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ORIGINAL ARTICLE

Physico-chemical composition, minerals, vitamins, amino acids, fatty acid profile and sensory evaluation of donkey milk from Indian small grey breed

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Abstract Composition, nutritional value and sensory characteristics of donkey milk of Indian small grey breed was analysed using AOAC and other standard methods. Fresh donkey milk had 90.63% (w.b.) moisture content, 0.76% fat, 1.96% protein, 6.30% lactose, 0.40% ash. Particle size of donkey milk was 355.00 d.nm. The UHPLC analysis ascertained that lysozyme content was more in donkey milk sample. The ICPMS confirmed that Ca, K, Mg, Na, vitamin C and E, glutamic acid, leucine, proline were the most abundant in donkey milk, but Fe, Zn, Vitamin A and B1, methionine shown lower amount. The GC analysis determined that butyric acid, lauric acid was more and lower amount of unsaturated fatty acids were observed in donkey milk sample. Finally, the TPC, yeast and mould count were acceptable and confirmed that donkey milk is microbiologically safe and sensory evaluation studies of donkey milk confirmed that the desired sensory attributes.

Keywords Amino acids · Donkey milk · Fatty acids · Lysozyme · Sensory attributes · Vitamins

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Introduction

Donkey (*Equus asinus*) is a member of the horse family, domestication began about 6000 B.C. in North Africa at valley of the Nile and over the centuries donkeys have spread across Asia, India, South America and South Europe. Food and Agricultural Organization (FAO) has reported three distinct types of Indian donkeys viz., Indian, Indian wild and Kiang. Indian wild donkeys are available in Rann of Kutch (Gujarat) while Kiang's are available in Sikkim and Laddakh. They are dark red brown with white underparts and patch behind the shoulder. Among Indian, two major types of donkeys following larger and smaller size are common. The larger size donkeys are light grey to almost white in colour. The smaller size ones are dark grey in colour (www.nrce.nic.in), as there are Indigenous breeds. Phenotypically differences of donkey population was observed in Rajasthan and Gujarat as large white, small grey, whereas, Zanskari in Zanskar valley, Spiti in Lahaul and Spiti valley (Gupta et al. 2017).

Donkeys are majorly reared for work, breed, meat and meagrely milk. It is a myth which says that consumption of donkey milk enhances growth of body, promotes brain development and improves voice in the new born babies. Donkey milk can be used in treating of CMPA for the infants due to the low casein content (6.60 mg mL^{-1}) compared to cow milk and almost similar to human milk (5.80 mg mL^{-1}) (Vincenzetti et al. 2008). The composition of donkey milk is nutritious. The high content of lactose in donkey milk is responsible for the good palatability and facilitates the intestinal absorption of calcium that is essential for infant's bone mineralization. The protein compound helps to avoid conditions of an excessive renal load of solute. The mineral composition is very close to human milk (Ca–P ratio) except highest level of calcium

and phosphorus. Donkey milk is a good source of essential fatty acids.

Donkey milk shows high content of both linoleic (C18:2) and linolenic (C18:3) acids, 9.0 g 100 g^{-1} and 5.1 g 100 g^{-1} of total fatty acids, respectively. The high content of lysozyme (1.00 g L^{-1}) in donkey milk is responsible for the low bactericidal concentration (Polidori et al. 2009) and it plays an important role in fighting infections in breast-fed infants during the late lactation. Donkey milk is a good source of vitamins and amino acids. The results on gross composition, mineral content, amino acids, vitamins, fatty acid profile and sensory characteristics related information of Indian small grey donkey milk will be beneficial to donkey keepers, industrial personnel and various government agencies as well as to society, in this context the objective of the study was determination of physico-chemical composition, minerals, vitamins, amino acids, fatty acid profile and sensory characteristics of donkey milk from Indian small grey breed.

Materials and methods

Milk sample was collected after parturition from post-monsoon (October to November) to winter season (December to February), during lactation period of 58th to 62nd days from three multiparous donkey of the small grey breed, aged between 12 and 13 years, with good healthy body conditions, in the village of *Chikkabanagere*, Sira Taluk, Tumkur District, Karnataka, India. From October to early March the animal on the natural grazing of pasture in one grazing season on natural scrub of grass, groundnut plants with natural water. The donkey milk was manually milked in the morning at 6.30 AM, 30 min after separating foal from their mother. Milk was completely removed from both udders, milking yield in the morning was 350 mL from one animal, 400 mL from second and 300 mL from third animal which was collected in sterilized polyethylene terepthalte bottle and mixed together (1050 mL), kept in an ice box at 4 °C during transport. The collected sample was frozen at − 20 °C until analysis. All the analysis was carried in triplicate.

Total plate count, yeast and mould count was determined by method No. 5402 and 5403 (IS 1999, 2012), moisture content by hot air oven method No. 990.20, fat by the Gerber method No. 2000.18, solids-not-fat by method No. 990.21, protein by Kjeldahl's method No. 991.20, total ash by muffle furnace method No. 925.23, titratable acidity by method No. 947.05 (AOAC 2005), lactose by difference method No. 1656 (IS 1997) using the following expression.

$$\text{Lactose}(\%) = 100 - (\text{moisture content} + \text{fat} + \text{protein} + \text{ash}) \quad (1)$$

Digital pH meter was used to determine pH, colour by Hunter lab colourimeter, water activity by water activity meter. Lysozyme was determined by Ultra High Pressure Liquid Chromatography (UHPLC) (Vincenzetti et al. 2008) and particle size determined by Zetasizer (Sats et al. 2014). Minerals were determined by Inductively Coupled-Plasma Mass Spectrometry (ICPMS) (Fantuz et al. 2012). The vitamins and amino acids were determined using High Performance Liquid Chromatography (HPLC) (Malik et al. 2008; Rafiq et al. 2016). Fatty acids were determined using Gas Chromatography (GC) Martini et al. (2010).

Sensory evaluation

Sensory characteristics were determined for judging the quality of the pasteurized donkey milk sample by ten panellists (three females and seven males, aged 22–45 years). Ten mL of milk sample at temperature between 8 and 12 °C was given to each of the panellists in disposable transparent plastic cups. Water was available to panellists during the test. Samples were described using quantitative descriptive analysis using 9-point hedonic scale to assess appearance/colour, smell, consistency, taste and overall acceptability (Malissiova et al. 2016; Schiano et al. 2017).

Statistical design

The data obtained from donkey milk was analyzed by using Design-Expert software version 7.7.0 (Stat-Ease Inc, 2005), Montgomery (2001). The analysis was carried out in triplicate.

Results and discussion

The physico-chemical properties of donkey milk are presented in Table 1. The average lactose content in donkey milk was similar to human (6.3–7.0%), horse milk (5.6–7.2%) and higher than that of cow, sheep and goat milk (Polidori et al. 2015). Moderately similar results were reported by Massouras et al. (2017) in pluriparous Arcadian donkey milk on the 30th, 60th, 90th, 150th, 180th, 210th day of lactation at south-eastern Peloponnese and higher value was reported by Salimei et al. (2004) in pluriparous for martina franca and ragusana donkey milk.

The average protein content of donkey milk was almost similar to human milk (1.94%) and much lower than cow, buffalo, mare, sheep and goat (Rathore et al. 2011; Swar

Table 1 Physico-chemical properties and microbial load in small grey donkey milk

Sl. no.	Composition	Range	Mean values	SD	CV	SEm±
1	M.C. (% w.b.)	89.85–90.91	90.63	0.36	0.40	0.15
2	Solids not fat (%)	8.38–9.34	8.61	0.35	4.02	0.14
3	Fat (%)	0.70–0.80	0.76	0.03	4.53	0.01
4	Protein (%)	1.78–1.96	1.91	0.06	3.19	0.02
5	Lactose (%)	6.03–6.96	6.30	0.31	4.87	0.13
6	Ash (%)	0.37–0.41	0.40	0.02	4.19	0.007
7	pH	7.10–7.28	7.19	0.06	0.87	0.03
8	Titratable acidity	0.049–0.054	0.052	0.002	4.041	0.001
	L^*	86.18–86.51	86.34	0.10	0.11	0.04
9	a^*	− 2.44–(− 2.57)	− 2.48	0.04	− 1.76	0.02
	b^*	2.95–3.25	3.12	0.10	3.25	0.04
10	Water activity (a_w)	0.980–989	0.98	0.003	0.38	0.002
11	Particle size (d.nm)	353.98–356.12	355.00	0.88	0.25	0.51
12	Lysozyme (mg L^{-1})	1969–1973	1971.00	2.83	0.08	0.94
13	Total plate count (cfu mL^{-1})	8.30–9.00	8.1×10^4	0.83	10.23	0.4784
14	Yeast and mould count (cfu mL^{-1})	8.50–9.10	< 10.00	0.41	4.55	0.2373

M.C. = moisture content; No. of replications = 6; SD = Standard Deviation; CV = coefficient of variation; SEm± = standard error mean; d.nm = Diameter in nanometer

2011; Claeys et al. 2014). Good agreement with protein content of present study was found by Aurelia et al. (2016) on primiparous and multiparous donkey milk in summer and winter season. In present study the protein was lower than the values reported by Gubic et al. (2016) in domestic balkan donkey milk on the 45th, 80th, 100th, 125th, 150th, 170th, 200th, 230th, 280th day of lactation except 60th day of lactation whereas higher values reported by Martini et al. (2014) for Amiata donkey milk. The mean fat content of donkey milk was quite similar to mare milk (1.30%) and much lower than cow, buffalo, sheep, goat and breast milk (Swar 2011). Higher fat content was reported by Malissiova et al. (2016) on indigenous Greek and Cypriot donkey milk and lower values were reported by Martemucci and D'Alessandro (2012) on pluriparous Martina Franca during entire lactation period of 7 months compared to present results.

Average ash content in donkey milk was similar to mare (0.3–0.5%) and human (0.2–0.3%) and lower than cow milk (0.7–0.8%) reported by Guo et al. (2007). Overall concentrations of minerals (23 No.) are presented in Table 2. Compared to present results higher concentrations of Ca and Fe was observed in human, cow, sheep, goat and buffalo milk and little similar concentrations was observed in mare milk (Claeys et al. 2014). The lower concentration of minerals in present study compared to other ruminants might be due to higher ash content.

Average pH and acidity of donkey milk was similar to human and mare milk and higher than that of cow, buffalo, sheep and goat milk (Sunaric et al. 2016; Swar 2011). Similar results were reported by Aurelia et al. (2016) on multiparous donkey in summer season. Little variation of pH and acidity was reported by Cosentino et al. (2012) in lactation stages of 30, 60, 90, 120 and 150th day in the spring season on donkey milk. The difference of current results and literature values is due to the lower casein and phosphate contents in the milk sample (Salimei et al. 2004). More b^* value was appeared in donkey milk due to the presence of β-carotene pigment in milk and it could be comparable with pasteurized cow milk with < 1% fat. Water activity of donkey milk was more and it depends on complex of biochemical compositions in the milk samples.

Chromatogram of donkey milk lysozyme shown in Fig. 1 and the time retention was ranged between 6.5 and 7 min, similar to mare milk and higher than human, buffalo, cow, goat and sheep milk (Claeys et al. 2014; Vincenzetti et al. 2008). Much higher concentration of lysozyme was observed in reggio emilia breed (Chiavari et al. 2005). Concentration of lysozyme in balkan donkey milk decreased as increase of parturition days from 2970 to 1040 mg L^{-1} at 45th to 280th days (Gubic et al. 2016). As well as, donkey milk reported lower TPC, yeast and mould count compared to dairy animals due to the presence of natural antimicrobial component (Chiavari et al. 2005). Similar results were observed by Massouras et al. (2017) for indigenous Greek and Cypriot donkey breed and Malissiova et al. (2016) for martina franca, ragusana and arcadian donkey breed.

Table 2 Minerals in small grey donkey milk

Sl. no.	Minerals (mg L^{-1})	Range	Mean values	SD	CV	SEm±
1	Silver	0.00	0.00	0.00	0.00	0.00
2	Aluminium	14.95–16.41	15.61	0.6	3.87	0.3488
3	Boron	N.D.	N.D	N.D.	N.D.	N.D.
4	Barium	0.37–0.48	0.42	0.05	11.14	0.0268
5	Bismuth	0.00	0.00	0.00	0.00	0.00
6	Calcium	461.88–473.48	466.68	4.94	1.06	2.8535
7	Cadmium	0.00	0.00	0.00	0.00	0.00
8	Cobalt	0.01–0.02	0.02	0.005	28.28	0.0027
9	Chromium	0.09–0.2	0.13	0.05	38.2	0.0287
10	Copper	0.30–0.48	0.36	0.07	18.84	0.0424
11	Iron	3.67–3.86	3.74	0.08	2.23	0.0482
12	Gallium	0.03–0.09	0.06	0.02	40.82	0.0141
13	Indium	0.00	0.00	0.00	0.00	0.00
14	Potassium	2009.15–2010.84	2009.67	1.12	0.056	0.6493
15	Lithium	0.002–0.009	0.01	0.003	48.81	0.0018
16	Magnesium	247.11–249.85	248.88	1.25	0.5037	0.7237
17	Manganese	0.36–0.41	0.39	0.02	5.53	0.0125
18	Sodium	910.14–911.15	910.55	0.43	0.0476	0.2504
19	Nickel	0.01–0.05	0.03	0.02	49.13	0.0095
20	Lead	0.05–0.09	0.07	0.02	23.33	0.0094
21	Strontium	4.35–4.81	4.61	0.19	4.18	0.1112
22	Thallium	0.00	0.00	0.00	0.00	0.00
23	Zinc	28.41–29.01	28.66	0.25	0.8896	0.1472

N.D. not detected

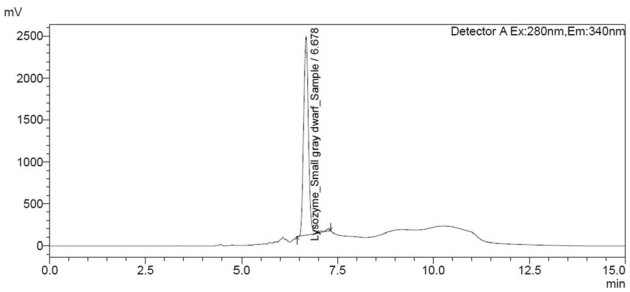

Fig. 1 Chromatogram of lysozyme in small grey donkey milk

Particle size of milk sample gives valuable information about colloidal systems. Average particle size of donkey milk shown in Table 1 and it was lower than ruminants, non-ruminants milk and much higher difference was obtained by Martini et al. (2014) for Amiata donkey milk (1920 nm) and huge difference was observed in cow milk (920–15750 nm) and goat milk (730–8058 nm) and lower result was observed by Sats et al. (2014) in colostrum whey milk (129.7–148 nm).

Average values of vitamins A, B1, B12, B2 B3, C and E in donkey milk are presented in Table 3, which are lower than human, cow, buffalo, sheep, goat and horse milk except vitamin C content and it was almost similar to human milk (Salimei and Fantuz 2012; Claeys et al. 2014). High vitamin C content was observed in current results compared to autochthonous breed of donkey milk reported by Gubic et al. (2014). Total amino acids were summarized (5.35 g 100 g^{-1}) and presented in Table 4.

The present investigation revealed that leucine was the major amino acid and phenyl alamnine was second among all essential amino acids as shown in Table 4. Leucine plays a distinct role in protein metabolism and the translation initiation pathway of muscle protein synthesis. A substantial quantity of valine, isoleucine, threonine, methionine, lysine, tyrosine was observed in the current study and these composition were almost similar to mare and donkey milk and little lower than cow milk (Guo et al. 2007). Among the non-essential amino acids, the arginine and glutamic acid content was highest followed by proline, histidine, serine, glysine, alanine, aspartic acid, cystine and tryptophan (Table 4). The present results are quite lower than the mare and cow milk concentration. Minimum similar results to the present results were observed by Guo et al. (2007) in jiangyue breed of donkey milk at Northwest China. Methionine and cysteine boost up the immune functions through intracellular conversion to glutathione, thereby serves as antioxidants. The variation of results to

Table 3 Vitamins in small grey donkey milk

Sl. no.	Vitamins	Range	Mean values	SD	CV	SEm±
1	B3-niacin (mg 100 g^{-1})	1.27–1.33	1.3	0.02	1.91	0.0144
2	A (mcg 100 g^{-1})	79.00–85.00	BLOQ:100	2.62	3.23	1.52
3	B1-thiamine (mg 100 g^{-1})	0.09–0.1	BLOQ:0.1	0.005	4.88	0.0027
4	B12-cyanocobalamine (mcg 100 g^{-1})	0.38–0.49	BLOQ:0.5	0.05	10.71	0.0276
5	B2-riboflavine (mg 100 g^{-1})	0.007–0.1	BLOQ:0.1	0.04	63.54	0.0253
6	C-ascorbic acid (mg 100 g^{-1})	0.40–0.49	< 0.50	0.04	8.24	0.0213
7	E (mg L^{-1})	1.36–1.54	1.46	0.07	5.13	0.0432

BLOQ: below limit of quantification

Table 4 Amino acid composition in small grey donkey milk

Sl. no.	Amino acids (g 100 g^{-1})	Range	Mean values	SD	CV	SEm±
	Essential amino acids					
1	Tyrosine	0.13–0.18	0.15	0.02	14.4	0.0125
2	Lysine	0.18–0.23	0.21	0.02	10.29	0.0125
3	Iso Leucine	0.09–0.13	0.11	0.02	14.85	0.0094
4	Methionine	0.01–0.02	0.10	0.004	35.36	0.0027
5	Phenyl Alamnine	0.19–0.25	0.22	0.02	11.51	0.0144
6	Threonine	0.08–0.13	0.11	0.02	19.26	0.0119
7	Valine	0.14–0.17	0.16	0.01	8.84	0.0082
8	Leucine	0.30–0.34	0.32	0.02	5.26	0.0098
	Non-essential amino acids					
9	Alanine	0.16–0.21	0.17	0.03	17.32	0.017
10	Aspartic acid	0.11–0.15	0.13	0.02	13.42	0.0098
11	Histidine	0.19–0.24	0.23	0.03	11.58	0.0152
12	Proline	0.27–0.32	0.29	0.02	7.01	0.0119
13	Trypotophan	0.01–0.07	0.04	0.02	61.24	0.0141
14	Arginine	0.39–0.42	0.40	0.01	3.09	0.0072
15	Glutamic acid	0.35–0.41	0.38	0.02	6.62	0.0144
16	Serine	0.19–0.22	0.20	0.01	6.13	0.0072
17	Glycine	0.16–0.20	0.18	0.02	9.27	0.0098
18	Cystine	0.02–0.06	0.04	0.02	46.35	0.0098

the present study is due to the difference of protein content in the milk sample, breeds, season and type of diet (Krizova et al. 2013).

The fatty acids in donkey milk are presented in Table 5. Among SFA the palmitic acid was most concentrated (27.29%) and lower concentrations were observed for butyric acid, lauric acid, myristic acid, capric acid, caproic acid, caprylic acid. Present results were compared with the literature values, the donkey milk has little higher amount of SFA compared to human and cow milk but similar to horse milk. Little lower amount of MUFA were observed in present study compared to human and cow milk (Claeys et al. 2014). The USFA were not observed in present results. A higher concentration of C16:0 and C4:0 observed in donkey milk. Furthermore, these fatty acids have health promoting effects on human health by inhibiting bacterial and viral growth, in addition dissolving cholesterol deposits.

Non-significant variation was observed in present result of fatty acids in donkey milk compared to the literature values (Salimei et al. 2004) and the authors have reported lower values for myristic acid, caproic acid, palmitic acid, lauric acid and higher capric acid, caprylic acid and oleic acid in martina franca and ragusana breed of donkey milk in Italy. Similar to the range found by Gastaldi et al. (2010) and Massouras et al. (2017). The variation might be dependent on breed, body conditions, amount of these acids in the animal's diet and the absence of biohydrogeneration of fatty acids in the digestive tract before absorption, unlike what occurs in ruminants.

Sensory characteristics of donkey milk is considered one of the most important attributes determines the consumers choice. The mean scores of sensory attributes of donkey

Table 5 Fatty acid composition in small grey donkey milk

Sl. no.	Fatty acid profile (%)	Range	Mean values	SD	CV	SEm±
1	Butyric acid (C4:0)	24.16–24.68	24.46	0.22	0.9032	0.1276
2	Caproic acid (C6:0)	3.59–3.79	3.69	0.08	2.22	0.0472
3	Caprylic acid (C8:0)	2.35–2.51	2.44	0.07	2.71	0.0381
4	Capric acid (C10:0)	4.49–4.68	4.59	0.08	1.71	0.0453
5	Undecanoic acid (C11:0)	0.00	0.00	0.00	0.00	0.00
6	Lauric acid (C12:0)	11.20–11.32	11.23	0.05	0.4841	0.0314
7	Tridecanoic acid (C13:0)	0.00	0.00	0.00	0.00	0.00
8	Myristic acid (C14:0)	6.56–6.65	6.61	0.04	0.5835	0.0223
9	Myristoleic acid (C14:1)	0.00	0.00	0.00	0.00	0.00
10	Pentadecanoic acid (C15:0)	0.00	0.00	0.00	0.00	0.00
11	*Cis*-10-pentadecanoic acid (C15:1)	0.00	0.00	0.00	0.00	0.00
12	Palmitic acid (C16:0)	27.20–27.37	27.29	0.07	0.2579	0.0406
13	Palmitoleic acid (C16:1)	0.00	0.00	0.00	0.00	0.00
14	Heptadecanoic acid (C17:0)	0.00	0.00	0.00	0.00	0.00
15	*Cis*-10-heptadecanoic acid (C17:1)	0.00	0.00	0.00	0.00	0.00
16	Stearic acid (C18:0)	0.00	0.00	0.00	0.00	0.00
17	Elaidic acid (C18:1n9t)	0.00	0.00	0.00	0.00	0.00
18	Oleic acid (C18:1n9c)	19.15–20.01	19.69	0.38	1.95	0.2217
19	Linolelaidic acid (C18:2n6t)	0.00	0.00	0.00	0.00	0.00
20	Linoleic acid (C18:2n6c)	0.00	0.00	0.00	0.00	0.00
21	Arachidic acid (C20:0)	0.00	0.00	0.00	0.00	0.00
22	Gama linolenic acid (C18:3n6)	0.00	0.00	0.00	0.00	0.00
23	*Cis*-11-eicosenoic acid (C20:1)	0.00	0.00	0.00	0.00	0.00
24	Linolenic acid (C18:3n3)	0.00	0.00	0.00	0.00	0.00
25	Heneicosanoic acid (C21:0)	0.00	0.00	0.00	0.00	0.00
26	*Cis*-11,14-eicosadienoic acid (C20:2)	0.00	0.00	0.00	0.00	0.00
27	Behenic acid (C22:0)	0.00	0.00	0.00	0.00	0.00
28	*Cis*-8,11,14-eicosatrienoic acid (C20:3n6)	0.00	0.00	0.00	0.00	0.00
29	Erucic acid (C22:1n9)	0.00	0.00	0.00	0.00	0.00
30	*Cis*-11,14,17-eicosatrienoic acid (C20:3n3)	0.00	0.00	0.00	0.00	0.00
31	Tricosanoic acid (C23:0)	0.00	0.00	0.00	0.00	0.00
32	Arachidonic acid (C20:4n6)	0.00	0.00	0.00	0.00	0.00
33	*Cis*-13,16-docosadienoic acid (C22:2)	0.00	0.00	0.00	0.00	0.00
34	Lignoceric acid (C24:0)	0.00	0.00	0.00	0.00	0.00
35	*Cis*-5,811,14,17-eicosapentaenoic acid (C20:5n3) eicosapentaenoic acid (C20:5n3)	0.00	0.00	0.00	0.00	0.00
36	Nervonic acid (C24:1)	0.00	0.00	0.00	0.00	0.00
37	*Cis*-4,710,13,16,19-docosahexaenoic acid (C22:6n3)	0.00	0.00	0.00	0.00	0.00
38	Saturated fatty acids	80.18–80.35	80.31	0.09	0.1134	0.0526
39	Mono-unsaturated fatty acids (MUFA)	19.61–19.85	19.69	0.11	0.5629	0.064
40	Poly-unsaturated fatty acids (PUFA)	0	0	0	0	0

milk sample is shown in Fig. 2. The mean scores value for the attribute such as appearance, smell, consistency, taste and overall acceptability were 8.10 (like very much), 7.10 (like moderately), 7.00 (like moderately), 8.00 (like very much) and 8.00 (like very much), respectively. The panellists gave lower sensory score (7.00, like moderately) for consistency of donkey milk sample it might be due to low fat content and high water content. Higher score was

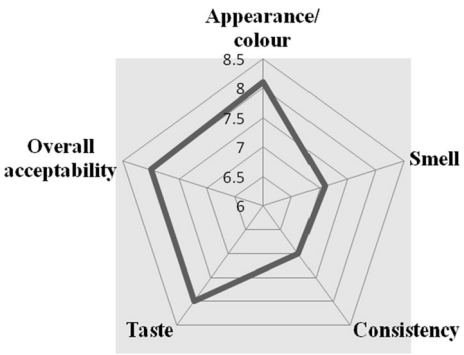

Fig. 2 Sensory profile of small grey donkey milk using 9-point hedonic scale

observed (8.10, like very much) for colour due to white colour, it might be due to low β-carotene. The panellists gave higher score (8.00, like very much) for taste attribute (slight sweet taste), it might be due to the high lactose content, reported by Gubic et al. (2014), whereas, lower score (7.00, like moderately) was observed for smell attribute compared to taste. Overall acceptability of the donkey milk was 8.00 (like very much). The mean score values of the present study is almost similar to the values reported by Malissiova et al. (2016) for donkey milk of Martina Franca, Ragusana and Arcadian breed from Greece and Cyprus. Little non-significant results were observed in the present study for the sensory characteristics compared to camel milk (Ahmed et al. 2014), it may be due to compositional difference of milk and feed intake. Overall, the consistency of donkey milk is slightly thin and it could be improved through evaporation of water using rotary vacuum flash evaporator.

Conclusion

In conclusion, Indian small grey breed donkey milk has lower total solids, fat, protein and higher amount of ash, lactose content compared to cow milk but it is almost similar to human milk, had tremendously low microbial counts and greatly acceptable sensory characteristics scores. Indian small grey breed donkey milk has abundant amount of lysozyme, Ca, K, essential amino acids and vitamins and little lower MUFA which are lightly similar to human milk and cow milk. Overall acceptability of donkey milk scored "like very much" from the panellists. Dairy products such as donkey milk powder, donkey milk chocolate, donkey milk biscuits, donkey milk candies, donkey milk ice cream and donkey milk cheese can be developed by standardization of donkey milk before processing.

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Compliance with ethical standards

Conflict of interest The authors describes there is no conflict of interest in the present study.

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