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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(11): 484-487

www.thepharmajournal.com
Received: 08-08-2022
Accepted: 12-09-2022

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Effect of milk somatic cell count on milk yield and composition in Jaffarabadi buffaloes

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Abstract
The present study was carried out on lactating Jaffarabadi buffaloes to observe the effect of milk Somatic cell count (SCC) on milk yield and composition. Milk samples (n = 320) were collected from forty buffaloes, and immediately milk constituents including milk SCC were estimated by using automatic milk analyzer. The samples were categorized into four groups based on milk SCC i.e. ≤50, 51-100, 101-200, >200 ×10^3 cells/ml. Results showed non-significant (p>0.05) effect of milk SCC on daily milk yield, milk fat and total solids content in Jaffarabadi buffaloes. However, milk SCC had significant (p≤0.05) effect on milk solid not fat (SNF), protein, lactose, salts and milk density. The mean values of milk SNF, protein, lactose, salts and density were significantly (p≤0.05) higher in the low SCC (≤50 × 10^3 cells/ml) group than the high SCC groups (101-200 and >200 × 10^3 cells/ml). The milk SCC was negatively and highly significantly (p<0.01) correlated with SNF (r = -0.171), protein (r = -0.178), lactose (r = -0.167), salts (r = -0.148) and density (r = -0.144) in Jaffarabadi buffaloes. The results reflected that milk SCC negatively affects milk components like SNF, protein, lactose, salts and density.

Keywords: Milk SCC, milk yield, milk composition, Jaffarabadi buffalo

Introduction
Globally India ranked first in both milk production and buffalo population. The buffalo population of India was 109.85 million as per 20th livestock census. The milk produced in India (198.40 MT of milk was produced during 2019-2020) shared about 23 percent of total global milk production (Anonymous, 2021a) [2]. However, the milk produced in India is mostly used for domestic consumption and very less quantity is exported. The lower milk export is due to the higher microbial count in raw milk and could not achieve the standard fixed by the developed countries. Milk somatic cells, secreted during normal course of milking are mixture of epithelial cells and leukocytes. The population of these cells in raw milk is now-a-days used as an indicator to know the intra-mammary health in dairy bovines and elevated milk somatic cells is associated with mammary infections (Alhussien and Dang, 2018). The elevated milk somatic cell counts (SCC) further negatively affect milk quality and its product, and causes huge economic losses to dairy sector.

The nutrients of milk like fat, lactose, protein and ash content are higher in buffalo milk than the cow milk. That's why compared to cow milk, the buffalo milk gets more attention and fetches higher price. In a healthy animal the milk fat is most variable followed by protein and lactose is least variable. However, in case of intra-mammary infection the milk lactose is most variable followed by protein and fat (Patbandha *et al*., 2015) [11]. Milk with elevated SCC, a result of udder infection has been associated with changes in milk components fat, protein, lactose and minerals. This alteration results poor quality of milk and milk products (Salam *et al*., 2011) [12]. However, the information pertaining to association of milk SCC on milk components in Jaffrabadi buffaloes is scanty although this breed produced 2239-2340 kg milk per lactation with average butter fat percent 7.7% (Anonymous, 2007) [1]. Hence, the present study was conducted to see the effect of milk SCC on milk yield and milk components in Jaffrabadi buffaloes.

Materials and Methods
The study was carried out on 40 healthy, lactating Jaffarabadi buffaloes at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh, Gujarat and the duration of experiment was 4 month (March to June 2022). Experimental buffaloes were maintained under loose housing system.

The buffaloes were maintained under similar managerial practices throughout the experiment period. Measured quantity of green fodder and ad-libidum dry fodder were provided to the experimental buffaloes in loose house where as concentrate was offered according to their production inside the milking parlour at the time of milking. Experimental animals were fed as per Indian Council of Agricultural Research (ICAR) feeding standards to meet their nutrient requirements (ICAR, 2013) [8] There was provision of free access of drinking water throughout day and night to the experimental buffaloes.

Milk samples (n=320) were collected at fortnightly intervals from 40 buffaloes. Immediately after collection CMT test was performed to check the health status of the experimental animals. The milk SCC and composition of the samples were performed by using the "Lactoscan MCC combo" (Milkotronic Ltd., Bulgaria). To study the effect of milk SCC on milk yield and milk composition (fat, SNF, protein, lactose, salts, total solids and density) the samples were categorised into 4 groups based on the milk SCC values (≤50, 51-100, 101-200, >200 thousand cells/ml). The effect of milk SCC on milk yield and composition was analysed by using ANOVA. The association of milk SCC with milk yield and milk composition was estimated by using correlation study.

Results and Discussion

The overall average daily milk yield of Jaffarabadi buffaloes was 7.76±0.18 kg/day (Table 1). There was non-significant (p>0.05) effect of milk SCC on milk yield. However, the milk yield of Jaffarabadi buffaloes was numerically higher in up to 50 thousand cells/ml group followed by 51-100, > 200 and 101-200 thousand cells/ml groups. The daily milk yield gradually reduced with increase in milk SCC upto 200 thousand cells/ml of milk. The results are in agreement with Verma and Kimothi (2021) [13], who noticed non-significant (p>0.05) effect of milk SCC on daily milk yield. However, Costa *et al.* (2020) [5] observed significant (p<0.05) variation of milk yield in different milk SCC groups in Italian buffaloes. Kul *et al*. (2019) [10] and Cinar *et al*. (2015) [4] also reported significant (p<0.05) effect of milk SCC on milk yield in Holstein cows.

The overall milk fat percent of the Jaffarabadi buffaloes was 8.74±0.08 (Table 1). The milk fat percent did not differ significantly (p>0.05) among different milk SCC groups. But the milk fat was numerically higher in 101-200 thousand cells/ml milk SCC group. In a similar line, Verma and Kimothi (2021) [13] and Cinar *et al*. (2015) [4] observed non-significant (p>0.05) effect of milk SCC on milk fat percent. Cinar *et al.* (2015) [4] observed numerically higher milk fat percent in Holstein cattle with high milk SCC value. However, Verma and Kimothi (2021) [13] reported numerically higher milk fat percent in low milk SCC groups, but it was non significant.

The overall milk protein content of Jaffarabadi buffaloes was 3.50±0.01%. There was significant (p≤0.05) effect of milk SCC on milk protein percent. The milk protein was significantly high (3.55±0.02) in ≤ 50 thousand cells/ml milk SCC group as compared to the groups having >100 thousand milk SCC. The gradual decrease of protein content with increase in milk SCC might be attributed to microbial utilization of milk protein, as the elevated milk SCC is associated with udder infection. Cinar *et al*. (2015) [4] and Kul *et al*. (2019) [10] also reported significant effect of milk SCC on milk fat percent in cows. Contrary to the present study, Verma and Kimothi (2021) [13] reported non-significant (p>0.05) effect of milk SCC on milk protein. Costa *et al*. (2020) [5] did not observe significant (p>0.05) effect of milk SCC on milk protein content in Italian buffaloes.

Table 1: Milk yield and composition of Jaffarabadi buffaloes with different milk SCC (× 10^3 cells/ml)

Parameters	Milk SCC Groups				
	≤50	51-100	101-200	>200	Overall
Milk yield (kg/day)	8.19±0.24	7.61±0.42	7.20±0.48	7.28±0.48	7.76±0.18
Fat (%)	8.68±0.11	8.77±0.16	8.86±0.22	8.74±0.24	8.74±0.08
Protein (%)	3.55^c±0.02	3.52^{bc}±0.03	3.40^a±0.04	3.44^{ab}±0.04	3.50±0.01
Lactose (%)	5.36^b±0.03	5.26^{ab}±0.05	5.15^a±0.06	5.20^{a}±0.71	5.28±0.02
SNF (%)	9.66^b±0.06	9.51^{ab}±0.10	9.26^a±0.11	9.36^a±0.13	9.51±0.04
TS (%)	18.34±0.08	18.28±0.14	18.11±0.36	18.10±0.17	18.25±0.08
Salts (%)	0.75^b±0.005	0.73^{ab}±0.010	0.71^a±0.010	0.72^{ab}±0.012	0.73±0.004
Density (kg/m^3)	1027.07^b±0.31	1026.37^{ab}±0.48	1025.43^a±0.56	1025.91^{ab}±0.71	1026.48±0.23

The overall mean milk lactose content of Jaffarabadi buffalo was 5.28±0.02%. There was significant (p≤0.05) effect of milk SCC on milk lactose content. The milk lactose level in ≤ 50 thousand cells/ml milk SCC group was significantly higher than the >100 thousand cells/ml milk SCC group. However, the milk lactose of 51-100 thousand cells/ml was at par with other groups. Costa *et al*. (2020) [5] reported that milk lactose varied between 4.61 and 4.78% in Italian buffaloes, which is comparatively lower than the milk lactose content observed in Jaffarabadi buffaloes. Kul *et al*. (2019) [10], Cinar *et al*. (2015) [4], Costa *et al.* (2020) [5] also reported significant effect of milk SCC on milk lactose content. These authors noticed that milk lactose content remained high in low milk SCC groups, which gradually decreased with increase in milk SCC value. The elevated milk SCC reflects bacterial infection in mammary glands. The microbes inside mammary gland utilize the milk lactose and convert it to lactic acid. This might be attributed to gradual reduction of milk lactose with increase in milk SCC in dairy cattle and buffaloes.

The overall milk SNF percent was 9.51±0.04 in Jaffarabadi buffaloes (Table 1). In Jaffarabadi buffaloes, the milk SNF percent was significantly (p≤0.05) affected by the milk SCC. The mean milk SNF content was significantly higher in ≤ 50 thousand cells/ ml milk SCC group compared to > 100 thousand cells/ ml milk SCC groups. However, the SNF percent of 51-100 thousand cells/ ml group was at par with other groups. In a similar line, Kul *et al.* (2019) [10] noticed significant (p≤0.05) effect of milk SCC on milk SNF percent in Holstein cows. Verma and Kimothi (2021) [13] observed non-significant (p>0.05) effect of milk SCC on the milk SNF percent in Murrah, Surti and Nili-Ravi buffaloes. The significant effect of milk SCC on milk SNF content might be attributed to alteration of permeability of secretory cells or utilization of different milk components by the microbes.

In Jaffarabadi buffaloes, the overall mean milk total solid percent was 18.25±0.08 (Table 1). The milk total solid percent did not differ significantly ($p>0.05$) among different milk SCC groups. The milk total solid content was numerically higher in ≤ 50 thousand cells/ml milk SCC group followed by 51-100, 101-200 and > 200 thousand cells/ml milk SCC groups in Jaffarabadi buffaloes. This indicates that milk total solids content reduced gradually with increase in milk SCC value. Salam *et al*. (2011) [12] cited that total solids content of buffalo milk showed variation between 16.3 and 18.4%. The milk total solids value observed in Jaffarabadi buffaloes in this study remains within the range as reported by Salam *et al*. (2011) [12] in buffaloes. Cinar *et al*. (2015) [4] observe significant effect of milk SCC on milk total solid percent. The mean milk total solids percent in Jaffarabadi buffaloes gradually reduced with increase in milk SCC although the variation was non-significant. The milk total solid is the result of combination of all milk components and alteration of any one could change the milk total solids.

The overall mean milk salt content of Jaffarabadi buffaloes was 0.73±0.004%. The milk salt content was significantly ($p\leq0.05$) affected by the milk SCC. The milk salt was significantly higher in ≤ 50 thousand milk SCC group in comparison to 101-200 thousand cells/ml. However, milk salt content of 51-100 and > 200 thousand cells/ml groups were statistically similar and were also at par with other two groups. Salam *et al*. (2011) [12] reviewed the milk composition of buffaloes and reported that milk salts/ash content ranged from 0.71 to 0.85%. The value observed in the present study remains within the above range. The gradual reduction of milk salts content with increase in milk SCC might be attributed to sub-clinical infection in the buffaloes. The mammary gland infection alters the cell membrane permeability and there by the changes of milk salts and other components.

The overall mean milk density (kg/m^3) was 1026.48±0.23 in Jaffarabadi buffaloes. There was significant ($p<0.05$) effect of milk SCC on milk density. The milk density was significantly higher in ≤ 50 thousand cells/ml milk SCC group as compared to 101-200 thousand cells/ml milk SCC group. However, the milk density of 51-100 and >200 thousand cells/ml milk SCC groups was at par with other groups. In Jaffarabadi buffaloes, in addition to milk density, other milk components except fat and total solids were also affected by milk SCC. The variation of other milk components may parallelly affect milk density in Jaffarabadi buffaloes.

The association of milk SCC with milk yield and its components (fat, solid not fat, density, lactose, salts, protein and total solids) of Jaffarabadi buffaloes are showed in Figure 1. The milk SCC showed highly significant ($p<0.01$) correlation with milk components in Jaffarabadi buffaloes. In Jaffarabadi buffaloes, the milk SCC had negative and highly significant ($p<0.01$) correlation with solid not fat (r = -0.171), density (r = -0.144), lactose (r = -0.167), salts (r = -0.148) and protein (r = -0.178) content of milk. However, milk SCC had non-significant negative correlation with test day milk yield (r = -0.075) and total solids (r = -0.047). Verma and Kimothi (2021) [13] observed negative and non-significant association between milk SCC and yield in Murrah, Surti and Nili-Ravi buffaloes. Further, Gupta *et al.* (2016) [7] in dairy cattle noticed negative and non-significant correlation of milk SCC with milk yield (r = -0.049) in crossbred Vrindavani cattle. There was positive and significant correlation of milk SCC with milk fat (Cinar *et al*., 2015; Vilas Boas *et al*., 2017; Costa *et al*., 2020) [4, 14, 5]. However, in Jaffarabadi buffaloes positive but non-significant ($p>0.05$) association between milk SCC and fat was observed. Bharti *et al*. (2015) [3] and Verma and Kimothi (2021) [13] observed significant and negative correlation of milk SCC and milk fat. Cinar *et al*. (2015) [4] observed positive and significant ($p<0.05$) correlation of milk SCC with total solids in Holstein cows and Vilas Boas *et al*. (2017) [14] observed significant ($p<0.05$) and negative correlation between these two milk traits. Bharti *et al*. (2015) [3] observed negative and highly significant ($p<0.01$) correlation between milk SCC and SNF percentage (r = -0.563, respectively) in Jersey cows. Further, Verma and Kimothi (2021) [13] observed negative and significant ($p<0.05$) correlation of milk SCC with milk SNF (r = -0.30) percent in buffaloes. Cinar *et al.* (2015) [4] and Costa *et al.* (2020) [5] observed positive correlation of milk SCC with milk protein in Holstein cows (r = 0.29) and Italian buffaloes (r = 0.03). Cinar *et al.* (2015) [4] and Vilas Boas *et al.* (2017) [14] noted that SCC showed highly significant ($p<0.01$) and negative correlation with milk lactose percentage (r = -0.206). In Italian buffaloes, Costa *et al.* (2020) [5] recorded highly significant ($p<0.01$) and negative correlation between lactose and SCC (r = -0.30).

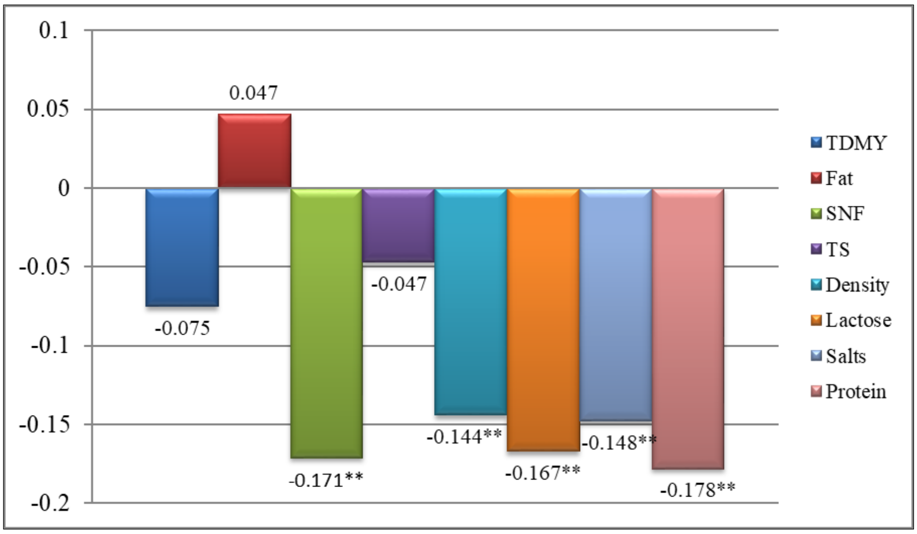

Fig 1: Correlation of milk SCC (× 10^3 cells/ml) with milk yield and milk composition (%) and density (kg/m^3) in Jaffarabadi buffaloes. ** $p<0.01$

Conclusions

Based on the findings of the study, it can be concluded that milk somatic cell count does not affect milk yield in Jaffrabadi buffaloes. Milk somatic cell count markedly influences milk components like solid not fat, protein, lactose and salts percent in Jaffrabadi buffaloes. Correlation analysis revealed negative mild association of milk somatic cell counts with milk solid not fat, protein, lactose and salts percent in Jaffrabadi buffaloes.

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