DOI : 10.5958/2277-8934.2019.00024.9 *Vol 26 No 2, p 157-162*

TEAT CHARACTERISTICS OF INDIAN DROMEDARY CAMEL (*Camelus dromedarius*)

Sumant Vyas, M.M. Ansari, Ved Prakash, N. Sharma, Kashinath and N.V. Patil

ICAR- National Research Centre on Camel, P.B. 07, Bikaner 334001 India

ABSTRACT

The present study describes teat characteristics of Indian dromedary females (n=75). Mean±SE of teat diameters measured using Vernier caliper at Right front top, Right front middle, Right front lower or tip; Right Rear top, Right Rear middle, Right Rear lower or tip, Left front top, Left Front middle, Left front lower or tip, Left Rear top, Left Rear middle and Left Rear lower or tip, were 48.45±1.45; 31.77±1.14; 12.16 ±0.42; 52.12±1.48; 34.58±1.3; 13.25±1.01; 47.01±1.58; 33.51±1.26; 12.33±0.49; 54.07±1.62; 36.48±1.41; 12.42±0.47 mm, respectively. Mean±SE of length of Right front, Right rear, Left front, Left rear teat were 63.83±1.88; 64.88±2.1; 64.71±1.8 and 63.92±1.87 mm, respectively with a wide range of 20-110.04 mm. The effect of parity was significant on most of the teat measurements. Ultrasonographic examination revealed presence of definite gland and teat cisterns in camel. The present results give baseline data about teat dimensions with respect to parity, age in female dromedary of Bikaneri, Jaisalmeri, Kachchi and Mewari breeds of Indian camels. This will help to develop teat cups and liners and in turn milking machine for Indian dromedary camels.

Key words: Age, breeds, *Camelus dromedarius*, India, parity, teat characteristics

Camel is the fifth most important dairy animals in world after dairy cattle, buffalo, goat and sheep. According to FAO 2012, camel milk production is around 2.8 million tons which equals to 0.3% of total world milk production. However, others believe that global camel milk production is much higher, around 5.4 million tons per year (Faye, 2008; Faye and Konuspayeva, 2012). The camel milk dairies have come up as business activity in most camel possessing countries (Musaad *et al,* 2017). The market potential for camel milk could be highly developed in the future (Faye *et al,* 2014).

In order to meet out increased demand, milk production through intensive camel dairy management are increasing and resulted into development of camel mechanical milking. Besides behaviour and reaction to human presence and contact, udder and teat traits are important improvement in milking ability. Selection of best udder and teat shape or traits is an important step towards adaption to machine milking (Marnet *et al,* 2016).

Identification of factors like udder and teat characteristics is very important for milking management and machine milking development for camel (Marnet *et al,* 2016; Nagy *et al,* 2015). However, udder and teat morphology have received little attention by camel scientists (Atigui *et al,* 2016). The present study was taken to identify the teat characteristics in Indian dromedary camel breeds.

Materials and Methods

The lactating camels belonging to ICAR-National Research Centre on Camel, Bikaner situated at 28.0229° N, 73.3119° E, 242 m above sea level were studied for teat characteristics. There were 75 camels of four breeds *viz* Bikaneri (n= 23), Jaisalmeri (n= 17), Kachchi (n= 15) and Mewari (n= 20). Lactating camels were supplemented with 1 kg of concentrate pellets besides 10 kg of dry fodder.

The teat measurements were taken immediately after "let down" of milk and just before morning milking. The following measurements were taken using a Vernier caliper (VITA PQ150, Taiwan)- Teat diameter at the orifice, middle and base of the teat, teat length as distance from the teat insertion base to the teat orifice. A total of 1200 measurements (16 from each camel) were recorded as,

Diameters- Right front top (RA1), Right Front middle (RA2), Right front orifice or tip (RA3)

Right Rear top (RB1), Right Rear middle (RB2), Right Rear orifice or tip (RB3)

Left front top (LA1), Left Front middle (LA2), Left front orifice or tip (LA3)

SEND REPRINT REQUEST TO SUMANT VYAS email: sumantv@mail.com

Left Rear top (LB1), Left Rear middle (LB2), Left Rear orifice or tip (LB3)

Length- Right front length (RAL), Right rear length (RBL), Left front length (LAL), Left rear length (LBL).

Ultrasound examination and body measurement

The ultrasound examination of udder and teat was performed using linear probe (6.5 MHz, V-5 portable ultrasound machine, Med-India) with camels in standing position immediately after "let down" of milk and just before morning milking.

Statistical analysis

The data was analysed to study the effect of breed, age and parity on various teat measurements. In order to study the effect of various factors affecting teat measurements a linear fix model was used. Data was analysed using GLM procedure of SPSS20. The linear model included fix effect of breed (4 levels- Bikaneri, Jaisalmeri, Kachchi and Mewari), parity (4 levels- first, second, third and fourth and above) and age of she camel at the time of calving (4 levels- 3-5 year, 6-8 year, 9-11 year and more than 11 year).

$$Y_{ijkl} = \mu + A_i + B_j + C_k + e_{ijkl}$$

Where, Yijkl is individual teat measurement, μ is overall population mean, Ai is fixed effect of age at calving, Bj is the fixed of breed, C_k is the fix effect of parity and e_{ijkl}= is a normally distributed random variable with mean zero and variance σ_e^2.

One way ANOVA was used to study differences in teat measurements which was recorded from different quarters and different sides.

Results

The results of the present study give baseline data about teat dimensions with respect to parity and age in female dromedary of four Indian breeds namely Bikaneri, Jaisalmeri, Kachchi and Mewari. The shape and size of the teat and udder was observed to vary greatly among the individual camels (Fig 1).

Overall least squares means for teat measurements of right quarters RA1, RA2, RA3, RAL, RB1, RB2, RB3 and RBL were 48.70 ± 1.73 cm, 33.04 ± 1.30 cm, 13.15 ± 0.51 cm, 66.10 ± 2.25 cm, 53.11 ± 1.87 cm, 36.64 ± 1.65 cm, 14.64 ± 1.41cm and 67.03 ± 2.80 cm, respectively (Table 1). Overall least squares means for teat measurements of left quarters LA1, LA2, LA3, LAL, LB1, LB2, LB3 and LBL were 48.84 ± 2.15 cm, 34.87 ± 1.65 cm, 13.24 ± 0.66 cm, 67.11 ± 2.38 cm, 53.72 ± 2.09 cm, 38.56 ± 1.66 cm, 13.07 ± 0.65 cm and 66.11 ± 2.36 cm, respectively (Table 2). The effect of age of she camels did not affect the teat measurements significantly except RA3. Effect of breed of camel was also found non-significant for majority of the teat measurements parameters except RA1, RB1 and LB1. Effect of breed was highly significant ($p \leq 0.01$) on RA1 and RB1 and significant on LB1. These measurements were higher in Bikaneri and Kachchi breeds compared to Jaisalmeri and Mewari Breeds. The parity of animals significantly affected most of the teat measurements parameters except RB1, RB3, RBL, LA3, LB1, LB3 and LBL. The parity of animals affected RA1, RA2, RA3, RAL, LA2, LAL significantly ($p \leq 0.01$) and affected RB2, LA1 and LB2 significantly ($p \leq 0.05$) (Table 1 and 2). Increasing trend for various teat measurements was seen up to third parity and thereafter decrease in teat measurements was observed for fourth parity animals. This trend was more consistent for right quarter teat measurements (Fig 2 and Fig 3).

The overall mean value of teat diameters at top/base, middle and tip/orifice and Length were 50.41±0.78, 34.08±0.65, 12.54±0.32 and 64.34±0.96 cm, respectively.

The ultrasound examinations clearly revealed milk in the teat canal and hence increase in dimensions of the teat canal just before the milking and empty teat canal after the milking. Teat's ultrasound scanning showed distinct teat canal connected to well defined teat cistern in each quarter. These were separated from each other by middle cistern wall (Fig 4 and 5).

Discussion

Investigating the teat characteristics is important step in developing machine milking in dromedary camels. Prerequisite for machine milking is the need to use a same liner/ cluster type for all the camels of one flock. During the past 10-15 years intensive camel milk production using machine milking has been introduced in some traditional camel keeping countries like United Arab Emirates, Saudi Arabia and Tunisia (Wernery *et al,* 2004; Hammadi *et al,* 2010; Ayadi *et al,* 2013; Atigui *et al,* 2015). Small scale farms have also come up in Netherlands, Australia and USA. The present study revealed that Indian dromedary camels have a well-developed udder and teats. The shape and size of the teat and udder was observed to vary greatly among the individual camels. Shehadeh and Abdelaziz (2014) has also reported big variability between camels but also intra-camels.

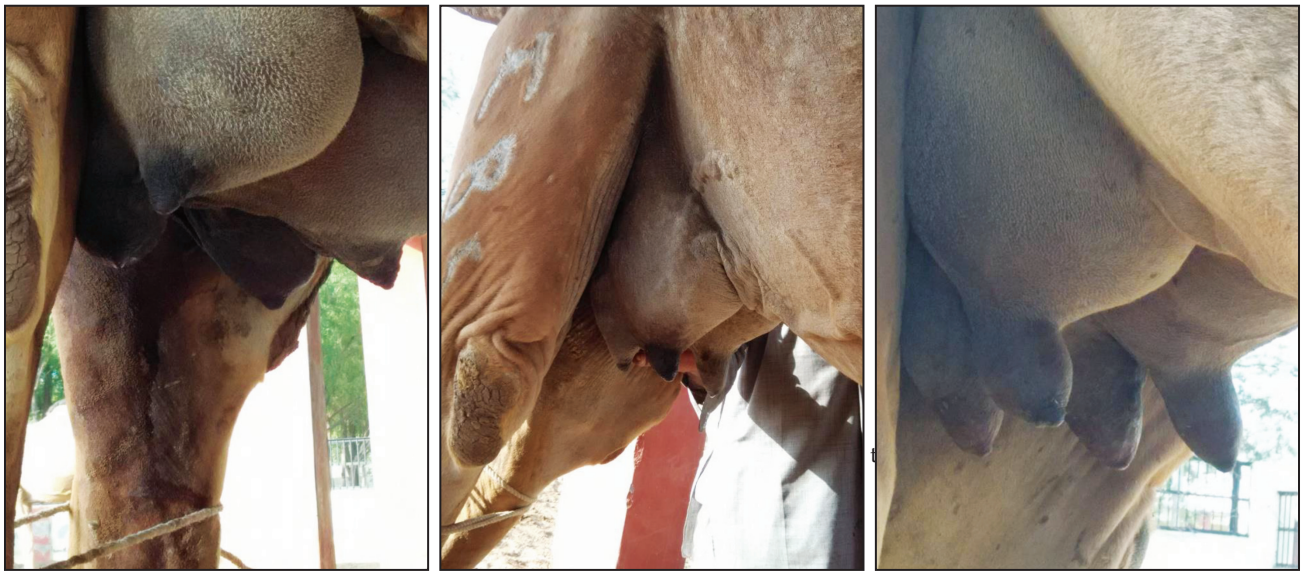

Fig 1. Udder and teats of different shapes and size in Indian *Camelus dromedarius.*

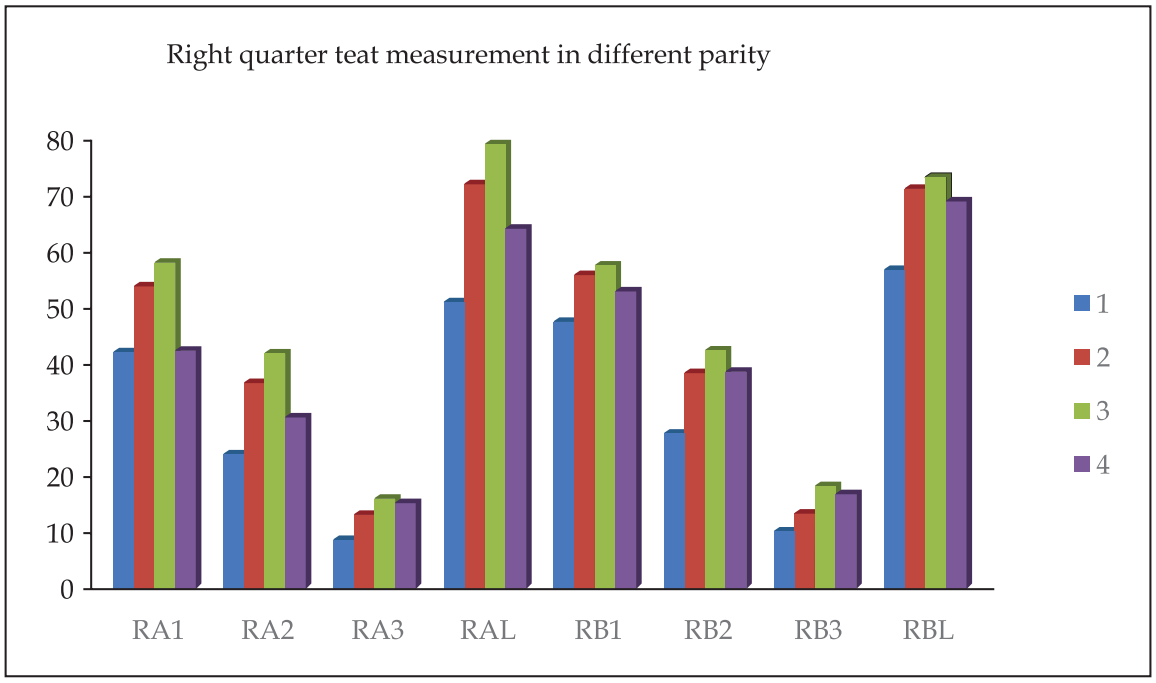

Fig 2. Right quarter teat measurements in different parity.

Teat length in NRCC camels was larger than those reported previously by Eisa *et al* (2010) (mean length 4.3 to 5.3 cm) and similar to that reported by Atigui *et al* (2016) using B-mode ultrasonography (mean length 6.16 to 6.17 cm) and Nagy *et al* (2015).

Teat characteristics are quite different in dromedary camels compared to other dairy animals. Such large teats might cause some problems during machine milking and require special settings and practice during milking. This should be taken into account when developing a milking machine for dairy camels. The teat length in Indian camels in the present study was more than the values reported for dairy cows (around 2.5 cm, Rogers and Spenser, 1991; Zwertvaegher *et al,* 2012) and buffaloes (2.76 ± 0.02 cm, Prasad *et al,* 2010). This indicates that existing milking machines used for cows and buffaloes should be modified before these are used for camels.

The current milking machines work by alternate periods of suction and massage by the liner wall pressure on the teats. The buckling point of the liner is generally situated in the middle of its barrel.

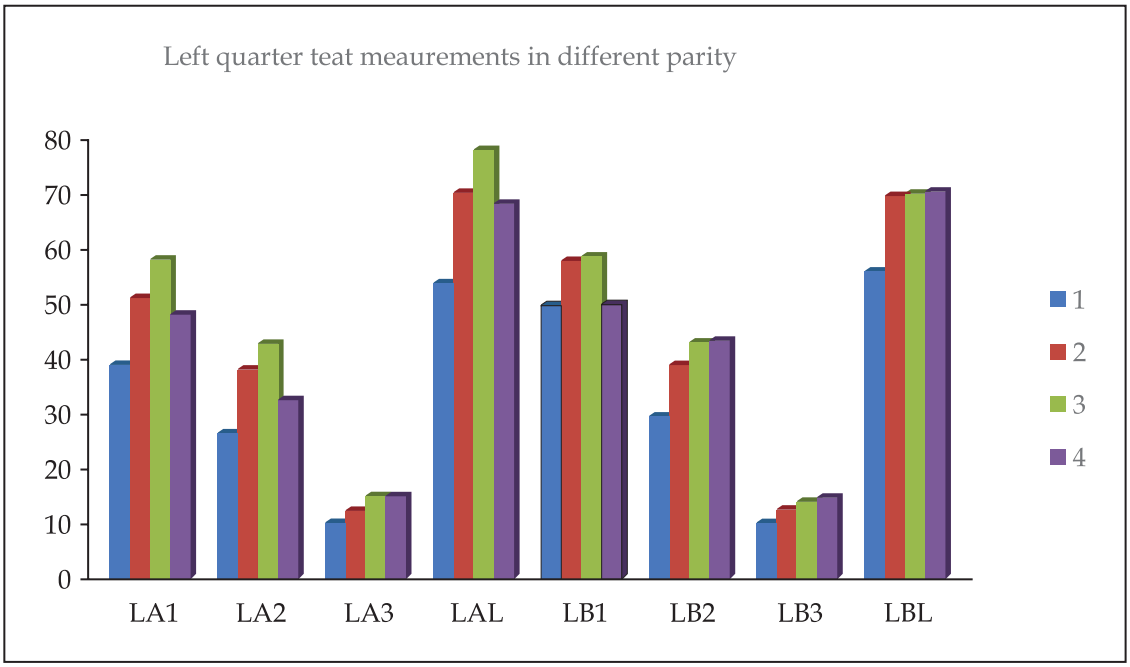

Fig 3. Left quarter teat measurements in different parity.

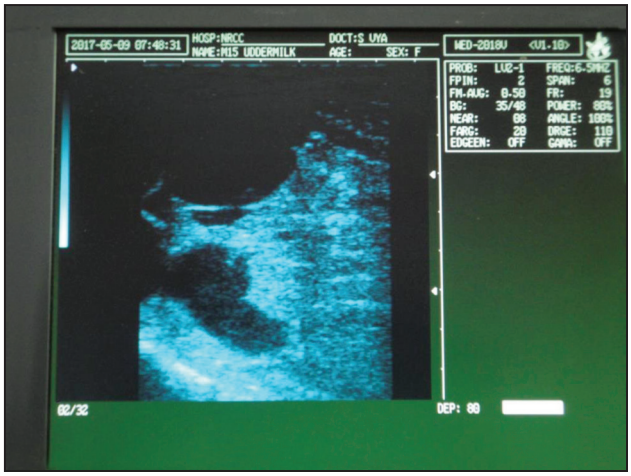

Fig 4. Distinct teat cistern and teat canal engorged with milk before milking.

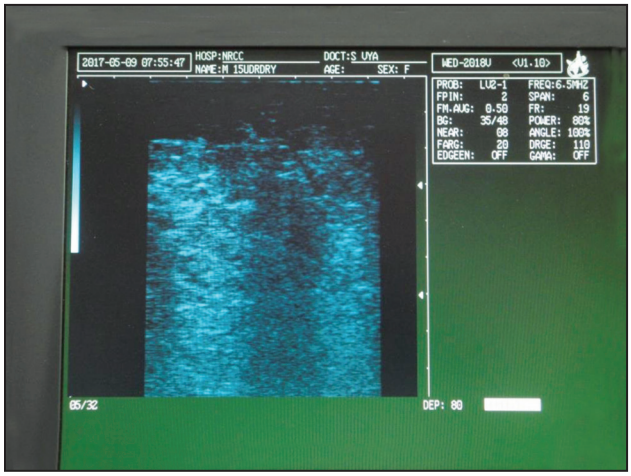

Fig 5. Ultrasonogram of udder and teat emptied after milking.

Therefore the length of liner must be adapted to the teat length to avoid massaging only at the teat apex (teat too short for the liner) or in the upper part of teat (teat too long for the liner) (Mein *et al,* 2003).

The size of dromedary teat undergoes great variation before (*i.e* after milk let down) and after milk ejection. Nagy *et al* (2015) described that change in teat size parameters are related to pre-milking milk ejection. During milk let down and ejection, teat cisterns are filled with milk causing changes in teat size and volume. This functional characteristic underlines the importance of effective pre-milking udder stimulation in this species. During milk let down or stimulation the teat length and volume is reported to increase by 40 to 50% and 130%, respectively. After milking teat length and volume returned to pre-stimulation (n=44, Nagy and Juhasz, 2016). Therefore the liners with large mouth piece (> 30 mm) tend to climb up with decreasing teat size while smaller liner (25 mm) can only accommodate the lower third of an enlarged teat (Nagy and Juhasz, 2016).

B-mode ultrasonography in the present study confirms the presence of definite gland and teat cisterns in camel as reported previously (Abshenas *et al,* 2007 and Atigui *et al,* 2016). This is in contrast to previous reports of a notion /conception that there is no mammary or teat cisterns in camels but the milk rapidly descends directly into the teats causing an enormous swelling, often requiring two hands to

Table 1. Least squares means of teat measurements of right quarters.

Traits	N	RA1	RA2	RA3	RAL	RB1	RB2	RB3	RBL
Overall Mean	75	48.70±1.73	33.04±1.30	13.15±0.51	66.10±2.25	53.11±1.87	36.64±1.65	14.64±1.41	87.03±2.80
Age at calving		NS	NS	*	NS	NS	NS	NS	NS
1(3-5 years)	13	50.74±4.44	35.39±3.34	13.61±1.31	69.75±5.77	53.16±4.80	38.61±4.23	13.80±3.62	66.82±7.18
2 (6-8 years)	26	48.63±2.99	35.28±2.25	15.26±0.89	72.25±3.89	53.23±3.24	38.27±2.86	15.14±2.44	69.79±4.84
3 (9-11years)	15	47.22±3.28	30.29±2.47	12.03±0.97	61.54±4.27	53.76±3.55	34.71±3.13	17.10±2.68	66.37±5.31
4 (>11years)	21	48.22±2.61	31.20±1.96	11.71±0.77	60.88±3.40	52.29±2.82	34.99±2.49	12.52±2.13	66.15±1.22
Breed		**	NS	NS	NS	**	NS	NS	NS
Bikaneri	23	53.87±2.65	33.92±1.99	13.41±0.78	68.11±3.44	58.46±2.86	38.45±2.52	13.46±2.16	69.68±4.28
Jaisalmeri	17	45.85±2.67	32.47±2.01	13.42±0.79	64.21±3.47	49.81±2.88	35.17±2.54	17.55±2.17	64.07±4.31
Kachchhi	15	52.37±3.01	36.03±2.27	12.90±0.89	70.74±3.92	58.03±3.26	41.07±2.87	13.03±2046	73.87±4.88
Mewari	20	42.73±3.06	29.75±2.30	12.89±0.91	61.36±3.89	45.15±3.31	31.89±2.92	14.51±2.50	60.50±4.95
Parity		**	**	**	**	NS	*	NS	NS
1	32	41.81±2.57	23.87±1.93	8.71±0.76	50.71±3.34	47.26±2.78	27.56±2.45	10.23±2.10	56.42±4.16
2	20	53.34±2.53	36.38±1.91	13.10±0.75	71.51±3.29	55.66±2.74	38.22±2.42	13.38±2.07	70.79±4.10
3	17	57.57±3.15	41.63±2.37	15.78±0.93	78.48±4.10	57.05±3.41	42.37±3.00	18.12±2.57	72.64±5.10
4 and above	6	42.10±5.28	30.29±3.97	15.03±1.56	63.71±6.86	52.48±5.75	38.43±5.03	16.83±4.30	68.27±8.54

N denotes number of observation. ** denotes (p≤0.01), * denotes (p≤0.05) and NS denotes- Non-significant at (p >0.05).

Table 2. Least squares means of teat measurements of left quarters.

Traits	N	LA1	LA2	LA3	LAL	LB1	LB2	LB3	LBL
Overall Mean	75	48.84±2.15	34.87±1.65	13.24±0.66	67.11±2.38	53.72±2.09	38.56±1.66	13.07±0.65	66.11±2.36
Age		NS	NS	NS	NS	NS	NS	NS	NS
1 (3-5 yrs)	13	54.09±5.50	37.92±4.23	13.78±1.70	69.79±6.11	51.26±5.34	37.69±4.25	12.84±1.67	62.98±6.05
2 (6-8 yrs)	26	51.75±3.71	37.02±2.85	13.63±1.15	71.52±4.12	54.25±3.61	41.97±2.87	13.83±1.12	69.13±4.09
3 (9-11yrs)	15	45.38±4.07	31.03±3.13	13.06±1.26	66.48±4.52	52.35±3.95	35.97±3.15	12.93±1.23	88.30±4.48
4 (>11yrs)	21	44.16±3.23	33.50±2.49	12.48±1.00	60.64±3.59	57.02±3.14	38.61±2.50	12.68±0.98	64.04±3.56
Breed		NS	NS	NS	NS	*	**	NS	NS
Bikaneri	23	51.98±3.28	34.77±2.52	13.60±1.01	69.32±3.64	59.18±3.19	42.51±2.53	14.59±0.99	62.98±6.05
Jaisalmeri	17	47.54±3.30	36.81±2.54	12.27±1.02	67.44±3.67	49.03±3.21	34.45±2.55	12.24±1.00	69.13±4.08
Kachchhi	15	50.98±3.73	37.25±2.87	13.84±1.15	65.07±4.15	58.82±3.63	45.07±2.89	12.99±1.13	68.30±4.48
Mewari	20	44.86±3.79	30.64±2.91	13.24±1.17	66.61±4.21	47.85±3.69	32.21±2.93	12.47±1.15	64.04±3.56
Parity		**	**	NS	**	NS	**	NS	NS
1	32	38.78±3.18	26.41±2.45	10.18±0.98	53.52±3.54	49.35±3.09	29.46±2.46	10.26±0.96	55.75±3.50
2	20	50.94±3.14	37.93±2.41	12.48±0.97	69.79±3.45	57.46±3.05	38.81±2.43	12.80±0.95	69.20±3.45
3	17	57.77±3.91	42.56±3.00	15.10±1.12	77.42±4.34	58.33±3.80	42.82±3.02	14.12±1.18	69.52±4.29
4 and above	6	47.88±6.54	32.56±5.03	15.19±2.02	67.71±7.26	49.74±6.35	43.15±5.05	15.11±1.98	69.98±7.19

N denotes number of observation. ** denotes (p≤0.01), * denotes (p≤0.05) and NS denotes- Non-significant at (p >0.05).

encompass a teat (Yagil *et al,* 1999 and Simpkin *et al,* 1997).

At present camel farmers at large in India are skeptical about possibility of machine milking for camels. But it could be possible if they overcome their traditional mindset and opt for selection of camels for udder and behavioural traits suitable for efficient milk ejection. Development or modification in existing milking machines using new material and settings is also necessary for successful machine milking in camels.

The present results offer a good base data which can be used effectively for selection camels for bringing an improvement in performance of dairy

camel. The findings of the present study will help to develop teat cups and in turn milking machine for Indian dromedary.

Reference

Abshenas J, Vosough D, Masouifard M and Molai MM (2007). B-mode ultrasonography of the udder and teat of camel (*Camelus dromedarius*). Journal of Veterinary Research 62:28-31.

Atigui M, Marnet PG, Barmat A, Khorchani T and Hammadi M (2015). Effects of vacuum level and pulsation rate on milk ejection and milk flow traits in Tunisian dairy camels. Tropical Animal Health and Production 47: 201-206.

Atigui M, Marnet PG, Harrabi H, Bessalah S, Khoerchani T and Hammadi M (2016). Relationship between external and internal udder and teat measurements of machine milked dromedary camels. Tropical Animal health Production 48:935-942.

Ayadi M, Aljumaah RS, Musaad A, Samara EM, Abelrahman MM, Alshaikh MA, Saleh SK and Faye B (2013). Relationship between udder morphology traits, alveolar and cisternal milk compartments and machine milking performace of dairy camels (*Camelus dromedarius*) Spanish Journal of Agricultural Research 1:790-797.

Eisa MO, Ishag IA and Abu-Nikhaila AM (2010). A note on the relationships between udder morphometric and milk yield of Lahween camel (*Camelus dromedarius*). Livestock Research for Rural Development. Volume 22, Article #188.

Faye B (2008). Dairy productivity potential of camels. In: R. Cardellion, A Rosati, C. Mosconi 9eds), Current status of genetic resources, recording and production systems in African, Asian and American Camelids, ICAR technical series No. 11, Proceedings of the ICAR/ FAO Seminar, Sousse, Tunisia, 2004, ICAR, Rome, 93-104.

Faye B and Konuspayeva G (2012). The sustainability challenge of the dairy sector- The growing importance of the non-cattle milk production worldwide. International Dairy Journal 24:50-56.

Faye B, Hassani M and El-Rouili Sageed AH (2014). Camel milk value chain in Northern Saudi Arabia. Emirates Journal of Food Agriculture 26:359-365.

Hammadi M, Atigui M, Ayadi M, Barnat A, Belgacem A, Khaldi G and Khorchani T (2010). Training period and short time effects of machine milking on milk yield and milk composition in Tunisian maghrebi camels (*Camelus dromedarius*). Journal of Camel Practice and research 17:1-7.

Marnet PG, Atigui M and Hammadi M (2016). Developing mechanical milking in camels? Some main steps to take. Tropical Animal Health and Production 48:889-896.

Mein G, Reinemann D, O'Callaghan E and Ohnstad I (2003). Where the rubber meets the teat and what happens to milking characteristics. In: IDF symposium: 100 years with Liners and Pulsators, Sept 2003. World Dairy Summit and Centenary, Bruges, Belgium.

Musaad A, Ayadi M, Khalil A, Aljumaah RS and Faye B (2017). Udder and teat shape and the relationship with milk yield in camels (*Camelus dromedarius*). Scholars Journal of Agriculture and Veterinary Sciences 4(10):418-423.

Nagy P, Keresztes M, Reiczigel J and Juhasz J (2015). Evaluation of udder and teat shape and size in lactating dromedary camels (*Camelus dromedarius*). In: G Konuspayeva (ed.), Proceeding of the 4th International Society of camelid research and Development (ISOCARD), Almaty, Kazakhstan, 2015. pp 134-135.

Nagy P and Juhasz J (2016). Review of present knowledge on machine milking and intensive milk production in dromedary camels and future challenges. Tropical Animal Health and Production 48:915-926.

Prasad RMV, Sudhakar K, Raghava Rao E, Ramesh Gupta B and Mahender M (2010). Studies on the udder and teat morphology and their relationship with milk yield in Murrah Buffaloes. Livestock Research for Rural Development, 22 (20) Volume 22, Article #20. Retrieved April 5, 2019, from http:// www.lrrd.org / lrrd22/ 1/ pras22020.htm.

Rogers GW and Spenser SB (1991). Relationships among udder and teat morphology and milking characteristics, Journal of Dairy Science 74:4189-4194.

Shehadeh K and Abdelaziz F (2014). The challenge of machine milking in dromedary camel. Scientific Journal of Review 3(12):1004-1017.

Simpkin SP, Rowlinson P, Tullu D and Lesorogol P (1997). Camel calf suckling behaviour and milk yield estimation studies in Kenya. Journal of Camel Practice and Research 4:235-239.

Wernery U, Juhasz J and Nagy P (2004). Milk yield performance of dromedaries with an automatic bucket milking machine. Journal of Camel Practice and Research 11:51-57.

Yagil R, van Creveld C, Abu-R'Kaik G and Merin U (1999). Milk "let down" in camels. Journal of Camel Practice and Research 6:27-29.

Zwertvaegher I, Van Weyenberg S, Piepers S, Baert J and De Vliegher S (2012). Variance components of teat dimensions in dairy cows and associated factors. Journal of Dairy Science 95:4978-4988.