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RESEARCH ARTICLE

Understanding the association of milk yield with major milk constituents and somatic cell count in Jersey crossbreds

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Abstract: In the dairy industry, understanding the correlation between somatic cell count (SCC), milk constituents and milk production is essential for optimizing milk production, ensuring milk quality, and maintaining cow health. Studying relationships among them can guide dairy farmers to enhance the productivity of their animals by making informed decisions thus improving food and nutritional security. Milk samples (n=400) were collected weekly from the fifty Jersey crossbred cows over five months and analyzed for SCC, total solids, solids not fat (SNF), lactose, protein, and fat content using standard methods. The study found correlations between test day milk yield with SCC, total solids, Solid Not Fat (SNF), lactose, protein, and fat as -0.233, -0.092, -0.056, -0.131, and 0.092 respectively. Protein and lactose content showed a significant, inverse relationship with milk yield, with correlation coefficients below zero ($P<0.01$). However, total solids, fat content, and SNF displayed a weaker, non-significant negative correlation with milk yield. Moreover, test-day milk yield and SCC also exhibited a significant negative ($P<0.05$) correlation. These results indicate that lower protein and lactose levels, along with higher SCC, are associated with reduced milk yield, indicating the importance of managing these factors to optimize dairy production and enhance the overall quality of the milk.

Keywords: Jersey crossbred, correlation, test day milk yields, somatic cell count, milk constituents

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Introduction

The dairy industry has placed a significant emphasis on improving milk production and quality (Singh et al. 2021; Bokharaeian et al. 2023), particularly focusing on the relationship between milk production and its major constituents. As per 20th livestock census the exotic and crossbred animals' population is 50.42 million which is an increase by 26.9% over the previous 19th livestock census (DAHD, 2020) in India. Milk quality is an essential factor in the dairy industry, determined by its chemical composition and hygienic properties. The primary components of milk include fat, protein, lactose, solids-not-fat (SNF), and total solids (TS), which not only define the nutritional value but also influence the processing and economic value of dairy products (Hnini et al. 2018). Milk composition is significantly affected by genetic (heritability) and non-genetic (lactation phase, nutrition, and seasonal variations) factors (Chaudhary et al. 2017). The seasonal shifts significantly impact milk's antioxidant activity and fatty acid profiles, with organic milk showing higher levels of polyunsaturated fatty acids and lower atherogenic indices compared to conventional milk (Kasapidou et al. 2023).

Milk production and its components are crucial parameters in determining the profitability of dairy farming and the quality of milk products. The fat content provides energy and is essential for flavor, while protein, particularly casein, contributes to milk's functional properties, making it ideal for cheese production (Kayihura, 2024). Lactose, the primary carbohydrate, plays a role in milk sweetness and supports fermentation in dairy products (Ohlsson et al. 2017). High-quality milk also requires a low somatic cell count (SCC), as elevated SCC levels, often indicative of mastitis, degrade milk quality by altering its composition, reducing fat and protein, and increasing the risk of spoilage (Sumon et al. 2020; Kaskous et al. 2022). Moreover, the exact nature of these relationships can vary on basis of genetic factors, seasonal conditions, and herd management practices (Bari et al. 2022).

Although several studies have explored the correlations between milk yield, composition, and SCC, many are breed-specific and limited to particular environmental conditions (Kul et al. 2019; Ablondi et al. 2023; Kasapidou et al. 2023). However, no studies have comprehensively examined these relationships in Jersey

crossbred cows, particularly under Indian climatic and management conditions. Identifying these associations is essential for developing balanced breeding and management strategies that enhance both milk quality and productivity. It was hypothesized that there exists a significant relationship between milk yield, composition, and SCC in Jersey crossbred cows. The objective of this study was to evaluate these correlations to provide insights that could guide breeding and management decisions for optimizing milk production and quality.

Material and methods

The current research was performed on the Jersey crossbred herd on the dairy Farm situated in Anjora city of District-Durg (Chhattisgarh, India). To investigate the relationship between milk yield, milk constituents, and somatic cell count (SCC), a total of 400 milk samples were collected weekly over a five-month period from February to June 2018. The samples were obtained from 50 lactating cattle aged 3 to 8 years, with parity ranging from 1 to 5, and in lactation stages from the first to the third. A sample of 30-40 ml milk was taken for analysis and cold chain for those samples was maintained using an ice box. The Milkotester (milk analyzing device of model LM2, Milkotester, Bulgaria) was used to measure the protein, lactose, total solid, fat, and SNF content of the milk samples. SCC analysis was done by smearing 10µl of fresh milk on a clean glass slide using sterilized platinum loop. After air drying, the smear was stained using a modified Newman's stain for 1-2 minutes, rinsed, and allowed to dry again. Microscopic examination of the stained smear under oil immersion was done. Only those cells, which possess blue stained nucleus, were counted. Milk samples were taken from all healthy animals. The correlation coefficient, between various milk constituents, test-day milk yield (TDMY) and SCC were calculated using the standards method used by Snedecor and Cochran (1994).

Results and Discussion

The correlation co-efficient between TDMY, various milk constituents as well as SCC are presented in Table 1. The findings indicates that there was negative correlation between the TDMY with milk constituents (total solid, lactose, protein, fat, and SNF) and SCC in Jersey crossbred cows. The descriptive statistics for milk constituents are presented in Table 2.

In this study negative (-0.092) and non-significant correlation was found between fat and TDMY. The negative correlation can be attributed to the dilution effect, where higher milk production is often associated with lower concentrations of fat due to increased secretion of milk volume. Similarly, Bekele et al. (2023) found negative association between fat and TDMY. The correlations of TDMY with lactose and protein were found to be negative and highly significant ($P<0.01$), with values of -0.131 and -0.192, respectively. Additionally, negative and non-significant correlation was found between TDMY and SNF and TS as -0.056 and -0.092, respectively. Similarly, several studies found a negative correlation between TDMY and various milk constituents (Ghule et al. 2016; Dora et al. 2020). These investigations suggest that selecting for higher milk production may lead to a decrease in the percentages of total solids, fat, protein and various other milk components. As a result, if milk composition is overlooked in selection programs focused on increasing milk yield, the quality of milk may decline. Therefore, developing a milk selection index that balances both milk yield and composition traits will be essential for improving both the quantity and quality of milk in dairy cows.

Correlation between fat with other milk constituents

A statistically significant and strong correlation ($P<0.01$) was observed between fat and various milk components such as protein (0.357), lactose (0.353), SNF (0.282), and total solids (0.890). The findings suggest that an increase in fat content tends to be associated with a rise in lactose, SNF, total solids (TS) and protein levels. Similar findings are reported by Yogi et al (2017) and Kro et al (2020) who observed positive and significant correlation. Bondan et al. (2018), Chandrakar et al (2017) also found a positive association between milk fat with protein and TS. So, selecting for higher fat content in Jersey crossbred cows will leads to simultaneous improvements in TS, SNF, protein, and lactose levels of milk.

Correlation between TS with protein, lactose and SNF

The correlation between TS with protein (0.506) was highly significant and positive ($P<0.01$). Similar findings were reported by Yogi et al (2017) also reported the positive and highly significant correlation between TS and protein. Correlation between TS and lactose (0.593) was highly significant and positive. Yogi et al (2017) also reported positive (0.304) and highly significant correlation between TS and lactose. Correlation between TS and SNF was (0.675) found to be positive and highly significant. Similarly, Chernet et al. (2024) reported a strong and statistically significant positive association between TS and SNF. A study on Gir cows demonstrated a correlation coefficient of 0.76 between TS and SNF, emphasizing that higher levels of SNF directly elevate TS, irrespective of fat content (Dora et al. 2020). Similarly, research on Anatolian buffaloes confirmed a significant positive relationship, indicating that SNF contributes consistently to TS across different lactation stages and environmental conditions (Şekerden and Avşar 2012). The positive and significant correlations observed between total solids and SNF, protein, and lactose are anticipated, as these components contribute to the overall total solids content.

Correlation between SNF with lactose and protein

The correlation between SNF and protein was positive (0.514) and highly significant ($P<0.01$). Likewise, the association between SNF and lactose was also positive (0.709) and highly significant

Table 1: Correlation of TDMY, milk constituents and somatic cell counts of Jersey crossbred cows

Parameter	TDMY	Fat	Protein	Lactose	SNF	TS	SCC
TDMY	1	-0.092	-0.192**	-0.131**	-0.056	-0.092	-0.233*
Fat		1	0.357**	0.353**	0.282**	0.890**	-
Protein			1	0.669**	0.514**	0.506**	-
Lactose				1	0.709**	0.593**	-
SNF					1	0.675**	-
TS						1	-
SCC							1

** Significant at <0.01; *Significant at <0.05

Table 2: Overall Means of various milk constituents (%), TDMY (kg/day) and Somatic Cell Count (x 10^5cell/ml)

Variable	N	Mean ± Std. Error	Standard Deviation
Fat	400	4.929 ± 0.032	0.641
SNF	400	8.051 ± 0.019	0.394
TS	400	12.983 ± 0.042	0.847
Protein	400	3.1905 ± 0.007	0.151
Lactose	400	4.425 ± 0.009	0.195
Test Day Milk Yield	400	10.571 ± 0.212	4.251
Somatic Cell Counts	400	1.3 ± 0.031	0.266

(P<0.01). It is desirable association indicates that selection for both traits can be practiced at the same time. Gautam et al. (2023) reported positive but non-significant correlation between SNF and protein. Chandrakar et al (2017) similarly found that the correlations of SNF with lactose (0.345) and protein (0.333) were both positive and highly significant (P<0.01), aligning with the results of the current study.

Correlation between protein and lactose

A significant positive correlation (0.669, P<0.01) was found between lactose and protein, suggesting that an increase in protein content may result in elevated lactose levels in milk. A similar finding was also found by Yogi et al (2017) and Henao-Velásquez et al (2014) reported significant and positive correlation between protein and lactose content. According to Alessio et al (2021) they also found positive association between lactose and protein in factor analysis. On contrary, Bondan et al (2018) observed negative correlation between milk protein and lactose. This divergence might be attributed to differences in genetic makeup, dietary factors, or environmental conditions affecting the dairy populations studied.

Correlation between somatic cell count (SCC) and test day milk yield (TDMY)

In the current study, a significant negative correlation (P<0.05) was observed between SCC and TDMY. Correlation coefficient was noted as -0.233. Similarly significant and negative correlation was reported by Ouedraogo et al (2008) and Bokharaeian et al. (2023). Research consistently demonstrates a negative association between SCC and milk yield. Contrary, Syridion et al (2012) reported non-significant association between SCC and TDMY. The elevated SCC causes decline in the milk quality of dairy animals (Safak and Risvanli 2023). Somatic cell count monitoring is advised in dairy farms on a frequent basis to keep an seye on changes.

Conclusion

The findings of this study highlight the significant associations between milk yield, SCC, and major milk constituents in Jersey crossbred cows. The study identified strong and significant positive correlations among milk constituents, such as protein, lactose, SNF, and TS, emphasizing their interdependence in determining milk quality. These findings suggest that while selecting for increased milk yield, care must be taken to maintain the balance of milk constituents to ensure high-quality production. This study underscores the importance of genetic and management strategies tailored to Jersey crossbred cows under Indian conditions.

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Conflict of interests

The authors declare that they have no conflict of interests.

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