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CHANGES IN THE PHYSICOCHEMICAL COMPOSITION OF RAW MILK AS A RESULT OF INCREASED SOMATIC CELL COUNT

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Abstract: This study aimed to assess the impact of an elevated somatic cell count (SCC)—a key indicator of udder health and milk quality—on the physicochemical composition of 4,287 raw cow milk samples collected from three dairies. As SCC levels increased, significant changes were observed in lactose and protein content, freezing point, and solids non-fat, with lactose exhibiting the most pronounced variations. These findings highlight the direct influence of SCC on milk composition, reinforcing the importance of strict hygiene practices in dairy farms to ensure optimal milk quality and safety.

Keywords: raw milk, physicochemical composition, somatic cell count, milk quality

Introduction

Milk, a biological fluid produced by the mammary glands of female mammals, boasts a complex composition containing essential elements crucial for human health, that comprises mainly water (>80%), milk fat, proteins, lactose, vitamins, minerals and active components, important for human health and source of energy (Asefa and Teshome, 2019). Given that milk originates in the mammary gland of animals, ensuring its quality inherently hinges on the health and welfare of the animal. Factors such as inadequate nutrition, improper storage, hereditary or acquired diseases, and various infections can notably impact both the quality of milk and derived dairy products (Ezzat Alnakip et al., 2014). The somatic cell count proves valuable as a predictor of intramammary infection, thus playing a pivotal role in evaluating various aspects of milk quality, hygiene, and mastitis control (Sharma et al., 2011).

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Monitoring the total bacteria count (TBC) and SCC is important for determining both the hygienic practices during milking and the health status of the mammary gland in lactating cows (Belage et al., 2017). The milk in Republic of Macedonia is classified and valuated in three classes, according to the total number of bacteria and total number of somatic cells (Table 1):

Table 1: Classification of milk according to the TBC and SCC (Republic of Macedonia Food Safety Agency, 2011)

Classes	TBC (CFU/mL)	SCC (SCC/mL)
Extra class	≤ 100.000	≤ 400.000
I class	100.001-700.000	400.001-500.000
II class	700.001-1.500.000	500.001-600.000

This study aimed to investigate how variations in SCC levels influence the composition and certain chemical properties of milk, thereby impacting both milk itself and derived milk products.

Materials and methods

The research was conducted in three dairies from the Bitola region. Raw milk, sourced individually from each milk producer and intended for processing in these dairies, served as the primary test material. The samples that were examined were taken as part of the official control of dairies to monitor the quality of raw milk. The sampling of the milk from the milk producers was carried out by the dairies, and transported to the laboratory in portable refrigerators at a temperature of up to 7°C. The milk samples for the microbiological tests were preserved with Broad Spectrum Microtabs, while for the physicochemical analyses the raw milk came to the laboratory fresh in a chilled state without added preservatives. All analyses were conducted in an accredited laboratory, according to the standard ISO/IEC 17025: Testing and calibration laboratories, using accredited methods for each parameter.

The number of somatic cells in milk was determined using Somacount FCM (Bentley Instruments), according to the standard MKC EN ISO 13366-2:2010. The chemical analysis of raw milk was conducted according to the standard MKC ISO 9622 IDF 141C:2013, with LACTOSCOPE C4+ (Advanced Instruments), which performs the analyses using infrared spectrometry. The examination of the freezing point, to determine the added water in the milk, was carried out in accordance with the standard MKC EN ISO 5764: 2010 with the thermistor

Cryoscope 4250 Advanced instruments. The results were analyzed using standard statistical methods, including descriptive parameters (mean, standard deviation, maximum, and minimum values), Student's t-test for statistical significance ($p<0.05$) between milk categories, correlation analysis, and presented in tables, with data processed using Microsoft Office Excel and SPSS 20.

Results and discussion

Table 2 shows the average values of the 4,287 samples of raw milk analysed. The average values for the physicochemical characteristics of milk are at a satisfactory level. Namely, the percentage of milk fat is on average 3.86%, proteins 3.32%, lactose 4.32% and solids non-fat (SNF) is 8.51%. At the same time, the standard deviation is at a low level, which indicates that throughout the year there were no large variations in the concentration of these parameters. The number of somatic cells is slightly above the allowed values specified in the Regulation (Off.Gazette No.151/2011), ie. 488 x 10^3 SCC/mL, and with a higher level of variation (SD=603).

Table 2: Descriptive statistics

Variables	Minimum	Average	Median	Maximum	SD
Fat content (%)	2.30	3.86	3.82	5.60	0.64
Protein content (%)	2.04	3.32	3.29	5.83	0.32
Lactose content (%)	2.43	4.32	4.34	5.43	0.24
SNF (%)	6.95	8.51	8.54	10.68	0.41
Freezing point (m°C)	-0.615	-0.532.28	-0.527	-0.406	38.63
SCC/mL x 10^3	1	488	835	7169	603

According to the results shown in Table 3, it can be noted that the percentage of milk fat ranges from 3.86% to 3.88%. As with fat, no statistical significance was observed between the studied categories of somatic cells ($p>0.05$) for protein and freezing point, though it was seen that when the SCC increased, the fat and protein content also increased. Cinar et al. (2015), also found positive correlations between SCC and total solids, fat and protein content, but with no statistical difference observed. The findings for the correlation of SCC and total fat content are inconclusive and conflicting; some studies indicate increased activity (Rajcevic et al., 2003), while others suggest a decrease (Wickström et al., 2009; Alhussien et al., 2016), or no significant differences (Cinar et al., 2015; Safak et al., 2022).

Most of the research shows that there are changes in the composition of proteins in mastitic milk, that is, there is an increase in the content of whey proteins, and on the other hand, a decrease in α- and β-casein. These changes may be the result of the regulation by the genes responsible for lactation, and in response to the infection, they may be due to the induced hydrolysis of milk proteins, which was determined by Le Maréchal et al. (2011) during an increase in the number of somatic cells as in both clinical and subclinical mastitis.

The percentage of lactose changes significantly ($p<0.05$) when the number of somatic cells increases. In the first defined class according to the number of somatic cells, lactose is 4.35% and that number gradually decreases reaching a value of 4.26% in the third defined category according to the number of somatic cells ($p<0.05$). Similar results have also been found by many authors (Wickström et al., 2009; Alhussien et al., 2016; Seferi and Idrizi, 2023). It is considered that milk containing less than 4.5% lactose originates from a diseased udder, affected by the inflammatory process. In this way, a smaller amount of blood flows through the mammary gland, and with-it glucose, which is one of the precursors in the synthesis of lactose (Antunac et al., 1997).

Including that, in the case of SNF, the lowest values (8.48% ($p<0.05$)) were observed in the third defined class. Statistically significant differences were not noted only with the second defined class according to the number of somatic cells ($p>0.05$). Similarly to our results, Silva et al. (2018), also found positive correlation with SCC and significant differences.

Table 3: Changes in the physicochemical composition

N	Class	Fat content (%)	Protein content (%)	Lactose content (%)	SNF (%)	Freezing point (m°C)
2716	Extra	3.86±0.65	3.31±0.32	4.35±0.23^{a}	8.53±0.39^{a}	-0.530.2±44.91
499	I	3.86±0.54	3.34±0.29	4.34±0.22^{b}	8.55±0.35	-0.528.8±2.41
1072	II	3.88±0.37	3.35±0.32	4.26±0.24^{c}	8.48±0.39^{b}	-0.532.7± 32.92

*Differences of values with different superscripts in the same column are statistically significant at the level: a:b, a:c, b:c, $p<0.05$

Implementing proper disinfection solutions, ensuring correct udder preparation, maintaining milking equipment, and upholding general hygiene practices on the farm are essential management practices for improving milk quality and reducing the occurrence of mastitis (Trajkovska et al., 2015). Additionally, like Kosovo, the dairy industry in Macedonia faces challenges with the quality of raw milk, including high SCC and total bacteria count, indicating the need for alignment with EU milk quality standards to enhance competitiveness in the market and ensure the production of high-quality dairy products (Kadriu and Trajkovska, 2023).

Conclusion

This study examines the relationship between (SCC) and different physicochemical parameters in raw cow milk. Our findings suggest that SCC influences alterations in milk composition, particularly evident in lactose content ($p < 0.05$) but not in milk fat content ($p > 0.05$). Additionally, variations in proteins, freezing point, and SNF were observed with increasing SCC. While SCC, often used as an indicator of mastitis severity and milk composition changes, exhibits correlations, they are not absolute due to the influence of other factors. Thus, controlling milk quality at the farm level is crucial for ensuring the production of high-quality dairy products for consumption.

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