Comparative Analysis of Milk Fatty Acids and Minerals of Indigenous *vis-à-vis* Crossbred Cattle and Buffaloes

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ABSTRACT

Background: The information about milk quality of different breeds of cattle and buffalo is still scanty. The objective of the study was to the compare milk fatty acid composition and mineral concentration in the crossbred cattle and indigenous cattle and buffalo reared on same farm.

Methods: This study was conducted on 187 individual milk samples, which includes 124 crossbred *Vrindavani* cattle, 19 indigenous cattle and 44 Murrah buffaloes.

Result: The Murrah buffalo milk had significantly ($P \leq 0.05$) higher concentration of fat and saturated fatty acids than indigenous or crossbred cow's milk. The mono unsaturated fatty acid (MUFA) and poly unsaturated fatty acid (PUFA) contents (C16:1, C20:2, C20:4n6 and C22:6N3) were significantly higher in indigenous cows compared to crossbreds and Murrah buffalo. The concentration of iron and zinc were significantly ($P \leq 0.05$) higher in indigenous cattle, whereas, the contents of Cu and Mn were higher in Murrah buffalo.

Key words: Buffalo, Cattle, Milk fatty acids, Milk minerals, MUFA, PUFA.

INTRODUCTION

Milk constituents including fat and protein percentage as well as fatty acid and mineral contents have drawn the attention of researchers in recent years, because of their direct effect on human health. The milk fat extracted from bovine milk constitute about 70% saturated fatty acid (SFA), 25% Mono unsaturated fatty acid (MUFA) and 5% Poly unsaturated fatty acid (PUFA) which deviates from the favourable fatty acid profile for human health of 30% SFA, 60% MUFA and 10% PUFA, respectively (Bilal *et al*., 2014). The SFAs are reported to be associated with the increased concentration of blood cholesterol and are responsible for cardiovascular diseases, weight gain and obesity (Pulina *et al*., 2017). Conversely, MUFAs, due to their cholesterol-declining properties (Schwingshackl and Hoffmann 2012) and PUFAs, due to influence on plasma lipids level associated in cardiac and endothelial functions are considered to lower the threat of coronary heart diseases (Zhang *et al*., 2016). Furthermore, conjugated linoleic acid modulates the plasma lipid concentrations and has anti-carcinogenic and anti-inflammatory effects (Palombo *et al*., 2018).

Minerals represent a small fraction of milk (approx. 8-9 g/L) and are distributed in the soluble and the colloidal phase depending on the chemical form (Zamberlin *et al*., 2012). Minerals play an important in regulation of biological systems and cellular metabolism, like calcium, phosphorus and magnesium are involved in development of bones and teeth (Soyeurt *et al*., 2009). The micro-minerals including Zn, Mn and Cu play pivotal roles in immune function and enzyme system (Dunshea *et al*., 2019). In recent times, the indigenous cattle milk demand has gained much popularity due to its A2 milk protein (Kumar *et al*., 2020). But in a study it was observed that in *Vrindavani* crossbred cattle genotypic frequency of A2A2 was 0.42, whereas genotypic frequencies of A1A2 and A1A1 were 0.47 and 0.11, respectively (Kumar *et al*., 2019). Further, there is dearth of information about the fatty acid and mineral profile of cattle and buffalo milk. Thus, this study will provide an overview of the fatty acid and mineral content in the milk of indigenous cattle and

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buffalo, compared to crossbred cattle. The fatty acid and mineral profile of indigenous cattle will also provide scientific data for the superiority of indigenous cow milk in terms of their content, if any.

Only limited number of studies are available on the effect of breed and non-genetic factors on composition of milk fatty acid and mineral concentration in tropical countries like India having a wide range of bovine genetic resources. Thus, the objectives of present study was to compare fatty acid composition and mineral concentration in milk of indigenous cattle, crossbred cattle and buffalo, under a similar production system.

MATERIALS AND METHODS

Experimental animals and farm

This study was conducted on 187 individual milk samples, which includes 124 crossbred *Vrindavani* cattle, 19 indigenous cattle (Tharparkar n=11; Sahiwal n=8) and 44 Murrah buffaloes, were collected from Cattle and Buffalo Breeding Farm, ICAR-IVRI, Izatnagar, Bareilly, India. *Vrindavani* cattle were developed as synthetic strain of composite cattle in India from the native indicine Hariana cattle crossed with three taurine dairy breeds: Holstein, Brown Swiss and Jersey (Singh *et al*., 2011). The animals are reared in loose housing system with free-stall dairy barn under tropical environmental conditions. During sample collection, animals were fed with green fodder and concentrate mixture composed of maize, wheat bran, Barley and Napier grass with other supplements.

Sample collection

Collection of milk samples were collected during January, 2019 from each animal. The morning milk samples were collected as suggested (Sharma *et al*., 2018). After proper mixing in plastic bottles, the milk samples were immediately transported to the laboratory on ice. The samples were homogenized using Vortex at 2400 rpm for thirty seconds before processing.

Estimation of milk constituents and fatty acid profile

After proper mixing of samples, the fat and protein percentage in 187 milk samples were analysed by using Lacto Scan milk analyser. The contents of different milk fatty acids were estimated using a gas chromatography (6890N, Agilent), which included SFAs (C6:0, C8:0, C10:0, C12:0, C14:0, C16:0, C18:0, C20:0, C24:0); MUFAs (C14:1, C16:1, C18:1n9c) and PUFAs (C20:2, C20:4n6 and C22:2).

Fatty acid profiling was done by direct FAME synthesis as explained by O'Fallon *et al*. (2007) with slight modification. The unsaturation indices for milk fatty acid were calculated as the ratio of an unsaturated fatty acid to the sum of unsaturated and its corresponding saturated fatty acid, multiplied by 100 (Schennink *et al*., 2008).

Estimation of milk minerals

Milk samples were analyzed for macro-minerals including, Calcium (Ca), phosphorus (P) and microminerals including iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn). The estimation of calcium and phosphorus was done as reported previously (Talapatra *et al*., 1940). The concentration of micro minerals (Fe, Cu, Zn and Mn) was determined using atomic absorbance spectrophotometer in their mineral extracts.

Statistics

The Proc GLM procedure of SAS 9.3 (SAS Institute, Inc. 2008) was used for estimating the effect of breed type on milk as follow:

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where

Y_{ij}= The jth observation of ith breed (3 level).

e_{ij}= Random error (NID = 0, σ^2_e).

RESULTS AND DISCUSSION

The least squares mean of individual and indices of milk fatty acid profile and mineral content for the different breeds are reported in Table 1. The fat percentage was significantly ($P\leq0.05$) higher (8.400±0.27) in Murrah buffaloes than crossbred (4.280±0.10) and indigenous (4.150±0.21) cattle. The protein percentage was significantly ($P\leq0.05$) higher in milk of Murrah buffaloes (3.140±0.02) and indigenous (3.000±0.02) cows than crossbred (2.810±0.02) cattle. The analysis of variance indicated highly significant ($P<0.0001$) breed differences in the concentration of almost all fatty acid composition traits under investigation, except C22:2. Further the mineral profile (except Ca and P) of indigenous cattle, crossbred cattle and buffalo differ significantly from each other. The concentration of SFAs (C6:0, C8:0, C10:0, C12:0, C14:0, C16:0, C18:0, C20:0, C24:0) were found to be significantly ($P<0.001$) higher in the Murrah buffaloes than the crossbred and the indigenous cattle (Table 1). The findings were in agreement with previously reported higher fraction of saturated fatty acid in buffalo milk (Pegolo *et al*. 2017). However, Haggag *et al*. (1987) found lower concentration of saturated fatty acid in the Egyptian buffalo compared to the Egyptian cow milk. However, MUFA and PUFA content (C16:1, C20:2, C20:4n6, C22:6N3) were higher in the indigenous cattle (0.434±0.07, 0.280±0.06, 0.096±0.02 and 0.450±0.08 gm/100 gm of milk, respectively) in comparison to crossbred cattle (0.247±0.02, 0.230±0.01, 0.031±0.00 and 0.178±0.02, gm/100 gm of milk, respectively) and Murrah buffaloes (0.214±0.07, 0.065±0.01, 0.050±0.01 and 0.211±0.03 gm/100 gm of milk, respectively). The concentration of Oleic acid (C18:1n9c) was found to be significantly higher ($P<0.001$) in crossbred cattle (0.38±0.02 gm/100 gm of milk), while the concentration of C14:1 (0.108±0.02 gm/100 gm of milk) was higher ($P<0.0001$) in buffaloes. In addition, the buffalo milk showed lower contents of C22:2 (0.447±0.11 gm/100 gm of milk) to the indigenous (0.459±0.13 gm/100 gm of milk) and the crossbred (0.596±0.04 gm/100 gm of milk) cows. The concentration of higher PUFAs content (C20:2, C20:4n6 and C22:6N3) in indigenous cattle also has been reported earlier (Sharma *et al.,* 2018). The higher concentration of PUFA and low SFA in indigenous cattle milk suggest its beneficial effect to human health. Considering the unsaturation index, buffalo milk contained significantly higher amount of C14 index and C18 index (1.178±0.02 and 1.227±0.02) than crossbred (1.110±0.01 and 1.113±0.02) and indigenous cattle (1.066±0.01 and 1.065±0.01). The C16 index was highest in crossbred cattle (23.895±1.53), while C20 index was highest in indigenous cattle (2.835±1.62).

The average concentration of Ca and P in milk did not differ significantly between different bovine breeds (Table 2). The Cu and Mn contents were found to be significantly (P<0.0001) higher in the Murrah buffaloes (1.817±0.05 and 2.271±0.03 mg/l, respectively) followed by the indigenous cattle (1.291±0.11 and 2.026±0.10 mg/l, respectively) and the crossbred cattle (1.071±0.05 and 0.922±0.06 mg/l, respectively), respectively. However, the Fe and Zn concentration were significantly higher in indigenous cattle (9.421±1.05 and 5.461±0.32 mg/l, respectively) in comparison to Murrah buffaloes (7.692±0.39 and 4.548±0.28 mg/l, respectively) and crossbred cattle (9.175±0.29 and 3.642±0.12 mg/l, respectively). Patel *et al.* (2018) has also reported the higher Ca content in Murrah milk, while the higher phosphorus content was in indigenous milk. The significant difference in milk mineral content among breeds was also reported by Mariani *et al.* (2002), with lower mineral content in Holstein-Friesian compared to Brown Swiss, Reggiana and Modenese breeds. The higher content of micro-minerals (Fe and Zn) in indigenous cattle milk are involved in boosting immune related pathways and other cellular physiological processes (Yamaguchi *et al.*, 2010). Inadequate concentration of Fe and Zn in diet may hamper the absorption and function of other nutrients leading to challenges in normal development of the animal.

Table 1: Profile of milk constituents, fatty acids (gm/100 gm of milk) and their indices in different breeds of bovines.

Traits	Overall mean	Crossbred (n=124)	Murrah (n=44)	Indigenous (n=19)
Fat (%)	5.230±0.16	4.280^b±0.10	8.400^a±0.27	4.150^b±0.21
Protein (%)	2.910±0.02	2.810^a±0.02	3.140^b±0.02	3.000^b±0.02
C6:0 (Caproic acid)	0.062±0.01	0.036^c±0.01	0.124^a±0.02	0.085^b±0.01
C8:0 (Caprylic acid)	0.049±0.01	0.033^b±0.01	0.090^a±0.01	0.059^b±0.01
C10:0 (Capric acid)	0.068±0.01	0.052^b±0.01	0.102^a±0.01	0.094^a±0.02
C12:0 (Lauric acid)	0.053±0.00	0.042^b±0.00	0.077^a±0.01	0.072^a±0.01
C14:0 (Myristic acid)	0.110±0.01	0.093^b±0.01	0.178^a±0.02	0.066^b±0.01
C16:0 (Palmitic acid)	0.177±0.03	0.026^b±0.00	0.626^a±0.08	0.118^b±0.02
C18:0 (Stearic acid)	0.135±0.01	0.113^b±0.02	0.227^a±0.02	0.065^b±0.01
C20:0 (Arachidic acid)	0.066±0.01	0.058^b±0.01	0.176^a±0.03	0.042^b±0.00
C24:0 (Lignoceric acid)	0.060±0.01	0.044^b±0.00	0.109^a±0.03	0.052^b±0.01
C14:1 (Myristovaccenic acid)	0.039±0.01	0.015^b±0.00	0.108^a±0.02	0.037^b±0.01
C16:1 (Palmitoleic acid)	0.258±0.02	0.247^b±0.02	0.214^b±0.07	0.434^a±0.07
C18:1n9c (Oleic acid)	0.334±0.02	0.387^a±0.02	0.199^b±0.04	0.307^{ab}±0.08
C20:2 (Eicosadienoic acid)	0.196±0.01	0.230^a±0.01	0.065^b±0.01	0.280^a±0.06
C20:4n6 (Arachidonic acid)	0.042±0.00	0.031^b±0.00	0.050^b±0.01	0.096^a±0.02
C22:2 (Docosadienoic acid)	0.547±0.04	0.596±0.04	0.447±0.11	0.459±0.13
C22:6N3 (Docosahexaenoic acid)	0.214±0.02	0.178^b±0.02	0.211^b±0.03	0.450^a±0.08
C14 Index	1.110±0.01	1.093^b±0.01	1.178^a±0.02	1.066^b±0.01
C16 Index	18.129±1.31	23.895^a±1.53	7.431^b±2.48	5.267^b±0.71
C18 Index	1.135±0.01	1.113^b±0.02	1.227^a±0.02	1.065^b±0.01
20 Index	1.687±0.2	1.478^b±0.11	1.780^{ab}±0.40	2.835^a±1.62

Means with different superscript in a row differing significantly.

Table 2: Milk mineral concentration in different breeds of bovines.

Traits	Overall mean	Crossbred (n=124)	Murrah (n=44)	Indigenous (n=19)
Ca (mg/l)	1433±0.04	1436±0.05	1478±0.06	1310±0.07
P (mg/l)	1242±0.03	1229±0.03	1237±0.06	1338±0.12
Fe (mg/l)	8.851±0.24	9.175^{ab}±0.29	7.692^b±0.39	9.421^a±1.05
Cu (mg/l)	1.269±0.04	1.071^b±0.05	1.817^a±0.05	1.291^b±0.11
Zn (mg/l)	4.040±0.12	3.642^b±0.12	4.548^{ab}±0.28	5.461^a±0.32
Mn (mg/l)	1.352±0.06	0.922^a±0.06	2.271^b±0.03	2.026^b±0.10

Means with different superscript in a row differing significantly.

CONCLUSION

This study provided an overview of fatty acid profile and mineral concentration in milk of crossbred and indigenous cattle *vis-à-vis* Murrah Buffaloes reared under the same managemental and feeding regime. The milk of indigenous cattle breed had significantly higher concentration of beneficial minerals contents (P, Fe, Zn) and unsaturated fatty acids (USFAs), suggested its greater potential benefit on human health compared to crossbred cattle and Murrah buffalo. Thus, the effort should be made to valorise the milk of indigenous breed.

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Conflict of Interest : None.

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