. Geographical location of the breeding tract of Jalori breed of camels.



Fig 2. Adult Jalori Male.



Fig 3. Adult Jalori Female.

be due to difference in the timings of conducting the census and the study.

The age-wise and sex-wise population of Jalori camels covered under the survey and status in the two districts and the breeding tract as a whole is presented in table 2. In the present survey, the ratio of breedable males to females was 1:18. The situation is alarming and indicates the danger of loss of genetic variation in the future generations. However, the ratio presented in the Breed-wise Report of Livestock and Poultry (2019) is 1: 2.25. Again, the difference in the two ratios could be due to the difference in the timings of conducting the census and the study. However, the present study has been carried out scientifically and appears more realistic as the

surplus males of breedable age are no longer being retained by the camel owners due to the reduction in the draught utility of the camel, usually seen in all draught species of livestock.

General appearance and physical characteristics

Body Colour

The predominant colour of Jalori camel varies from light brown to dark brown. When the calves are born, the body colour is generally lighter in shade and the hairs are curly. The body colour gets darker and the curls, they open with increase in age. The body colour of the Jalori camels is quite close to that of Jaisalmeri camel (Mehta and Sahani, 2006).

Table 1. Status of Jalori Camel in the breeding tract.

District	Camel Population*	Population Covered	Jalori Camels				Jalori (%)	Estimated Population Jalori
			≤1 year	1-4 Years	Adults	Total		
Jalore	4962	1954	416	410	856	1682	86.08	4271
Sirohi	3589	1770	349	368	788	1505	85.03	3052
Total	8551	3724	765	778	1644	3187	85.58	7323

* Livestock Census 2019

Table 2. Age-wise and sex-wise population of Jalori camels covered under the study.

Sex	Age Group-wise Number of Camels Covered			
	1 Year	1-4 Years	>4 Years	Total
Male	336	293	88	717
Female	429	485	1556	2470
Total	765	778	1644	3187

Head

The head in Jalori camel is medium in size and is well carried on a thin neck. The eyes are prominent. Unlike the Bikaneri camel, in Jalori camels, the forehead is not dome shaped and has no "Stop", which is a name given to a depression on the frontal bone at the upper edge meeting the parietal bone. The supraorbital foramen, which is in the form

Table 3. Morphometric measurements (cm) of adult Jalori Males (N = 69).

S. No.	Character	Male (N=69)		Female (N=559)	
		Mean ± S.E.	Range	Mean ± S.E.	Range
1	Heart girth	205.72 ± 2.12	140-240	207.58 ± 0.66	142-240
2	Body length	155.01 ± 1.38	110-184	154.90 ± 0.40	108-184
3	Height at wither	199.12 ± 1.73	163-230	199.12 ± 0.60	133-230
4	Tail length	54.45 ± 0.75	40-66	54.99 ± 0.28	38-68
5	Neck length	103.54 ± 1.16	72-125	105.47 ± 0.43	70-124
6	Face length	46.75 ± 0.43	35-53	46.38 ± 0.15	35-54
7	Distance between eyes	22.58 ± 0.24	18-27	22.09 ± 0.08	16-27
8	Ear length	11.22 ± 0.13	8-14	10.85 ± 0.04	7-14
9	Fore leg length	149.33 ± 0.85	125-172	149.86 ± 0.22	125-175
10	Hind leg length	160.7 ± 0.92	136-182	161.18 ± 0.28	135-182
11	Foot pad (L/W)				
	i. Fore (Length)	18.42 ± 0.23	12-23	18.92 ± 0.08	12-23
	(Width)	19.43 ± 0.23	13-24	19.95 ± 0.08	13-24
	ii. Hind (Length)	16.77 ± 0.27	10-22	17.23 ± 0.09	10-23
	(Width)	17.80 ± 0.27	11-23	18.27 ± 0.09	11-24

of a deep fissure at the rostromedial margin of the orbit, is normal in depth as compared to the Bikaneri camels where it is deep (Rathore, 1986; Mehta and Sahani, 2006). The muzzle is narrow and mostly pointed in camels of Jalore district but rounded in the camels of Sirohi district. Ears are up-right and set well apart. The typical adaptive feature of desert camel, the “Jheepra” character, i.e. the luxuriant growth of hairs on eye lashes, ears and around the neck, which is often observed in Bikaneri camels is absent in Jalori camel. The lower lip is not droopy as seen in Kachchhi camels (Rathore, 1986; Mehta and Sahani, 2006).

Body and Stature

It is a medium sized breed of camel. The Jalori camels are of active temperament and have thin neck and legs. The body hairs are coarse in quality and medium in length (Mehta and Dahiya, 2021). The Jalori camels appear close to Bikaneri and Jaisalmeri camels and little bigger than the Mewari camels (Rathore, 1986; Mehta and Sahani, 2006).

Udder

The milk vein is small to medium in size. The udder is mostly round in shape. There are four quarters and each quarter has a small cone shaped teat with two canals in it. The shape of the udder is quite similar to other Indian dromedary breeds (Mehta and Sahani, 2006).

Morphometric characteristics

The morphometric measurements of adult male and female camels of Jalori have been presented in Table 3. The Jalori camels of 4 year and above age were considered adult as the camels of both sexes attain puberty at this age and the permanent incisors start erupting. However, the camel continues to gain weight significantly over previous year till 8 years of age (Mehta *et al*, 2010; Mehta, 2008), which is generally noticed by the presence of prominent canines in the month. However, the morphometric measurements of Jalori camel were observed to be close to Bikaneri and Jaisalmeri camels and little higher than that of Mewari camels (Rathore, 1986; Mehta and Sahani, 2006).

Growth

The body weight of healthy Jalori camels from birth to adulthood were recorded and have been presented in table 4. The body weight figures presented by Mehta *et al* (2010) for Bikaneri, Jaisalmeri, Kachchhi and Arab-cross camels are

relatively lower than the one recorded for Jalori camels in the present study but the difference could well be accounted to significant difference in the samples size among the two studies. Still, the growth of the Jalori camels maintained by the farmers in the extensive system can be rated as excellent.

Table 4. Body Weight (kg) of Jalori Camel.

Age	Mean ± Standard Error	Range
≤1 Year	260.64±0.00 (1)	160-160
2 Years	282.50±22.93 (12)	170-470
3 Years	328.89±21.24 (9)	220-420
4 Years	452.50±24.98 (8)	360-590
≥5 Years	510.67±17.71(15)	380-650

Figures in parenthesis indicate number of animals.

Milk Production

Since, there had been lot of attention on the production of non-bovine milk in last few years (Faye and Konuspayeva, 2012; Bekhit *et al*, 2022), the weekly recording of the milk production was carried out in the breeding tract and the results have been presented in table 5. The average per day milk yield in Jalori camels was observed as 4.86 litres. The milk production potential of Indian dromedary breeds is now a well-studied parameter. The milk production potential of Mewari camels in the breeding tract has been quantified and it was reported that on an average 3.39 litres of milk per female is being sold in the market per day and it was extrapolated that if the Mewari camel model of milk production is adopted, it is expected that the milk collection is expected to increase by about 8-times its present level and the share of camel milk in the total milk produced in the state may reach to 2.5% (Mehta *et al*, 2009). Faye and Konuspayeva (2012) presented that about 16.9% of milk consumed by human comes from species other than cattle. However, a comprehensive picture of non-bovine milk and its sources and properties has been presented by Bekhit *et al* (2022). On the basis of FAOSTAT data, the authors presented that in the year 2022, goat, sheep, and camel milk represented 2.3%, 1.2%, and 0.4% of the world milk production. This clearly indicates the growing importance of camel milk. The average milk production of Bikaneri and Kachchhi camels from 2-teats was reported as 3606.31±64.59 ml at the organised farm (Mehta *et al*, 2011) and the average daily milk production from 2-teats was reported as 2.7±0.05 litre in Bikaneri, 3.2±0.07 litre in Kachchhi and 2.6±0.08 litre in Mewari breed of camel at the organised farm (Mehta *et al*, 2015). Though the 2-teat milk production at an

organised farm cannot directly be compared with the present observation where the 4-teat milking with some restriction on calf suckling is in practice as well there were differences in the parity of animals, feeding and grazing management; nevertheless, the milk production potential of Jalori camels can be rated as quite comparable or little better than other Indian breeds. The milk yield was almost comparable for about 9 months indicating very good persistency of lactation. This is in agreement with the findings of Mehta *et al* (2015) where the persistency of lactation was reported as 76.20, 67.07, 55.67 and 35.87% when calculated for lactation length of 10, 12, 14 and 16 months, respectively. The highest average per day milk for a month was 5.38 litres and it was 3.6 litres per day in the 14th month of lactation. It is clear from the data (Table 5) that the Jalori camels are producing on an average 10 litres of milk per day and during peak months the production is still higher. Mehta *et al* (2015) also reported that highest individual average daily milk yield from 2 teats was 8.06 litre in indigenous camel breeds and the peak yield was observed in fifth month. The selection of elite animals for breeding (Mehta *et al*, 2014) and proper feed supplementation can further increase the milk production and add to the income of camel farmers in the breeding tract. The camel milk in the breeding tract is being sold for human consumption and is generally used for the preparation of tea and coffee. However, ICAR-National Research Centre on Camel,

Table 5. Average per day milk yield of Jalori camels in the breeding tract.

Month of Lactation	Milk Production (ml)		
	N	Mean±Std. Error	Range
1	77	4977.27±95.187	3500-7000
2	89	5148.88±79.271	4000-7250
3	110	5381.09±83.614	4000-7250
4	89	5143.26±106.142	2000-7250
5	94	4938.83±80.365	3000-6500
6	112	5040.09±66.477	2500-6500
7	114	5129.39±60.261	2250-6500
8	105	5145.24±72.783	1000-6500
9	101	5165.84±78.371	3000-6250
10	108	4546.48±75.511	3000-6000
11	99	3985.05±73.121	2500-6000
12	79	3623.67±69.214	1500-5250
13	13	3596.15±151.220	2500-4500
14	3	3666.67±166.667	3500-4000
Pooled	1193	4858.52±26.671	1000-7250

N - Number of records.

Bikaner has prepared a variety of products from camel milk, the preparation and sale of such products may further add to the income of the farmers.

The month-wise per cent fat content was recorded at the field level for a total of 376 records (Table 6). The analysis of milk quality was also carried out and the concentration of fat (Table 6), SNF (Solid Not Fat), protein, lactose and ash was recorded as 3.70 %, 7.6 %, 2.76%, 4.01% and 0.81%, respectively. The pH was recorded as 6.4. The milk composition of Jalori camels comfortably meets the standards defined by the FSSAI (Food Safety and Standards Authority of India) for camel milk (Fat 2% and SNF 6.0%) vide its notification dated June 1, 2017.

Table 6. Month-wise fat content (%) in Jalori camel milk.

Month of Lactation	N	Mean ± Std. Error	Range
1	10	3.47±0.18	2.60-4.60
2	32	3.58±0.12	2.60-5.40
3	7	3.84±0.14	3.10-4.30
4	44	3.73±0.08	2.40-4.70
5	64	3.75±0.06	2.40-4.70
6	68	3.83±0.06	2.80-4.70
7	60	3.83±0.06	2.80-4.70
8	46	3.54±0.08	2.00-4.60
9	31	3.49±0.09	2.00-4.10
10	12	3.56±0.16	2.40-4.20
11	1	3.60±0.00	3.60-3.60
12	1	3.60±0.00	3.60-3.60
Total	376	3.70±0.02	2.00-5.40

N - Number of records.

Improvement and Conservation

The Jalori camels are used for riding, camel dancing, camel carts, camel safari and other aspects of camel draught utility. These activities need to be supported and encouraged by converting this unorganised business into organised one and by modernising them. The other important source of income to the camel farmers in the tract is through sale of camel milk and surplus animals. The Open Nucleus Breeding programme for increasing the milk production with its nucleus at the government farm or research centre and associated herds with the camel owners may lead to significant improvement in the production potential of the animals and increase their income. An integrated rotational grazing system, silvi-pasture development programme along with proper nutritional and health care support will facilitate the camel owners in rearing the camels *in situ*. Continued policy support and awareness programme will not

only help the camel owners in maintaining the Jalori camel with diverse livestock species under optimum production but also will boost their morale and bring happiness in them.

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References

- Bekhit AA, Ahmed IAM and Al-Juhaimi FY. Non-bovine milk: sources and future Prospects. *Foods*. 2022; 11(13):1967. doi: 10.3390/foods11131967.
- Breed-wise Report of Livestock and Poultry. Based on 20th Livestock Census -2019. Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. New Delhi. 2019.
- FAOSTAT Data-2022. <https://www.fao.org/faostat/en/#data/QCL>, date of accession August 25, 2024.
- Faye B and Konuspayeva G. The sustainability challenge to the dairy sector - The growing importance of non-cattle milk production worldwide. *International Dairy Journal*. 2012; 24:50-56.
- IBM Corp. Released. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp. IBM Corp., New York. 2019.
- Livestock Census. 20th Livestock Census-2019, All India Report, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. New Delhi. 2019.
- Mehta SC, Bapna DL and Bhure SK. Mathematical functions for the prediction of growth in Indian dromedary genotypes. *The Indian Journal of Animal Science*. 2010; 80(2):148-151.
- Mehta SC and Dahiya SS. Analysis of hair quality attributes of Mewari and Jalori camels managed under natural habitat. *Journal of Camel Practice and Research*. 2021; 28(3):361-366.
- Mehta SC, Pathak KML, Bhardwaj B, Arora S and Bhatnagar C S. Camel Dairying: An Indian Perspective. *The Indian Journal of Animal Sciences*. 2009; 79(4):454-456.
- Mehta SC, Bissa UK, Patil NV and Pathak KML. Importance of camel milk and production potential of dromedary breeds. *The Indian Journal of Animal Sciences*. 2011; 81(11):1173-1177.
- Mehta SC, Yadav SBS, Singh S and Bissa UK. Sire evaluation and selection of Indian dromedary for milk production: issues and strategies. *Journal of Camel Practice and Research*. 2014; 21(1):93-98.
- Mehta SC, Sharma AK, Bissa UK and Singh S. Lactation persistency, yield and prediction models in Indian dromedary. *The Indian Journal of Animal Sciences*. 2015; 85(8):875-82.
- Mehta SC and Sahani MS. Indian camel breeds. In: *The Indian Camel : A Research Profile*. Published by Director, National Research Centre on Camel, Bikaner, Rajasthan. 2006; pp 74-103.
- Mehta SC. Mathematical functions for the prediction of body weight gain in dromedary. *Journal of Camel Research and Practice*. 2008; 15(2):239-244.
- Rathore G S. *Camels and Their Management*. ICAR publication, New Delhi.1986.
- Sharma R, Sharma H, Sharma P, Ahlawat S, Mehta SC and Tantia MS. Microsatellite analysis generates hope for sustainability of two dwindling camel populations of Rajasthan. *The Indian Journal of Animal Sciences*. 2018; 88(11):1281-1288.