



Morphometric characterization of udder and teat of Jennies

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Received: 29 April 2023; Accepted: 8 March 2024

ABSTRACT

The present study was conducted in eight districts of Marathwada region, Maharashtra, India. A pre-survey was carried to find the maximum available population of donkeys in the respective area. Two hundred two (202) female donkeys were selected for the study. The data was collected based on morphometry of udder, teat, physiological status, pregnancy, lactation, and milk composition. Udder traits such as udder length, udder depth, udder width, udder circumference and teat traits such as teat length and teat diameter were found highly significant in lactating Jennies when compared with dry and pregnant females. The milk composition parameters were milk fat (MF), milk protein (MP), milk solid not fat (MSNF), total solid (TS), odour (O) and test (T): 1.31 ± 0.08 , 1 ± 0.01 , 6.93 ± 0.03 , $8.31 \pm 0.09\%$ and 4593 ± 120 per ml, respectively, for overall lactating jennet population.

Keywords: Donkey milk, Jennie, Parity, Teat, Udder

India is the world's largest milk producer, contributing 24% of global milk production. Milk production in the country has grown at a compound annual growth rate of about 6.2% to reach 209.96 million tonnes in 2020-21 from 146.31 million tonnes in 2014-2015. Over 96% of India's milk production comes from two species - cattle and buffaloes. Cattle produce 81% of world's milk production, followed by buffaloes 15%, goats 2%, sheep 1% and camels provide 0.5%. The remaining share is produced by other dairy species such as equines and yaks (NIPFA Report 2022). The yield of donkey milk is relatively low, as donkey produces 100–150 kg in one lactation and donkey milk has scientific value represented in many researches (Fantuz *et al.* 2013). Because of the difficulties of milk acquisition, preservation, transportation and ethnic customs, donkey's milk development has not been taken seriously. The nutritional values of donkey milk have not been well-studied, and systemic researches are still blank. Nowadays, there is no acceptance criteria of donkey milk, therefore appropriate standards are required to be set for standardizing the donkey milk market, strengthening the donkey milk product quality inspection and market regulation (Li and Guo *et al.* 2018). Donkey's milk has successfully been used as a substitute for human milk, especially in children with cow milk-allergy (Monti *et al.* 2008, Perna *et al.* 2015). The composition of donkey milk is very close to human milk, especially the lipids content

(high levels of linoleic and linolenic acid) and proteins (low casein content). Furthermore, high lysozyme content of donkey's milk may be the cause of its low bacterial count when compared with bovine, caprine and human milk (Vincenzetti *et al.* 2008). Donkeys are rustic animals and the adaption to the climate is very early and they can be reared in a semi-wild state, so it reduces initial investment costs and expenditure.

The conformation of the udders and teats of dairy animals are considered fundamental traits for milk production and important for efficiency of milking (Tilki *et al.* 2005). The storage of milk between milking and its yield at the time of milking is affected by the anatomy and morphology of the udder (Labussière 1988) and varies among species. The distribution of milk in the udder, also affects the milk composition (De Bie *et al.* 2001). Moreover, unlike small ruminants in which most milk is cisternal up to 75% in dairy breeds (Marnet and McKusick 2001, Salama *et al.* 2004), in equids 70–85% of secreted milk is alveolar (Le Du 1986) and it can be drawn only if milk ejection occurs. However, in donkeys no information is available on the morphological characteristics of the udder, cistern size and milk storage. The aim of this study was to assess the morphological and anatomical characteristics of the udders and teats of female donkey by measurement.

MATERIALS AND METHODS

The present experiment was conducted at eight districts of Marathwada region in Maharashtra, India. Presurvey was carried out to find the maximum available population of donkeys. The data was collected based on physiological status, pregnancy and lactation. The

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instrument used for measurement was tailor's measuring tape and visual examination. For the present study, 29 jennets milk samples were collected for milk composition of donkeys. Parameters under study were milk fat (MF), milk protein (MP), milk solid not fat (MSNF), total solid (TS), odour (O) and test (T) for overall lactating jennet population. Observation of these parameters were studied using Lactoscan milk analyser. The number of somatic cells (SSC) was determined by using direct microscopic somatic cell count method under the magnification of 40× in 50 fields and the average number of cells per field is multiplied by the microscopic factor (0.882). The obtained data was analysed using WASP (2022) Web Agriculture Statistics Package.

RESULTS AND DISCUSSION

Udder and teat traits: The data of the udder and teat traits were presented in Table 1. It was observed that the udder and teat traits showed highly significant difference ($p < 0.01$) for dry, lactating and pregnant local Jennies in Marathwada region. Udder traits like UL (Udder length), UD (Udder depth), UW (Udder width), UC (Udder circumference) and teat traits like TL (Teat length), TD (Teat diameter) were found to be significantly increased in lactating Jennies compared with dry and pregnant females, increase in udder and teat parameters due to the increased volume of milk in teats. The continuous suckling of teat by foal may be responsible for increase in teat length and diameter of lactating females. UHFG (Udder height from ground) and THFG (Teat height from ground) also seen to be increased in dry females compared with lactating and pregnant females, due to which decreased UL and TL in dry females. DBT is seen to be increased in pregnant females than lactating and dry females. Teats of the pregnant females were tight and voluminous and distantly placed from each other unlike closely placed in case of dry females due to contraction of teat and udder.

Very scanty work has been carried out on udder and teat traits in female donkeys. D'Alessandroa *et al.* (2013) and D'Alessandroa *et al.* (2014) observed the effect of before and after milking on udder and teat traits in Martina Franca

breed of female donkey and found significant differences in udder and teat traits, i.e. UL, UW, UD, TL, TD, and DBT of female donkeys before and after milking. Baimukanov *et al.* (2021) studied udder and teat traits in Kazakh horse mare, i.e. TL, DBT, UL, and UC were 4.0 ± 0.5 , 7.2 ± 0.6 , 25.4 ± 1.8 , and 70.3 ± 2.1 cm respectively. Chirgin *et al.* (2021) studied udder and teat traits in Russian heavy draft breed, i.e. UL, UW, UC, and DBT were 3.1 ± 0.16 , 5.40 ± 0.26 , 14.35 ± 0.61 , and 7.40 ± 0.82 cm respectively.

Udder and teat shape: The data of the udder and teat shape were presented in table 2. In present study the udder shapes were recorded in pregnant, lactating and dry female donkeys and it was observed that the bowl and globular udder shapes were seen commonly in the adult Jennies. Bowl shaped udder was seen in all 100% pregnant and lactating Jennies, whereas, the percentage of bowl and globular shaped udder in dry Jennies were 82.45 and 17.55%, respectively. The percentage of bowl and globular udder shapes in overall (pregnant + lactating + dry) Jennies were 88.61 and 11.38% respectively. The teat shapes were observed by visual examination. The two types of teat shapes commonly observed in the local adult female are conical and cylindrical shape. The conical shaped teats were mostly seen in pregnant, lactating, dry, and overall female status were of 61.76, 83.78, 75.57, and 74.75%, whereas, for cylindrical shaped teats were 38.24, 16.22, 24.43, and 25.24%, respectively.

Similar results were observed by D'Alessandroa *et al.* (2013). D'Alessandroa *et al.* (2014) worked on udder and teat measurements in healthy adult female donkeys before and after milking and recorded bowl-shaped udder in majority of the animals (89%) and globular udder in (11%) of females. Kaskous *et al.* (2022) studied morphological properties of mammary gland of female donkeys and observed (89%) bowl shaped and (11%) globular shaped udder in female donkeys. Baimukanov *et al.* (2021) recorded cup shaped and round shaped udder in Kazakh mares. The present results about teat shapes are analogous to the findings reported by D'Alessandroa *et al.* (2013) and D'Alessandroa *et al.* (2014) were (78%) conical and (22%) cylindrical shaped teats in female donkeys.

Table 1. Physiological status of udder and teat traits (n=202)

Parameter	Dry (n=131)	Lactating (n=37)	Pregnant (n=34)	Overall (n=202)	F cal. Value
UL	13.13 ^a ±0.08	15.56 ^a ±0.17	14.17 ^b ±0.12	13.74±0.09	102.5**
UW	8.21 ^c ±0.03	9.94 ^a ±0.14	9.23 ^b ±0.16	8.70±0.06	120.9**
UD	8.27 ^b ±0.03	9.31 ^a ±0.14	9.11 ^a ±0.09	8.61±0.05	68.42**
UC	21.05 ^b ±0.12	25.13 ^a ±0.27	25 ^a ±0.18	22.47±0.16	179.6**
UHFG	67.81 ^a ±0.21	66.13 ^b ±0.27	64.68 ^c ±0.27	66.98±0.17	31.40**
TL	3.11 ^c ±0.04	4.15 ^a ±0.05	3.76 ^b ±0.08	3.42±0.04	73.89**
TD	2.33 ^c ±0.03	2.97 ^a ±0.07	2.71 ^b ±0.03	2.51±0.03	44.69**
DBT	3.68 ^b ±0.05	4.56 ^a ±0.08	4.68 ^a ±0.77	4.00±0.05	58.12**
THFG	64.72 ^a ±0.22	62.05 ^b ±0.30	60.91 ^c ±0.29	63.59±0.19	47.12**

Means bearing different superscripts (^{a,b}) differ significantly (** $p < 0.01$) in row. US, Udder shape; UL, Udder length; UW, Udder width; UD, Udder depth; UC, Udder circumference; UHFG, Udder height from ground; TS, Teat shape; TL, Teat length; TD, Teat diameter; DBT, Distance between teat; THFG, Teat height from ground; MF, Milk fat; MP, Milk protein; SNF, Solid not fat; TS, Total solid; SCC, Somatic cell count.

Table 2. Udder and teat shape as per the physiological status (n=202)

Physiological status	Udder shape		Teat shape	
	Bowl	Globular	Conical	Cylindrical
Pregnant (n=34)	100% (n=34)	0	61.76% (n=21)	38.24% (n=13)
Lactating (n=37)	100% (n=37)	0	83.78% (n=31)	16.22% (n=6)
Dry (n=131)	82.45% (n=108)	17.55% (n=23)	75.57% (n=99)	24.43% (n=32)
Overall (n=202)	88.61% (n=179)	11.38% (n=23)	74.75% (n=151)	25.25% (n=51)

Udder and teat traits as per the parity: The data as per parity of udder and teat traits were presented in Table 3. From the table, it is observed that udder and teat traits in female donkeys at different parities showed highly significant ($p<0.01$) differences in most of the udder and teat traits, except significant differences ($p<0.05$). For UHFG, it showed that the gradual increase in udder and teat traits from first parity to third parity. The UHFG and THFG were seen to be higher in first parity and gradually decrease towards second and third parity.

Table 3. Udder and teat traits as per the parity (n=202)

Parameter	1 st parity (n=143)	2 nd parity (n=17)	3 rd parity (n=17)	F Cal. value
UL	13.06 ^c ±0.06	15.04 ^b ±0.06	16.22 ^a ±0.06	243.1**
UW	8.34 ^c ±0.05	9.30 ^b ±0.12	10.2 ^a ±0.22	72.38**
UD	8.37 ^b ±0.04	9.13 ^a ±0.11	9.27 ^a ±0.22	34.27**
UC	21.5 ^b ±0.16	24.4 ^a ±0.33	25.06 ^a ±0.39	48.99**
UHFG	67.3 ^a ±0.21	66.2 ^{ab} ±0.28	65.6 ^b ±0.44	6.149*
TL	3.10 ^c ±0.04	4.07 ^b ±0.02	4.44 ^a ±0.44	135.7**
TD	2.39 ^b ±0.03	2.83 ^a ±0.07	2.77 ^a ±0.07	22.14**
DBT	3.79 ^b ±0.05	4.45 ^a ±0.08	4.68 ^a ±0.13	27.31**
THFG	64.3 ^a ±0.22	62.1 ^b ±0.35	60.5 ^b ±0.32	27.71**

Means bearing different superscripts (^{a,b}) differ significantly (* $p<0.05$) (** $p<0.01$) in row.

Udder shape and teat shape as per the parity: The data as per parity of udder and teat shape were presented in Table 4. It is observed that the shapes of udder in adult females for bowl and globular shapes were 88.61% and 11.39%, respectively. The percentage of bowl-shaped udder in female donkeys of 1st, 2nd and 3rd parity were 87.41, 88.09 and 100% respectively, whereas, for globular shaped udder were 12.59, 11.91 and 0%, respectively. The teat shape in adult female i.e., conical and cylindrical shaped teats were 75.25 and 24.75%. The percentage of conical shape of 1st, 2nd and 3rd parity donkeys were 77.62, 73.80, and 58.82% respectively and for cylindrical shape 22.38, 26.20 and 41.18%, respectively.

Milk composition and milk quality traits of local Jennies: Total 29 milk samples were analysed for estimation of milk

composition and milk quality as given in Table 5.

It is found that the milk fat in the local female donkeys was higher and milk protein and total solids were found to be comparatively lower than milk of female donkeys reported by various authors. Salimei *et al.* (2004), who have reported milk composition, i.e. MF, MP, and TS in Italian donkeys as 0.38, 1.72, and 8.84% respectively. Guo *et al.* (2007) recorded 0.50±0.15 MF, 1.85±0.20 MP, and 9.26±0.81 TS in Jiangyue breed of donkey in northwest China. Conte *et al.* (2009) reported fat, protein, and somatic cell count in Ragusana breed as 0.25-2.96, 1.44-2.07% and 45000/ml. Ivankovic *et al.* (2009) estimated MF, MP, TS and SCC in Littorl-Dinaric breed from the County of Zadar as 0.33, 1.55, 8.80% and 4.09 log 10 ml⁻¹, respectively. Malissiova *et al.* (2016) reported MF, MP, and SCC in Greece and Cyprus donkey as 0.52±0.40, 1.22±0.58%, and 8.1×10³±2.5×10³/ml respectively. Tavsanlı *et al.* (2020) estimated MF, MP, TS and SCC in donkeys of Balikesir, Marma region of Turkey as 0.7±0.05, 1.57±0.71, 8.89±0.43%, and 3461±924.14/ml respectively. Similar findings for taste and odour of milk of Jennies has been recorded by Gubic *et al.* (2014), as the taste of milk was slightly sweetened and had pleasant odour.

The donkey rearing population of Marathwada region were from backward communities. Lack of scientific rearing practices was due to illiteracy amongst the donkey rearing communities. There is need of awareness, research and extension programmes in the society. The composition of donkey milk is very close to human milk, especially the

Table 5. Milk composition and milk quality traits of local Jennies

Parameter	Mean±Standard error
MF (%)	1.31±0.08
MP (%)	1.00±0.01
SNF (%)	6.90±0.03
TS (%)	8.31±0.09
SCC (per ml)	4593±120
Odour	Pleasant
Taste	Slightly sweet

Table 4. Udder shape and teat shape as per the parity

Parity	Udder shape		Teat shape	
	Bowl	Globular	Conical	Cylindrical
1 st parity (n=143)	87.41% (n=125)	12.59% (n=18)	77.62% (n=111)	22.38% (n=32)
2 nd parity (n=42)	88.09% (n=37)	11.91% (n=5)	73.80% (n=31)	26.20% (n=11)
3 rd parity (n=17)	100% (n=17)	0.00	58.82% (n=10)	41.18% (n=7)
Over all (202)	88.61% (n=179)	11.39% (n=23)	75.25% (n=152)	24.75 % (n=50)

lipids content (high levels of linoleic and linolenic acid) and proteins (low casein content). Donkey's milk has been used as a substitute for human milk, especially in children with cow milk-allergy and it is observed that milk of donkey had pleasant odour and slightly sweet taste.

ACKNOWLEDGEMENTS

Authors express special thanks to Associate Dean, College of Veterinary and Animal Sciences, Udgir and MAFSU, Nagpur for extending support to carry out the present research work.

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