Compositional and fatty acid analysis of Kankrej cows' milk

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Abstract: A study was conducted to assess the composition and fatty acid profile of milk obtained from Kankrej Cows. Milk samples from twenty Kankrej cows (average 60 days in milk; 9.5 kg/d of milk yield and 355 kg of body weight) were collected to determine milk composition and fatty acid profile. Mean milk fat, solids not fat, protein and lactose were 4.15, 8.55, 3.40 and 4.48%, respectively. In Kankrej cow milk saturated fatty acids (SFA) accounted for 73.17% and unsaturated fatty acids (UFA) accounted for 26.83% of total fatty acids. In UFA, concentration monounsaturated fatty acids (MUFA) was 22.94% and polyunsaturated fatty acids (PUFA) was 3.89%. The ratio UFA/SFA was 0.37 which ranged from value 0.28 to 0.47. Among the SFA, palmitic acid (C16:0; 31.22%) was present in the highest level followed by stearic acid (C18:0; 16.02%) and myristic acid (C14:0; 13.45%). Oleic acid (C18:1) was ranged between 13.43 to 25.31%. The average value for C4:0 and C6:0 were 2.07 and 1.84%, respectively. Linoleic acid (C18:2) and linolenic acid (C18:3) were ranged between 1.12 to 5.42% and 0.65 to 2.18%, respectively. Results indicated that milk composition and fatty acid profile of Kankrej cow are comparable to other Indigenous breeds.

Keywords: Fatty acid profile, Kankrej cow, Milk composition

India is the largest producer of milk in the world with 187.7 million tonnes production in 2018-19 (BAH&FS, 2018-19). Dairying is an important activity in Indian economy contributing about 27 per cent of the agricultural gross domestic product which is around 4 per cent of the national GDP (Singh et al. 2019). Milk and milk products are the major source of nutrients in the human diet as they are rich source of fat, protein and carbohydrates. Milk fat is also carrier of the naturally present fat-soluble vitamins (A, D, E and K) as well as β -carotene. The main lipids in dairy fat are the triacylglycerides, accounting for more than 98% of total fat. Triacylglycerides composition is extremely complex as more than 400 different fatty acids are present in milk fat (Hanuš et al. 2018). Milk fat consists of about 70% of saturated fatty acids (SFA) and 30% unsaturated fatty acids (UFA). Among UFA, 25% is monounsaturated fatty acid (MUFA), 2.3% is polyunsaturated fatty acid (PUFA) and 2.7% is trans-fatty acid (Meena et al. 2019). The milk fatty acids are preferentially hydrolysed and transferred directly from the intestine to the bloodstream. Afterwards, they are rapidly metabolized in the liver and used as energy source for active cells. They also contribute to the regulation of cell metabolism and play an important role in intracellular signalling (Schönfeld and Wojtczak, 2016). The fatty acid composition of milk fat greatly influences the physico-chemical, functional and nutritive properties of milk. Composition of milk fat varies from species to species, feed consumed by lactating animal and lactation status.

Nowadays, not only the nutritional value of milk but also composition and fatty acid profile of milk have attracted interest of consumers. However, very limited research has been conducted with regards to milk fatty acid profile of Indigenous cows (Saroj et al. 2017). Out of the total 192.49 million cattle population, 142.11 million was contributed by Indigenous cattle with a decline of 6% in the total indigenous cattle population (20th Livestock Census, 2019). Among the Indigenous cattle, Kankrej is one of the important breeds of cattle in India which is mainly found in the region of north Gujarat and neighboring districts of Rajasthan. Though, Kankrej is dual purpose breed, but also good milk producers (Ekka et al. 2014; Gupta et al. 2019). The average milk yield of Kankrej cattle is around 1,738 kg with fat content around minimum 2.9 to maximum 4.2% (NBAGR, 2019). However, Kankrej cows maintained at Livestock Research Station, Sardarkrushinagar

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Dantiwada Agricultural University, Gujarat had average standard (305 days) lactation yield of 2501 litres during the year 2018 (Anonymous, 2019). Knowledge of milk fatty acid composition offers an opportunity to know the concentrations of various fatty acids and bioactive lipids present in milk. To the best of our knowledge only one study (Bharwade et al. 2017) has reported the fatty acid profile of Kankrej cow milk. Therefore, this study was planned to evaluate milk fatty acid profile of Kankrej cows.

Milk samples from twenty lactating Kankrej cows (average 60 days in milk; 9.5 kg/d of milk yield, 355 kg of body weight) were collected during the month of March (2019) from the cows at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India. It is located in semi arid region of north Gujarat having latitude of 24.35 North and longitude of 72.59 East and at an elevation of 189 meters above the mean sea level. All animals were maintained under uniform management conditions and feeding regime. Cows were fed with commercial concentrate, lucerne, maize fodder and jowar hay to meet the nutrient requirement. The feed was offered twice daily in equally divided doses, while clean drinking water was made available *ad lib*. The chemical composition of feeds and fodder used in this study is given in Table 1.

Analysis of milk fatty acid profile was conducted at ICAR-Central Institute for Research on Goats, Makhdum, India. Fat was

separated from each collected sample and was methylated using sodium methylate according to O'Fallon et al. (2007). Fatty acid methyl esters were analyzed using a gas chromatograph (Thermo Scientific Ceres 800) with flame ionization detector and capillary column (60m×0.25mm×0.20mm). The initial oven temperature was 120°C, held for 5 min, subsequently increased to 240°C at a rate of 2°C min⁻¹, and then held for 60 min. Nitrogen at a flow rate of 1 ml/min was used as the carrier gas. Both the injector and the detector were set at 260°C. The split ratio was 30:1. Fatty acids were identified by comparing their retention times with the fatty acid methyl standards and were expressed as percentage of total fatty acids. Milk samples were also analyzed for milk composition (fat, solids not fat, protein and lactose) using EKOMILK Ultra Pro Milk Analyzer (Everest Instruments Pvt. Ltd.). The mean, standard error (SE), minimum and maximum values for individual fatty acid, groups of fatty acids and milk components were estimated using R (R core team, 2019).

The average values for milk fat, solids not fat, protein and lactose were 4.15, 8.55, 3.40 and 4.48%, respectively (Table 2). In agreement with the current findings, earlier studies reported similar values for milk components in Kankrej cows (Joshi et al. 2018; Gami et al. 2019). Gajbhiye et al. (2019) reported 4.16, 8.86, 3.28 and 4.83% of fat, solids not fat, protein and lactose in milk of Gir cows. The mean concentration of PUFA linoleic acid (C18:2) and linolenic acid were 2.60 and 1.28%, respectively in Kankrej

Table 1 Chemical composition (% DM basis) of feeds and fodder

Composition	Concentrate	Lucerne	Green maize	Jowar hay
Dry matter	95.55	89.73	15.64	19.92
Crude protein	18.59	2.29	6.16	18.76
Crude fibre	6.58	37.58	27.43	22.64
Ether extract	2.43	1.36	1.16	2.93
Ash	8.25	10.51	8.56	9.38
NFC	35.53	28.22	40.32	27.80
NDF	35.2	57.62	43.80	41.13
ADF	19.05	45.17	33.76	21.15

NFC: Non-fiber carbohydrate, calculated by equation: NFC (% of DM) = 100 – (CP + NDF + EE + ash); NDF: Neutral detergent fiber; ADF: Acid detergent fiber.

Table 2 Milk composition and concentrations of fatty acid groups (%) in milk of Kankrej cows (n=20)

Fatty acid group	Mean	SE	Minimum	Maximum
Milk composition (%)				
Fat	4.15	0.07	3.13	5.09
Solids not fat	8.55	0.04	7.72	8.90
Protein	3.40	0.02	3.06	3.59
Lactose	4.48	0.02	4.03	4.68
Fatty acid groups (%)				
Saturated fatty acids (SFA)	73.17	0.62	68.23	78.31
Unsaturated fatty acids (UFA)	26.83	0.62	21.69	31.76
Monounsaturated fatty acids (MUFA)	22.94	0.56	19.04	28.85
Polyunsaturated fatty acids (PUFA)	3.89	0.33	2.16	6.75
UFA/SFA	0.37	0.01	0.28	0.47

Table 3 Milk fatty acids profile (%) of Kankrej cows (n=20)

Fatty acid	Isomer	Mean	SE	Minimum	Maximum
Butyric acid	C4:0	2.07	0.10	1.26	2.86
Caproic acid	C6:0	1.84	0.18	0.89	3.60
Caprylic acid	C8:0	0.97	0.08	0.26	1.64
Capric acid	C10:0	2.01	0.13	1.07	3.00
Lauric acid	C12:0	2.00	0.17	0.60	3.40
Myristic acid	C14:0	13.45	0.37	10.92	16.65
Myristoleic acid	C14:1	0.68	0.05	0.22	1.09
Pentadecanoic acid	C15:0	0.56	0.05	0.20	0.94
Pentadecenoic acid	C15:1	0.29	0.10	0.08	1.75
Palmitic acid	C16:0	31.22	0.62	26.86	36.63
Palmitoleic acid	C16:1	2.35	0.22	1.01	5.17
Heptadecanoic acid	C17:0	0.64	0.05	0.22	1.32
Heptadecenoic acid	C17:1	0.43	0.09	0.14	1.53
Stearic acid	C18:0	16.02	0.47	11.67	18.31
Oleic acid	C18:1	19.18	0.68	13.43	25.31
Linoleic acid	C18:2	2.60	0.26	1.12	5.42
Linolenic acid	C18:3	1.28	0.10	0.65	2.18
Arachidic acid	C20:0	0.48	0.09	0.12	1.42
Behenic acid	C22:0	1.92	0.21	0.95	5.53

cow milk. SFA accounted for 73.17% and UFA accounted for 26.83% of total fatty acids. In UFA, concentration MUFA was 22.94% and PUFA was 3.89% (Table 2). The ratio UFA/ SFA were ranged from 0.28 to 0.47, with average value of 0.37. Saroj et al. (2017) reported that milk of Sahiwal and crossbred cows contain 61.35 and 67.43% of SFA, respectively. The SFA in milk fat of African Indigenous cows were ranged from 60.9 to 78.4% (Myburgh et al. 2012). The SFA contents of 78.4 vs. 74.5% were reported in milk of Jersey as compared to milk of Mafriwal (Yassir et al. 2009). Kirchnerová and Vrškova (2015) reported SFA, UFA and PUFA were 69.34, 30.66 and 3.55%, respectively in the milk of Simmental dairy cows. In cow milk PUFA account for as little as 3% of all fatty acids (Markiewicz-Kęszycka et al. 2013); however, Frelich (2009) has found more than 4% of PUFA in Czech Fleckvieh and Holstein cows. Saroj et al. (2017) reported 1.94 and 1.53% of PUFA in milk of Sahiwal and crossbred cows, respectively. The PUFA in milk fat of African Indigenous cows were ranged from 1.68 to 3.06%, respectively (Myburgh et al. 2012). Discrepancies in milk fatty acid profile of dairy cows among various studies might be due to type of breed, diet and season of the experiment.

Concentration of individual milk fatty acid in Kankrej cows is given in Table 3. Among the SFA, palmitic acid (C16:0; 31.22%) was present in the highest level followed by stearic acid (C18:0; 16.02%) and myristic acid (C14:0; 13.45%). The average value for short chain fatty acids (SCFA) C4:0 and C6:0 were 2.07 and 1.84%, respectively. Oleic acid (C18:1) a MUFA was ranged between 13.43 to 25.31% with mean value of 19.18%. Linoleic acid (C18:2) was recorded between 1.12 to 5.42% with mean value of 2.60% and linolenic acid (C18:3) was ranged from 0.65 to 2.18% having average of 1.28%. Very long chain fatty acids C20:0 and C22:0

were found to be 0.48 and 1.92%, respectively. In agreement with the present findings, Bharwade et al. (2017) in milk fat of Kankrej cows recorded 33.18 and 10.87% palmitic acid (C16:0) and myristic acid (C14:0), respectively. Similar values for palmitic acid (C16:0) and myristic acid (C14:0) were reported in milk of Sahiwal and crossbred cows (Saroj et al. 2017). Palmitic acid (16:0) was accounted for approximately 30% by weight of the total saturated fatty acids. While, oleic acid (18:1) accounting for 23.8% by weight of the total unsaturated fatty acids (Samková et al. 2018). Also, different studies suggests that monounsaturated fatty acids (MUFA) content of milk fat was is similar in sheep, cow, and goat milk and may range from about 20% to about 35%. Among the MUFA group, the oleic acid (C18:1) is characterized by the highest content (Krizova et al. 2017; Samková et al. 2018).

Conclusions

Results indicated that milk composition and fatty acid profile of Kankrej cow are comparable to other Indigenous breeds. Milk fatty acids concentration is depends upon the interrelationship among dietary lipid supply, rumen fermentation, and metabolic changes occurring in liver, blood, and finally in mammary gland. Further studies are required to know the non-genetic factors influencing milk fat composition in cows.

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