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# Effect of Breed, Season and Stage of Lactation on Different Milk Parameters at Organized Farm

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## ABSTRACT

**Background:** The current study had been conducted to understand the impact of breed as well as season and stage of lactation on various milk constituents *viz*. freezing point, SNF, pH, lactose, protein, fat and electric conductivity of Sahiwal and Kankrej cows maintained at LRS "Livestock Research Station", College of Veterinary and Animal Science, RAJUVAS, Bikaner, Rajasthan.

**Methods:** Milk samples from 45 each Sahiwal and Kankrej cows were collected and analyzed for milk composition parameters. Data have been classified as per breed along with season and stage of lactation.

**Result:** The analysis of variance for breed demonstrated highly significant impacts of fat and SNF whereas non-significant effect was found on pH, freezing point, lactose and protein.The analysis of variance demonstrated highly significant (P<0.01) impact of season on fat, SNF, freezing point and significant effect on protein whereas non-significant effect on lactose, pH and Electric conductivity in Kankrej cattle however highly significant (P<0.01) effect was found on fat in Sahiwal cattle. The analysis of variance presented significant (P<0.05) effect of lactation stage on fat and Protein in Sahiwal cattle whereas on fat and SNF in Kankrej cattle.


**Key words:** Breed, Kankrej, Milk composition, Sahiwal, Season, Stage of lacataion.

## INTRODUCTION

The nutritional composition of cow milk comprises 3.5% protein, 4.5% fat, 8.5% solid not fat, 4.6% lactose and freezing point -0.55°C. Study on milk composition along with functional properties of the indigenous cow milk are of the considerable importance to milk consumers, manufacturers as well as dairy farmers. Dairy farmers, manufacturers and consumers all depend on milk components and composition for ensuring the quality of their raw milk along with milk products and overall health and well-being (Reis *et al*., 2013).

These properties of milk might be impacted by various factors including: seasonal variation (Bernabucci *et al.,* 2002), storage of milk (Hanna *et al.,* 2004), nutritional level, breeds of animals, parity of cows, milk somatic cell (Ramos *et al.,* 2015; Singh, 2019) lactation stage as well as farm's geographic location (Alyaqoubi *et al.,* 2014).

Breed is a genetic factor which affects the composition, quantity and quality of milk significantly. Milk characteristics may show changes in a year as a result of the influence of the seasons on animals. Among the main causes of seasonal variations could be due to dietary factors, in particular the characteristics of feeds, as well as housing factors, feeding methods and climatic conditions of the region. A few conditions, like cows confined indoors and given silage in the winter, then kept on pasture as well as fed new grass in the spring and summer, have a key impact in the dietary aspects. The season could be considered the main factor that has affected the fluctuations in milk characteristics throughout as feed, climatic variables changes. According to Bernabucci *et al.* (2015), milk fat and protein concentrations are lower in summer, higher in winter; intermediate in spring milk.

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Stage of lactation also shows variable impact upon milk constituents. During the height of lactation, high-yielding cows require more energy than they can get from their food. This is due to a decrease in hunger following parturition, as well as an increase in metabolic activities, which has the effect of necessitating a high number of substrates for the synthesis of milk ingredients (Józwik *et al.,* 2012). Fat percentages and milk protein percentages are influenced by the lactation stage in a similar way. Just after freshening, colostrum contains the maximum concentration of fat and protein in milk. During the first 25 to 50 days after calving, levels drop to their lowest point and they reach their maximum at 250 days, when milk production begins to decline (Heinrichs *et al.,* 2016). In this study we included genetic factor *viz*. breed and non genetic factors season and stage of lactation into consideration and analysed the effect of these factors upon different milk constituents.

## MATERIALS AND METHODS

The current research was performed at Livestock Research Station, Collage of Veterinary and Animal Science, Bikaner (RAJUVAS), Rajasthan, India, during 2019-20 on Kankrej along with Sahiwal cattle that were kept in loose housing system. Every animal on farm fed with seasonal dry fodder, green fodder and compound concentrate mixture in accordance with the farm's typical feeding schedule. 45 total milk samples were collectedfrom 45 healthy, lactating Kankrej and Sahiwal cows. Clean sampling bottles were used to collect about 50 ml of aseptic milk sample after discarding the first 2-3 streaks of foremilk. After collecting all samples, they have been immediately taken to the laboratory for additional analysis. On the same day, all milk samples were processed. According to normal protocol, all samples were tested using milk auto analyzer whereas pH and electric conductivity were measured by pH meter and EC meter. The seasons were classified *viz*. Summer, Winter, Rainy. In the present study, effect of breed, season and stage of lactation were taken into consideration. ANOVA (One-way analysis of variance) has been utilized for evaluating the data whereas Duncan's multiple range test has been utilized for comparing the means. In order to do any statistical analysis, SPSS software were utilized (version 20.0).

## RESULTS AND DISCUSSION

Milk composition is the primary index for assessment of quality; mainly milk fat content is utilized as quality test (Zelalem, 2010). Milk's solids content determines both its nutritional and commercial value. Nutritional value increases as the solids level increases and more milk products may be produced (Pandy and Voskull, 2011). Protein content is a major criterion for evaluating the quality of milk and is used to determine payments to dairy farmers in many countries when other factors such as fat and solids content are taken into account the product's non-fat content (FAO, 2004). Breed, species, parity (Sarkar *et al.,* 2006; Mushtaq *et al.,* 2012; Singh, 2019), BCS (Mushtaq *et al.,* 2012; Singh, 2019), dietary composition, season, lameness, heat stress, behavior, locality udder health, along with lactation stage all are the factor that influence the Milk composition (Sarkar *et al.,* 2006; Kayastha *et al*., 2008; Arora and Bhojak, 2013).

### Effect of breed on milk composition

The mean±SE values for effect of breed on fat, protein, lactose, SNF, freezing point, pH and EC are presented in Table 1. The outcomes of the analysis of variance revealedthat breed had significant impact on fat storage. According to Adesina, (2012) breed had significant effect on fat per cent. Fat content in milk on a daily basis was also obtained to be significantly higher ($p<0.05$) in synthetic cows (Ethiopian Ogaden cattle, Jersey × Horro crosses and Holstein Friesian × Jersey × Horro crosses) whereas lowest in Holstein Frisian, according to a study by Kebede, (2018). Analysis of variance revealed breed'ssignificant impact on SNF. The significant difference of SNF in our study has been in agreement with Bobbo *et al.* (2014), Falta *et al.* (2014) and Kedzierska-Matysek *et al.* (2011). As per the analysis of variance, there was no significant influence of breed on protein, which is in agreement with Adesina, (2012). African cattle breeds like Bonsmara, Afrikaner, Tuli, Nguni and Boran, were analysed by Myburgh *et al.* (2012) and found non significant variation in protein content. According to Ivanov *et al.* (2017), Bendelja *et al.* (2011) and Pintic *et al.* (2007), the influence of breed on milk protein content was shown to be non-significant. The analysis of variance results presented that breedlactose content has not been significantly affected by breed. The similar findings were also observed by Kebede, (2018), Adesina (2012), Falta *et al.*, (2014) and Singh, (2019). Contradicted finding and significant differences in lactose content among different breeds reported by Myburgh *et al.* (2012). Analysis of variance results demonstrate that breed had no effect on the freezing point. Same results wereobserved by Kedzierska- Matysek *et al.* (2011) and Brzozowski and Zdziarski (2006) for freezing point. Breed had no significant impact on pH, according to the analysis of variance. As per Singh (2019) stated non significant impacts of breed on pH among Sahiwal, Kankrej and Rathi. Contrary to our findings Bobbo *et al.* (2014) found significant difference in the milk pH in the different cattle breeds. There is variations in electric conductivity among breeds as electrical conductivity in milk is influenced by theudder health status of the cow. Electrical conductivity of milk may bea potential trait in a breeding program. Electrical conductivity was also found a low heritable trait (Povinelli *et al.,* 2005)

**Table 1:** Means ± SE milk composition from Sahiwal and Knakrej breeds.

| Parameters | Sahiwal | Kankrej | Level of significance |
|---|---|---|---|
| Fat (g/100 g) | 3.46±0.03[a] | 4.37±0.06[b] | ** |
| Protein (g/100 g) | 3.51±0.04 | 3.57±0.03 | NS |
| Lactose (g/100 g) | 4.45±0.07 | 4.64±0.08 | NS |
| SNF (g/100 g) | 8.73±0.08[a] | 9.2±0.07[b] | ** |
| Freezing point | -0.553±0.005 | -0.560±0.002 | NS |
| pH | 6.33±0.03 | 6.31±0.03 | NS |
| EC | 3.50±0.07 | 3.60±0.06 | NS |

a, b- differences significant at $P<0.05$.

**$P<0.01$.

in Italian brown cattle but still effect of genetic parameters on electric conductivity needs to be researched in indigenous cattle.

**Effect of season on milk composition**

The Mean±SE values for effect of season on fat, protein, lactose, SNF, freezing point, pH and EC are given in Table 2 along with Table 3. The analysis of variance has significant impact of season on SNF, fat and protein whereas non significant effect on lactose, pH and electric conductivity in Kankrej and Sahiwal cattle. The significant effect of season was found on freezing point in Kankrej cattle whereas non significant was observed in Sahiwal cattle. The post hoc DMRT revealed higher values of Fat, protein, lactose and SNF in winter season than rainy and summer season in Kankrej and Sahiwal cattle. Similar result was reported by Parmar *et al.* (2020) researched significant effect of season on proteinalong withfat. Sahu *et al.* (2018) found that season had significantly ($p<0.01$) affect protein, solid not fat, fat along with lactose percentage except total solids in Kosali cow. Kabil *et al.* (2015) observed higher fat and protein during winter season in cow's milk in Egypt.

These variations in season *viz*. rainy, winter and summer might be due to that it is well established fact that diet and photo period (Parmar *et al.,* 2020) affect milk composition in dairy cattle. During later part of rainy season and first half of winter season cattle offered abundant amount of green fodder and regional grasses and cows are allowed to graze outdoor and this will affect milk composition *viz*. fat. Feeding patterns and milk composition are influenced by photoperiod in dairy cattle (Parmar *et al.,* 2020). Photo period refers to day length or day light received by an animal which influences series of hormonal changes which ultimately affects the feeding behaviour and milk composition. Therefore combination of these factors affects milk composition.

**Effect of stage of lactation on milk composition**

The Mean±SE values for effect of stage of lactation on fat, protein, lactose, SNF, freezing point, pH and EC are presented in Table 4 along with Table 5. Fat in Sahiwal and Kankrej cattle were shown to have a significant impact on lactation stage, but lactose, EC and freezing point were found to have no effect. The significant effect of lactation stage was found on protein in Sahiwal cattle and significant effect was observed on SNF in Kankrej cattle. The post hoc DMRT revealed higher values of SNF, lactose, protein and fat, in late lactation stage in Sahiwal and Kankrej cattle. Same results have been seen by Parmar *et al.* (2020) who reported higher protein and fat in late lactation stage. Józwik *et al.,* (2012) observed higher values of fat, protein and lactose in late lactation stage (Days in milk-200) in Polish Holstein-Friesian White along with Black dairy cows. An examination of the late stages of lactation in Holstein Friesian cross cows by Shibru *et al*. (2019) found no significant differences in fat percentage but a substantial difference in protein %. Gajbhiye *et al.* (2019) reported increased fat, SNF along with protein in later lactation stages in Gir cows. Shuiep *et al.* (2016) stated significant impacts of lactation stage on SNF, fatas well as lactose and reported higher fat

**Table 2:** Means ± SE different milk composition of kankrej breed in different seasons.

| Parameters | Rainy | Winter | Summer | Level of significance |
|---|---|---|---|---|
| Fat (g/100 g) | $3.92^{a}$±0.06 | $4.64^{b}$±0.05 | $4.56^{b}$±0.05 | ** |
| Protein (g/100 g) | $3.47^{a}$±0.05 | $3.67^{b}$±0.07 | $3.56^{ab}$±0.04 | * |
| Lactose (g/100 g) | 4.59±0.04 | 4.69±0.02 | 4.64±0.04 | NS |
| SNF (g/100 g) | $8.92^{a}$±0.08 | $9.46^{b}$±0.12 | $9.31^{b}$±0.14 | ** |
| Freezing point | $-0.555^{a}$±0.002 | $-0.568^{b}$±0.003 | $-0.557^{a}$±0.004 | ** |
| pH | 6.41±0.03 | 6.2±0.05 | 6.3±0.06 | NS |
| EC | 3.64±0.05 | 3.60 ±0.06 | 3.56 ±0.07 | NS |

a, b, c - Differences significant at P<0.05.

* P<0.05; **P<0.01.

**Table 3:** Means ± SE milk composition of sahiwal breed from different seasons.

| Parameters | Rainy | Winter | Summer | Level of significance |
|---|---|---|---|---|
| Fat (g/100 g) | $3.34^{a}$±0.04 | $3.52^{b}$±0.05 | $3.53^{b}$±0.03 | ** |
| Protein (g/100 g) | $3.44^{a}$±0.05 | $3.62^{b}$±0.06 | $3.48^{a}$±0.07 | * |
| actose (g/100 g) | 4.6±0.12 | 4.46±0.12 | 4.28±0.14 | NS |
| SNF (g/100 g) | $8.55^{a}$±0.1 | $8.9^{b}$±0.09 | $8.69^{a}$±0.17 | * |
| Freezing point | -0.559±0.01 | -0.557±0.006 | -0.544±0.003 | NS |
| pH | 6.38±0.03 | 6.29±0.06 | 6.32±0.05 | NS |
| EC | 3.49±0.04 | 3.45 ±0.06 | 3.56±0.06 | NS |

a, b, c - Differences significant at P<0.05.

*P<0.05.

**Table 4:** Effect of stage of lactation on Means±SE of milk composition of Sahiwal cattle.

| Parameters | First stage | Second stage | Third stage | Level of significance |
|---|---|---|---|---|
| Fat (g/100 g) | 3.36$^{a}$±0.04 | 3.45$^{ab}$±0.04 | 3.56$^{b}$±0.05 | ** |
| Protein (g/100 g) | 3.38$^{a}$±0.07 | 3.48$^{a}$±0.04 | 3.65$^{b}$±0.05 | ** |
| Lactose (g/100 g) | 4.43±0.12 | 4.36±0.16 | 4.54±0.12 | NS |
| SNF (g/100 g) | 8.54±0.12 | 8.74±0.15 | 8.92±0.12 | NS |
| Freezing point | -0.566±0.008 | -0.556±0.008 | -0.538±0.008 | NS |
| pH | 6.38±0.06 | 6.31±0.03 | 6.26±0.06 | NS |
| EC | 3.49±0.06 | 3.51 ±0.04 | 3.53±0.05 | NS |

a, b, c - differences significant at P<0.05.

**P<0.01.

**Table 5:** Effect of stage of lactation on Means±SE of milk composition of Kankrej cattle.

| Parameters | First stage | Second stage | Third stage | Level of significance |
|---|---|---|---|---|
| Fat (g/100 g) | 4.18$^{a}$±0.12 | 4.39$^{a}$±0.09 | 4.54$^{b}$±0.08 | * |
| Protein (g/100 g) | 3.48±0.06 | 3.54±0.05 | 3.66±0.05 | NS |
| Lactose (g/100 g) | 4.62±0.06 | 4.65±0.04 | 4.67±0.04 | NS |
| SNF (g/100 g) | 8.95$^{a}$±0.09 | 9.20$^{a}$±0.11 | 9.53$^{b}$±0.13 | ** |
| Freezing point | -0.556±0.003 | -0.558±0.002 | -0.560±0.003 | NS |
| pH | 6.38±0.05 | 6.32±0.04 | 6.24±0.05 | NS |
| EC | 3.59±0.04 | 3.55 ±0.06 | 3.66±0.06 | NS |

a, b, c - differences significant at P<0.05.

**P<0.01; *P<0.05.

in late stage of lactation. The variations during various lactation stages in fat might be due to increases in energy deficit, which is always the case in early lactation, but mainly increases at the end of lactation (Vanbergue *et al.,* 2017). Water drawn into milk influences the quantity of lactose synthesis. Lactose and water secretion rates are essentially consistent during lactation (Pollott, 2004). Milk SNF, which is mostly made of minerals, proteins, along withlactose, has a larger amount of additional nonfat ingredients in the late lactation stages (Gurmessa and Melaku, 2012). However, increase in fat and protein in late lactation stage might be due change in milk composition as it reduces partially due to milk reduction in volume at late lactation (Auldist *et al.,* 1998; Hickey *et al.,* 2006).

## CONCLUSION

The milk composition is significantly affected by breed factor. Selective breeding could be an effective tool to improve milk quality. The season has a considerable impact on milk fat in Kankrej and Sahiwal cattle, these changes are mostly due to the variation in feed quality in accordance with the season. Stage of lactation is an important physiological parameter divided the lactation period according to milk yield *viz*. early, mid and late lactation according to which milk components *viz*. protein, lactose and fat varies as the lactation proceeds. Milk fat variation is an essential parameter for dairy farmer fetching premium prices. Dairy farmer can improve their income by understanding these variations and tuning the feeding programme and housing practices for improvement.

### Conflict of interest

All authors declare that they have no conflict of interest.

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