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Biochemical components of milk during early lactation in Amrit Mahal, Holstein Friesian crossbred and jersey crossbred cows

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Abstract
Present study was undertaken to determine various milk components during different weeks of lactation in different breeds of cattle. Three groups comprised of Amrit Mahal, Holstein Friesian crossbred and Jersey crossbred cows with six animals in each group, respectively. Milk samples collected during three consecutive months with monthly intervals was utilized for determination of milk components like lactose, protein, fat and solids-not-fat using lactoscan milk analyser. The milk lactose, protein and solids-not-fat were significantly higher in Amrit Mahal at Eighth week of lactation compared to crossbred cows. The milk yield (Kg/day) was significantly higher in crossbred cows compared to Amrit Mahal cows. It is concluded that the variations in milk components during different weeks of lactation could be attributed to differences in the metabolic profile of the mammary gland to synthesize various milk components and variation with respect to breeds might be due to genetic inheritability of the dairy cows.

Keywords: Indigenous, crossbred, lactation, milk profile

Introduction
The improved lactation performance can be achieved through enhanced mammary cell proliferation, structural differentiation, synthesis and secretion of milk components. The milk constituents are synthesized in the mammary gland from various precursors present in the blood stream. Acetate and β-hydroxybutyrate are the most important energy metabolites in the mammary gland of ruminants. The composition of milk includes 87.7 per cent water, 4.9 per cent lactose, 3.4 per cent fat, 3.3 per cent protein, and 0.7 per cent minerals (ash).
The term lactation refers to the combined process of milk secretion from the alveolar cells and milk removal from the alveolar lumen [17]. The milk composition varies based on species, breed, nutrition, environment and the stage of lactation. The milk lactose synthesis takes place in the presence of an enzyme lactose synthase in Golgi apparatus of the mammary epithelial cells from the blood glucose. The milk proteins are synthesized in rough endoplasmic reticulum of the mammary epithelial cells which is similar to protein synthesis in any other body cell. The milk fat includes large amount of triglycerides with short chain fatty acids, which is synthesized in smooth endoplasmic reticulum of the mammary epithelial cells [1].
Smith and Risco (2005) reported that the transition period from the stage of pregnancy to lactation stage is critical due to the drastic endocrine and metabolic changes during this stage in dairy cows, which accompany the parturition and onset of lactation. The low solids-not-fat (SNF) problem in milk of high yielding animals is becoming a common problem nowadays and it is below the minimum standard levels of 8.5% SNF as prescribed by FSSAI, 2006. Hence, it is creating a major loss to the farmers rearing crossbred cows. The knowledge about the milk yield and components of the milk in dairy animals is helpful to upgrade or enrich the quality and quantity of the milk composition in the dairy animals [17].
Even though, the quantity of milk produced in indigenous breed such as Amrit Mahal cows is less, they possess unique characteristics such as disease resistance capacity, survival in drought conditions and adjustable to hot and humid conditions. Amrit Mahal breed of cattle which is well recognised for its draught capacity has been evolved by using Hallikar, Hagalawadi and Chitradurga cattle of Karnataka state, India, during the year 1572 and it is the first new cattle breed evolved at world level even much before the evolution of Shorthorn cattle at England [11]. Since, there is paucity of information on the comparative studies of milk

components between Amrit Mahal, Holstein Friesian crossbred and Jersey crossbred cows, the present study was conducted.

Materials and Methods

The present study was carried out with prior approval of the Institutional Animal Ethics Committee (VCH/IAEC/2018/57) dated 13.03.2018. Six each of Amrit Mahal, Holstein Friesian crossbred and Jersey crossbred cows at third lactation were selected from Chitradurga district, Bangalore Rural and Chikkaballapur districts of Karnataka, respectively. These animals were randomly selected from different dairy farms on the basis of iso-nutritional and iso-managemental conditions. Selected animals were screened by California Mastitis test to ensure the Mastitis free condition. The animals were divided into three groups, *viz*., Amrit Mahal cows (Group I), Holstein Friesian crossbred cows (Group II) and Jersey crossbred cows (Group III).

Milk samples were collected aseptically at 4^{th}, 8^{th} and 12^{th} week of the third lactation between the months of April 2018 to June 2018. About 30 ml of milk sample was collected in each sampling. The milk samples were preserved by adding two to three drops of formalin (40% formaldehyde) and were stored at –20 °C until further analysis.

Various components of the milk were determined using Ksheera 270A lactoscan milk analyser manufactured by Sukratu Technologies, i.Logix Services, Basaveshwaranagar, Bengaluru, Karnataka, India [19].The data were analysed by two way ANOVA using GraphPad Prism version 7.04 (2018), a computerized software.

Results and Discussion

The milk lactose percentage was significantly (P<0.05) lower in crossbred cows compared to Amrit Mahal cows during eighth week of third lactation (Table 1). This finding was in agreement with the reports of [1] in Vechur and crossbred cows.

In Amrit Mahal cows, significantly higher milk lactose percentage was observed during eighth week compared to fourth week of lactation. These findings were in concurrence with the reports of [8] in dairy cows and [6] in Holstein cows. Krolow *et al*. (2012) attributed the lower lactose content during early lactation to the osmotic control of the mammary gland, following the higher milk yield. Henao-Velasquez *et al*. (2014) ascribed the alterations in lactose level to variations in glucose concentration, somatic cell count and energy availability for physiological processes.

From the present study, it is concluded that the lower level of milk lactose in crossbred cows compared to indigenous cows could be attributed to negative energy balance in the high producing animals during early phase of lactation.

The milk protein percentage in the present study was significantly (P<0.05) higher in Amrit Mahal cows compared to Holstein Friesian crossbred cows during different weeks of lactation (Table 1). These findings were in accordance with the reports of [2] in Swiss brown, Holstein, Holstein and Jersey cross, Holstein Friesian, Sindhi cross and inbred cows and was also in agreement with the findings of [7] in Bangladeshi Buffaloes, Holstein Cross, Indigenous cattle and Red Chittagong cattle. Islam *et al*. (2014) attributed the higher milk protein in indigenous cows to genotypic variation and Basheer (2011) attributed it to the presence of higher casein content in indigenous breeds compared to crossbred cows.

In HF crossbred cows, significantly higher milk protein percentage was recorded during fourth week compared to eighth week of lactation. These findings were in corroboration with the reports of [10] in Black and White cows and Jersey cows which was attributed to the increased milk protein in the later stages of lactation to the increase in dry matter intake and also increase in the levels of casein.

Table 1: Mean ± SE values of milk components in different groups of lactating cows (n=6)

Parameters	Groups	Weeks of Third Lactation		
		4^{th} week	8^{th} week	12^{th} week
Milk Lactose (%)	Group I	4.65 ± 0.16^{Aa}	5.32 ± 0.08^{Bb}	5.04 ± 0.05^{ABb}
	Group II	4.73 ± 0.08^{Aa}	4.37 ± 0.13^{Aa}	4.48 ± 0.10^{Aa}
	Group III	4.78 ± 0.12^{Aa}	4.61 ± 0.19^{Aa}	4.70 ± 0.10^{Aab}
Milk Protein (%)	Group I	3.45 ± 0.15^{Ab}	3.55 ± 0.05^{Ab}	3.45 ± 0.05^{Ab}
	Group II	3.19 ± 0.04^{Ba}	2.96 ± 0.03^{Aa}	3.15 ± 0.04^{ABa}
	Group III	3.27 ± 0.06^{Aab}	3.16 ± 0.07^{Aa}	3.21 ± 0.02^{Aa}
Milk Fat (%)	Group I	7.07 ± 0.66^{Bb}	5.55 ± 0.35^{Aa}	5.99 ± 0.30^{ABb}
	Group II	4.19 ± 0.28^{Aa}	4.52 ± 0.25^{Aa}	4.22 ± 0.16^{Aa}
	Group III	5.50 ± 0.61^{Aa}	5.83 ± 0.38^{Aa}	5.10 ± 0.21^{Aab}
Milk SNF (%)	Group I	8.99 ± 0.10^{Aa}	9.69 ± 0.14^{Bc}	9.23 ± 0.15^{Ab}
	Group II	8.69 ± 0.10^{Ba}	8.24 ± 0.05^{Aa}	8.48 ± 0.03^{ABa}
	Group III	8.93 ± 0.12^{Aa}	8.71 ± 0.13^{Ab}	8.77 ± 0.03^{Aa}
Milk Yield (Kg/day)	Group I	3.03 ± 0.04^{Aa}	3.00 ± 0.06^{Aa}	2.60 ± 0.04^{Aa}
	Group II	18.80 ± 1.90^{Bc}	18.37 ± 1.48^{Bc}	14.78^{Ac}
	Group III	11.82 ± 1.01^{Ab}	11.03 ± 1.01^{Ab}	9.42 ± 0.50^{Ab}

The values with different superscripts within a row (A and B) and within a column (a, b and c) differ significantly (P<0.05).

In Amrit Mahal cows, significantly higher milk fat percentage was observed during fourth week compared to eighth week of lactation. These findings were in agreement with the reports of [16] in crossbred cows and [14] in dairy cows. The higher fat per cent in Amrit Mahal cows during fourth week compared to 12^{th} week of lactation in the present study might be attributed to negative energy balance after calving encouraging the animal to use body lipids as alternative energy source [4]. It is concluded that the higher milk protein and fat percentage in Amrit Mahal cows compared to crossbred cows could be due to genetic heritability.

In the present study, significantly higher per cent of milk SNF was observed in Amrit Mahal cows (Group I) compared to HF crossbred (Group II) and Jersey crossbred cows (Group III) during 8^{th} and 12^{th} week of third lactation (Table 1). These findings were in concurrence with the reports of [9] who attributed the lower SNF content in Holstein crossbred cow's milk to the increase in the exotic blood to the extent of >50%

exotic inheritance. In Amrit Mahal cows and Holstein Friesian crossbred cows, significant changes in the per cent of SNF was observed during different weeks of lactation. Similar findings were reported by [5] in dairy cows, which were attributed to the changes in level of milk protein percentage.

It is concluded that the higher milk SNF percentage in Amrit Mahal cows compared to crossbred cows could be due to higher milk protein per cent. Further, the lower level of SNF percentage in Holstein Friesian crossbred cows might be attributed to increased level of exotic genetic inheritance. The alterations in milk SNF percentage could also be linked to more changes in milk protein and less alteration in lactose percentage.

The milk yield was significantly higher in Holstein Friesian crossbred cows compared to Amrit Mahal and Jersey crossbred cows during different weeks of third lactation (Table 1). These findings were consistent with the results of [13] in crossbred cows and [18] in Holstein Friesian and Jersey cross Holstein Friesian cows. In HF crossbred cows, milk yield was significantly lower during twelfth week compared to fourth and eighth week of lactation. These findings were in corroboration with the reports of [3] in dairy cows and [14] in dairy cows. Chaiyabutr (2012) owed the lower milk yield in indigenous cows to lower genetic potential compared to crossbred cows. Hence, it is concluded that the milk yield was higher in crossbred cows compared to Amrit Mahal cows could be due to genetic potential.

Conclusion

Significant differences between the breeds and also during different weeks of lactation were observed with respect to the levels of milk lactose, protein, fat, solids-not-fat, pH and milk yield. Higher level of milk fat and solids-not-fat were observed in Amrit Mahal cows compared to crossbred cows. In order to reduce these problems, Amrit Mahal cows might be used for cross breeding programmes with Holstein Friesian crossbred and Jersey crossbred cows in order to restrict the exotic blood levels within the limit of 50 per cent.

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