ID: 772

Evaluation of milk quality parameters in first parity Holstein cows

Yağmur Yıldırım Kırış[1]*, Savaş Atasever[2]

[1] *Cattle Breeders Association, 5300, Merzifon-Amasya, Türkiye.*
[2] *Ondokuz Mayis University, Faculty of Agriculture, Department of Animal Science, 55139, Samsun, Türkiye.*

Abstract

Today, breeding objectives in cattle farms have shifted from focusing solely on milk production to also improving milk quality. In this context, this study aims to evaluate milk quality parameters in first parity Holstein cattle raised in farms enrolled to Amasya Province Breeding Cattle Breeders Association (CBA). Milk SCC, fat, protein, and lactose values of 108 cows within days 30 and 150 of their lactation were analyzed using an automated analyzer. Obtained values were evaluated using one-way analysis of variance (ANOVA) in three regions (Amasya-Center, Merzifon, and Suluova) and four calving seasons (Winter: December-February; Spring: March-May; Summer: June-August; and Fall: September-November). Milk fat and SCC values of cows that calved in the winter calving season, and the average SCC of samples from the Merzifon region, were found to be higher compared to other groups ($P<0.001$). The calculated negative correlations between SCC and lactose ($r=-0.323$) and fat ($r=-0.359$) revealed that these components, in addition to SCC, can also be used in determining raw milk quality. While fat (3.72±0.061%) and protein (3.48±0.015%) percentages of the milk samples were higher than the threshold declared by FAO, the lactose content (4.86±0.013%) was more consistent with the pronounced value. The calculated overall average SCC (419x103 cells/ml) was found to be quite close to the values reported by the Turkish Food Codex (TFC) and EU directives. It was suggested that adjustments should be made in milking hygiene, udder cleaning and milk storage conditions to further reduce this level.

Keywords: *Dairy cow, Somatic cell count, Milk components, Milk Quality*

Introduction

Breeding objectives have expanded beyond focusing solely on milk production to include a variety of characteristics such as reproduction, animal health, individual comfort, overall productivity, and improved milk quality. Since phenotyping some of these traits is generally difficult, costly, and time-consuming, indicators that are highly correlated with them and easier to measure have become more attractive in breeder selection. For instance, the fat/protein ratio of raw milk is assumed to be an evidence for negative energy balance and also ketosis case, while somatic cell count (SCC) is used to monitor udder health and susceptibility to mastitis. (Costa et al., 2020). Mastitis is classified into two forms, subclinical (latent) and clinical, depending on the severity of the infection. In the subclinical form, the infection remains hidden; no visible changes in the udder or milk are noticeable. Diagnosis of subclinical mastitis is made using laboratory tests such as determining the amount of SCC in the milk and bacterial count. In a healthy udder lobe, SCC is below 200x103 cells/ml, and values above this are considered indicative of abnormality and inflammation in the udder. (Querengässer et al., 2002). It is stated that increasing resistance to mastitis will improve animal welfare and lactation numbers, and in this context, a positive impact on the total milk production and profitability of the farm can be observed (Hu et al., 2021). High SCC not only negatively affects milk yield but also affects milk composition and quality (Cinar et al., 2015). It has been determined that young cows have lower SCC in their milk due to their relatively low milk production capabilities (Sharma et al., 2017). Furthermore, it has been reported that mammary gland immunity in cows in their first lactation is higher compared to cows that have given birth multiple times (Dang et al., 2014). In a study that determined the factors affecting mammary gland immunity in Holstein cows in their first lactation (Stadnik and Atasever, 2015), the average mammary gland immunity was determined to be 302x103 cells/ml, while the calving season was found to have an insignificant effect on mammary gland immunity. The researchers emphasize that mammary gland immunity data can be a reliable source in breeding selection and should be monitored throughout all periods of production.

In a study conducted to determine SCC and milk components in Holstein cattle (Çardak, 2016), correlations of 0.080, 0.216, and -0.951 were estimated between SCC and fat, protein, and lactose values in milk samples from cows in their first lactation, respectively.

Cattle raw milk contains emulsion-formed fat globules, colloidal and soluble proteins, and lactose in solution. Acidity, density, dry matter, fat, total protein, casein, serum protein, lactose, and mineral content are considered important parameters in evaluating raw milk quality (Sezgin et al., 2013). Milk fat, one of the indicators of raw milk quality, is synthesized in the cytoplasm of the alveolar secretory cell. In the first stage, short-chain fatty acids and carbohydrates are formed, followed by a significant portion of medium and long-chain fatty acids. Acetic acid acts as the main structural component in the synthesis of milk fat, and the synthesized milk fat is secreted into the alveolar lumen from the apical region of the alveolar secretory cell in the form of lipid droplets (Clegg et al., 2001). In addition, lactose content, another component among milk quality indicators, shows very little variation (Costa et al., 2020). In ruminants, the amount of glucose taken up from the blood by the udder is approximately 60-85% of the total blood glucose, and about 70% of this glucose is used in lactose synthesis. After synthesis, lactose is stored in the Golgi apparatus and controls the entry of water into the cell (Mert et al., 2020). It has been reported that the highest lactose concentrations are observed in cows calving for the first time, and a gradual decrease occurs in subsequent lactations. Researchers emphasize that the low level of variability in milk lactose content is due to physiological reasons and that lactose, the main compound determining milk osmolality, is subject to biological constraints (Costa et al., 2020). The fact that the fat, protein, and lactose percentages, which are used as quality indicators in raw cow's milk, show values close to 3.42%, 3.30%, and 4.87% respectively for Holstein cow's milk, allows for interpretations regarding the quality of the analyzed milk (FAO, 2025).

In a study conducted to determine the SCC and milk components in Holstein cattle raised in two farms in Germany (Çardak, 2016), the fat, protein, and lactose percentages in milk samples from first-lactation cows were determined as 4.06±0.04%, 3.27±0.02%, and 4.47±0.00%, respectively. The study estimated correlations of 0.437 and -0.101 between fat and protein and lactose, respectively; and -0.226 between protein and lactose. In the study by Davut and Atasever (2017) investigating the seasonal variation of SCC and milk components in raw cow milk, the fat, protein, and lactose levels of the analyzed milk samples were determined as 3.57±2.66%, 2.83±0.45%, and 3.85±0.61%, respectively. The highest numerical values for these components were obtained in milk samples collected in spring, winter, and summer, respectively, while a correlation of 0.141 and 0.125 was found between fat and protein and lactose, respectively; and a correlation of 0.979 was found between protein and lactose.

As seen, determination of different quality parameters of cow milk plays important role to achieve an elite herd in dairy farms. Therefore, the current study aims to determine the relationships between key quality indicators in milk samples obtained from frst parity Holstein cows raised in farms of Amasya province of Türkiye. .

Materials and Methods

Animal material: This study was conducted on Holstein cattle raised in farms that are members of the Cattle Brreders Association (CBA) of Amasya province, Türkiye. Since it was planned to include farms with a total number of milking cows of at least 100 head, the distribution of ther farms that met this condition is as follows: Merzifon: 4, Amasya-Center: 3, Suluova: 2 and Göynücek: 1. To facilitate statistical analysis, the farm in Göynücek, which has four cows and meets the necessary conditions, was included in the Amasya-Center group, the closest region in terms of distance, for the evaluation. In these farms, all milking cows in their first lactation and between days 30-150 of their lactation were determined as animal material (with the complete enumeration method). While 110 cows with these characteristics were selected as research material, the values of two animals with problematic records were excluded from the trial, so the present study was completed on a total of 108 cattle (Suluova: 22, Merzifon: 41 and Amasya: 45).

Providing data on milk quality parameters: Individual milk samples were collected from all animals included in the study in October 2024. The collected samples were transported within 24 hours in cold chain containers to the Çorum Provincial Directorate of Dairy Products and Animal Husbandry laboratory and subjected to SCC, protein, fat and lactose analysis with the CombiFoss 7 automated milk analyzer (FOSS Electric, Hillerød, Denmark) (the ISO/IDF approved device has the capacity to analyze 19 different parameters in the same sample in 7 seconds using flow cytometry technology).

Statistical analyses: The values of milk quality indicators were evaluated using one-way analysis of variance (ANOVA) in three regions (Amasya-Center, Merzifon, and Suluova) and four calving seasons (Winter: December-February; Spring: March-May; Summer: June-August; and Fall: September-November). Differences between parameters with three or more groups were determined using Duncan's multiple comparison method, and the linear model used is:

$$Yijk = \mu + ai + bj + eijk \qquad (1)$$

In the formula: Yijk: observed value, µ: population mean, ai: effect of the regions (i: 1,2,3), bj: effect of the calving season (j: 1,2,3,4) and eijk is the random error. Comparison of paired groups was performed using the t-test. Since the obtained SCC data showed wide variation, all SCC values were converted to log10SCC values in base 10 logarithm to ensure homogeneity and uniformity among the data. The relationships between milk quality indicators were estimated using Kendall's tau-b correlation analysis method. SPSS.17 software package was used for all statistical analyses, while Excel program was used for the preparation of the tables.

Results and Discussion

Descriptive statistics on milk components and SCC values in the study are presented in Table 1. According to FAO (2025), the ideal milk fat content for Holstein cows is defined as 3.41%, protein content as 3.30%, and lactose content as 4.87%. It can be stated that the fat and protein content of the analyzed milk samples were higher than these values, while the lactose content was more consistent with FAO data. A significant difference has been ontained between the lowest and highest SCC values. This difference is thought to stem from variations in hygiene, milking techniques, and care practices in the farms.

Table 2 shows the effect of calving season on milk fat, protein, lactose, and logSCC. Seasonal variation has had a significant effect on milk fat percentage. While the highest fat percentage was obtained in winter and spring during the study conducted by Tuncer et al. (2017), the findings of Davut and Atasever (2017) emphasize the prominence of the autumn season. In our study, the highest fat percentage in milk was observed in winter calving season, and this value was statistically different from other seasons. The higher fat content during the winter calving season is thought to be due to the need for more intensive care and feeding conditions, allowing farms to navigate the winter months more smoothly. Milk fat percentages are similar in spring, summer, and autumn, with no statistically significant differences found between them. No statistically significant differences were found in protein and lactose percentages depending on the season. The study conducted by Tuncer et al. (2017) also determined that protein ratios did not show seasonal variation. In contrast, Kul et al. (2019) reported that protein and lactose ratios were lowest levels in the spring season. Regarding LogSCC values (Table 2), a statistically significant difference was found between the calving seasons ($P<0.001$). The highest logSCC mean was observed in the winter, while lower values were obtained in the spring, summer, and autumn calving seasons, respectively. This result suggests that an increase in SCC values may be observed during winter months due to exposure of the udder to environmental contamination (dirty bedding, manure, urine) caused by adverse weather conditions, negatively affecting udder health. Kul et al. (2019) also found the highest SCC levels in cows calving in winter. Çoban et al. (2007) reported that the increase in SCC in milk during winter is due to the fact that dairy cows cannot obtain sufficient vitamin A, which has epithelial protective properties, from pasture in summer. These findings indicate that calving season should be considered among the factors affecting milk quality. Winter is particularly prominent in terms of milk fat percentage and SCC.

Table 3 shows the variation of milk components and logSCC values according to different regions. No significant difference was found between regions in terms of fat content. The average milk fat percentages were determined as 3.69±0.054%, 3.73±0.150%, and 3.75±0.054% in Amasya-Center, Merzifon, and Suluova regions, respectively, and the overall average was calculated as 3.72±0.061%. This value is above the value predicted by FAO (2025).

Table 1. Descriptors of the parameters

Parameter	*n*	*Min*	*Max*	$\bar{x} \pm s_x$
Fat	108	2.05	6.28	3.72 ± 0.061
Protein	108	3.06	4.18	3.48 ± 0.015
Lactose	108	4.41	5.06	4.86 ± 0.013
SCC	108	27000	1178000	419259.25 ± 28020.619
LogSCC	108	4.43	6.07	5.53 ± 0.027

Table 2. Milk components (%) and logSCC means according to calving season

Calving season	n	Fat (%)	Protein (%)	Lactose (%)	LogSCC($\bar{x} \pm s_x$)
Winter	26	4.09 ± 0.189^{b}	3.54±0.043	4.86±0.025	5.82 ± 0.049^{B}
Spring	8	3.45 ± 0.172^{a}	3.46±0.066	4.89±0.075	5.40 ± 0.106^{A}
Summer	59	3.64 ± 0.059^{a}	3.46±0.016	4.87±0.016	5.42 ± 0.30^{A}
Fall	15	3.49 ± 0.96^{a}	3.45±0.034	4.79±0.040	5.49 ± 0.041^{A}
Overall	108	3.72±0.061	3.48±0.015	4.86±0.013	5.53±0.027

Means indicated by different letters in the same column are different (^{a,b}: $P<0.05$; ^{A,B}: $P<0.001$)

Table 3. Milk components and logSCC values by regions

Region	*n*	*Fat (%)*	*Protein (%)*	*Lactose (%)*	*LogSCC* ($\bar{x} \pm s_x$)
Amasya-Center	45	3.69±0.054	3.48±0.009	4.87±0.017	5.42 ± 0.012^{A}
Merzifon	41	3.73±0.150	3.49±0.037	4.82±0.022	5.68 ± 0.053^{B}
Suluova	22	3.75±0.054	3.46±0.021	4.89±0.035	5.44 ± 0.047^{A}
Genel	108	3.72±0.061	3.48±0.015	4.86±0.013	5.53±0.027

Means indicated by different letters in the same column are different (^{A,B}: $P<0.001$)

Table 4. Correlation coefficients among the parameters

Parameter	*Protein*	*Lactose*	*LogSCC*
Fat	-0.043	0.006	-0.359**
Protein		0.022	-0.017
Lactose			-0.323**

There was no statistically significant difference between regions in terms of protein and lactose content (P>0.001). Protein content ranged approximately 3.46–3.49% in all regions, while lactose content ranged 4.82–4.89%. This indicates that milk components are not significantly affected by regional factors. However, the calculated values for protein were higher than those reported by FAO (2025), and the calculated values for lactose were quite close to the rate that reported.

The average SCC calculated in this study is within the 400x103 cells/ml limit reported by the Turkish Food Codex (TFC), but is lower (Atasever et al., 2012; Keskin and Atasever, 2013) or similar (Davut and Atasever, 2017; Önal et al., 2021) with some previous research results conducted under Türkiye conditions. According to Table 3, a high level of statistical difference was found between regions in terms of logCC values (P<0.001). The highest logSCC value was observed in the Merzifon region, which is statistically significantly higher compared to the Amasya Center and Suluova regions. This case suggests that the samples were taken from different farms in the Merzifon region compared to other regions, or that udder health problems may be more prevalent there. Consequently, no significant differences were observed between regions in terms of milk components. However, it is assessed that additional measures should be taken to improve udder health management and hygiene conditions in the region with high SCC values.

The relationships between milk components and logSCC were evaluated, and the obtained correlation coefficients are presented in Table 4.

Milk fat percentage shows a negative and significant correlation with logSCC. This indicates that SCC decreases as milk fat percentage increases. Similarly, lactose percentage also shows a negative and significant relationship with logSCC; this supports the idea that lactose may decrease in cases of mastitis. Furthermore, the inverse relationship between fat and lactose percentages in milk components and logSCC suggests that these parameters are important indicators of udder health..

Conclusion

In this study, which determined the effects of calving season on milk quality parameters in Holstein cattle, no significant effect was found on milk protein content, while milk fat and SCC values were higher in calves calving in winter. The average SCC of samples collected from Merzifon was found to be higher than that from other regions. Furthermore, the negative correlations calculated between SCC and lactose (r=-0.323) and fat (r=-0.359) indicate that, in addition to SCC, lactose and fat levels can also be reliably evaluated in determining raw milk quality.

In the general evaluation, the calculated average SCC was quite close to the limit reported by the TFC; the average lactose content was close to the recommended value for Holstein cow milk reported by FAO (2025); and the fat and protein ratios were found to be higher. It is thought that making adjustments to milking hygiene, udder cleaning, and milk storage conditions would be beneficial in order to further reduce SCC in the farms included in the present study.

Declarations

Ethical approval: This study did not require ethical approval since Animal Experiments Ethics Committee (HAYDEK) in Türkiye excludes milk sampling process from the approval necessities..However, the research proposal was approved by Institute of Natural Science of University of Ondokuz Mayis, Samsun,Türkiye (Decision No: 2016/772) prior to the field work.

Author Contribution Statement

Y.Y.K.: collecting data, constructing tables and writing initial manuscript; S. A.: planning the study, statistical analyses and finalization of the article.

Fund Statement

No funding was received.

Conflict of Interest

Authors declare that there is no conflict of interest.

Acknowledgments

The paper was designed from the MSc. thesis of the first author. The authors acknowledge the staff of CBA on obtaining data for the current study.

References

Atasever, S., Erdem, H., & Demiryurek, K. (2012). Association of some milking parameters with milk quality of smallholder dairy farms in Samsun region, Turkey. Journal of Environmental Biology, 33(1), 123. PMID: 23033654.

Atasever, S., Tóth, V., & Jónás, E. M. (2020). Factors affecting mastitis cases and the correlations of somatic cell count with milk production in Holstein cows. TURJAF, 8(1), 171-173. https://doi.org/10.24925/turjaf.v8i1.171-173.2937

Cinar, M., Serbester, U., Ceyhan, A., & Gorgulu, M. (2015). Effect of somatic cell count on milk yield and composition of first and second lactation dairy cows. Italian Journal of Animal Science, 14(1), 3646. https://doi.org/10.4081/ijas.2015.3646

Clegg, R. A., Barber, M. C., Pooley, L., Ernens, I., Larondelle, Y., & Travers, M. T. (2001). Milk fat synthesis and secretion: molecular and cellular aspects. Livestock Production Science, 70(1-2), 3-14. https://doi.org/10.1016/S0301-6226(01)00194-4

Costa, A., Bovenhuis, H., & Penasa, M. (2020). Changes in milk lactose content as indicators for longevity and udder health in Holstein cows. Journal of Dairy Science, 103(12), 11574-11584. https://doi.org/10.3168/jds.2020-18615

Çardak, A. D. (2016). Effects of somatic cell count, parity and lactation stage on yield and components of milk in Holstein-Friesian cows. Harran University Journal of the Faculty of Veterinary Medicine, 5(1), 34-39. https://izlik.org/JA98DR72FY

Coban, Ö., Sabuncuoğlu, N., & Tüzemen, N. (2007). Effect of various factors on Somatic Cell Counts in Brown Swiss and Holstein Friesian cows. Livestock Studies. 47, 15-20.

Dang, A. K., Mukherjee, J. O. Y. D. I. P., Chaudhury, M., Shiv, P., Mohanty, A. K., Kapila, S. U. M. A. N., & Kapila, R. (2014). In vitro phagocytic activity of blood and milk neutrophils against Saccharomyces cerevisiae in primiparous and multiparous Karan Fries crossbred cows throughout the dry period and lactation cycle. Indian Journal of Animal Science, 84, 262-266. https://doi.org/10.56093/ijans.v84i3.38700

Davut, M., & Atasever, S. (2017). Seasonal changes of composition and somatic cell count of bucket milk from Jersey crossbred cows in Northern Turkey. 11th International Symposium Modern Trends in Livestock Production, October 11-13, Belgrade, Serbia.

FAO. (2025). Importance, technology and economics of traditional milk products. https://www.fao.org/4/t0251e/t0251e01.htm

Hu, H., Mu, T., Ma, Y., Wang, X., & Ma, Y. (2021). Analysis of longevity traits in Holstein cattle: A review. Frontiers in Genetics, 12, 695543. https://doi.org/10.3389/fgene.2021.695543

Keskin, A., & Atasever, S. (2013). Somatic cell count of bovine bucket milk: a study from Turkey. IJCMAS, 2(9), 98-102.

Kul, E., Şahin, A., Atasever, S., Uğurlutepe, E., & Soydaner, M. (2019). The effects of somatic cell count on milk yield and milk composition in Holstein cows. Veterinarski Arhiv, 89(2), 143-154. https://dx.doi.org/10.24099/vet.arhiv.0168

Mert, İ., N. Artık, G. Dellal, T. Şireli, T. (2020). Süt Kalitesi ve Süt-Sağlık İlişkisi. Ulusal Süt Konseyi Raporu, Ankara, Türkiye. 56 s. (in Turkish)

Önal, A. R., Özkan, M., & Tuna, Y. T. (2021). The effects of season and lactation number on the composition and quality of Holstein cattle raw milk. Journal of Tekirdag Agricultural Faculty, 18(2), 368-374.

Querengässer, J., Geishauser, T., Querengässer, K., Fehlings, K., & Bruckmaier, R. (2002). Investigations of milk quality from teats with milk flow disorders. Journal of Dairy Science, 85(10), 2582-2588. https://doi.org/10.3168/jds.S0022-0302(02)74342-7

Sezgin, E., M. Atamer, C. Koçak, A. Yetişemiyen, A. Gürsel, A. Gürsoy. (2013). Süt Teknolojisi. Ankara Üniv. Ziraat Fak. Yayın No: 1560, 298 s. (in Turkish).

Sharma, T., Das, P. K., Ghosh, P. R., Banerjee, D., & Mukherjee, J. (2017). Association between udder morphology and in vitro activity of milk leukocytes in high yielding crossbred cows. Veterinary World, 10(3), 342. https://doi.org/10.14202/vetworld.2017.342-347

Stádník, L., & Atasever, S. (2015). Influence of some environmental factors on body condition score and somatic cell count in Czech Holstein cows. Indian Journal of Animal Research, 51(4): 771-775. https://doi.org/10.18805/ijar.5921

Tuncer, K., Kul, E., & Şahin, A. (2017). Determination of some quality characteristics of raw milk samples collected from dairy farms in TR71 region. Mediterranean Agricultural Sciences, 30(1), 65-69. https://izlik.org/JA92NC79YB