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INFLUENCE OF SOMATIC CELL COUNT IN RAW MILK ON THE QUALITY OF BEATEN CHEESE

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Abstract: *The somatic cells count (SCC) is an important indicator of the hygienic condition of milk. In general, any increase is due to infection of the mammary gland with mastitis, which causes a series of unwanted changes in milk composition and dairy products, respectively.*
The objective of our research was to determine the impact of somatic cell count on physic-chemical parameters (proteins, fats, moisture, dry matter, salt, and titration acidity), yield and sensory evaluation of beaten cheese. The research was conducted over a period of one year on milk processing capacity in the Pelagonia region. A total of 24 samples of raw bulk milk were analyzed, which depending on the somatic cells count were divided into two categories (SCC≤400.000/mL and SCC≥400.001/mL). Accordingly, raw bulk milks were used for production of beaten cheese.
The results obtained from the conducted research indicate the fact that the changes in the somatic cells count have a significant impact on the physico-chemical parameters, yield and sensory scores on beaten cheese. High SCC above 400.001/mL reduced the percentage of protein, fat, yield and the average sensory score of the beaten cheese.

Keywords*: dairy, physic-chemical parameters, SCC, yield*

1. Introduction

Beaten cheese is an autochthonous dairy product on the territory of the Republic of Macedonia which originates from the area of Mariovo and was previously made from sheep's milk [1]. Today, it is made in industrial conditions and from cow's milk [2]. In general, the composition and properties of beaten cheese are conditioned by the composition of the milk and the production process [3]. The nutritional characteristics of beaten cheese depend on the nutritional quality of the raw milk from which it is obtained [4] i.e., proteins and fats are largely transferred to the cheese. While the other parameters (percentage of salt, dry matter, moisture and titratable acidity) are individual and depend on the production process [2].

According to the [5], the milk intended for production of beaten cheese from a physico-chemical aspect should contain 12.5% dry matter, pH = 6.4-6.6 and °SH = 6.6-7.2, while in relation to hygienic condition SCC≤400.000/mL and CFU≤100.000/mL.
The objective of this research was to evaluate the influence of SCC of raw milk in cheese yield, sensory evaluation, and physicochemical parameters.

2. Materials and methods

The research was conducted over a period of one year, in a dairy processing capacity in the Pelagonija region. A total of 24 samples of raw bulk milks were analyzed. Also, from every batch was obtained beaten cheese.

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Milk samples were taken from bulk tank for determination of SCC which was previously conserved with bronopol (Broad Spectrum Microtabs II preservative) as preservative in a 40 mL collecting bottle. Samples were cold transported and stored under refrigeration (4 °C ± 1 °C). The analyses were performed on the same day. Total SCC was analyzed on the LACTOSCAN SCC apparatus (Nova Zagora, Bulgaria).

Milk samples were divided into two categories according to SCC, namely: I category where SCC≤400.000/mL and II category where SCC≥400.001/mL. So, we analyzed two different groups of beaten cheese - Group 1 cheese obtained from raw milk with SCC≤400.000/mL, and Group 2 cheese obtained from raw milk with SCC≥400.001/mL.

The samples for analysis of beaten cheese (50g) were taken on the 18th day of production, placed in plastic cups, and transported to the laboratory where analyzes were performed. The determination of the percentage of proteins was done by the method of Kjeldahl, while the percentage of fats was determined by the method of Gerber. The titration acidity was determined by the method of Soxhlet Henkel. The percentage of NaCl was determined by the Mohr method. Mettler Toledo MJ33 (Greifensee, Switzerland) was used to determine the percentage of moisture and dry matter. All chemical analyzes were performed according to the methods presented in [6].

The yield of the beaten cheese was calculated according to the following formula:

$$yield = 100 : \frac{liters\ (l)\ milk}{kilograms\ (kg)\ cheese}$$

where the result tells us how many kilograms of cheese are obtained from 100 liters milk [7].

For sensory analysis of beaten cheese the scoring method was used. Panels of 30 untrained panelist from the staff and students of the Faculty of Biotechnical Sciences who are familiar with beaten cheese were included in this evaluation. The qualitative parameters of the beaten cheese that were evaluated are color (1), taste (9), smell (5), texture (2) and appearance (3). Additionally, the scores for the individual characteristics of the examined products were corrected with the "weight coefficient" (as a quantitative expression of the total product quality) [8] and their sum was expressed as a percentage - "% of the maximum possible quality". When this value is divided by the sum of the weight coefficient (Σ = 20), a weighted average value is obtained, i.e., a weighted grade. The obtained results are presented graphically (in the form of a spider web).

Microsoft Office Excel, (Microsoft Office Corporation, USA) and SPSS 20 were used for statistical analysis of the data. The results were expressed in form of the mean ± SD (Standard Deviation). Two-way ANOVA was conducted to test if there was a significant difference between groups and $p<0.05$ was taken to be significant.

3. Results and discussion

In general, infection of the mammary gland with mastitis results in a decrease in milk synthesis and qualitative and quantitative changes in milk composition followed by changes in the ratio of proteins (decrease in casein and increase in whey protein), decrease in fats and lactose and increase in enzyme activity [9]. According to [10] when SCC≤600.000/mL, the percentage of proteins is 3.27% and fats 4.21% and it continuously decreases to 3.19% and 4.11% when SCC≤1.000.000/mL, i.e. 3.14% and 3.99% when SCC≥1.000.000/mL. Additionally, because proteins and fats are largely transferred to cheese [3] these negative changes further lead to qualitative and quantitative changes

in the physico-chemical composition of cheese, yield and sensory scores [11;12] because of starter culture activity, coagulation time and thermostability of milk [10].

As a result of the increase of SCC in II category in raw milk there is a decrease in the percentage of proteins and fats content in cheese obtained from Group 2 (Table 1). When SCC≤400.000/mL the percentage of proteins is 25.83%, and of fats 33.60% and it is respectively reduced to 25.10% and 33.06% when SCC≥400.001/mL. Similar results were presented by [4]. According to [13] when SCC≤200.000/mL the percentage of proteins is 22.6%, and of fats 30%, while when SCC≥600.000/mL they are reduced to 21.8% and 29%, respectively. Additionally, because of the increase in the SCC (SCC≥400.001/mL), an increase in the percentage of moisture was observed. The percentage of moisture in Group 1 is 41.79% and it increases to 42.93% in Group 2, which according to [12] is a result of increasing the water holding capacity (WHC) and a shorter coagulation period.

Table 1

Physico-chemical changes in beaten cheese as a result of the increased number of SCC ±SD

Cheese parameters	Proteins (%)	Fats (%)	Moisture (%)	Dry matter (%)	Salt (g)	Titration acidity (°SH)
Group 1 (N=9)	25.83±2.46	33.60±0.17	41.79±4.49	58.21±0.78	6.33±0.55	58.83±2.07
Group 2 (N=15)	25.10±3.25	33.06±1.77	42.93±1.69	57.07±0.98	6.54±0.34	58.13±3.58

According to the results obtained from this research (Table 2) where beaten cheeses are produced under the same technological conditions, the yield is more favorable in Group 1. Namely the yield in Group 1 is 9.69 kg, while in Group 2 is 9.58kg. This only confirms the fact that the cheese yield is conditioned by the quality of the milk [3;9] and according to [12] it decreases from 1% to 4% depending on SCC. According to [11] who performed the analysis on Parmigiano Reggiano cheese, when the SCC ≤ 400.000/mL yield is 7.39 kg, while when SCC ≥ 400.001/mL is 6.74 kg. Additionally, according to the presented data of [12] when the SCC increases from 240,000/mL to 640,000/mL the yield decreases by 3.26%. While, according to [9] when they produced white brine cheese from the raw milk with the SCC≤600.000/mL, the yield is 17.64 kg and it continuously decreases to 15.89 kg when SCC≤1.000.000/mL and 14.79 kg when SCC≥1.000.000/mL. In accordance with this, which refers to different types of cheeses, it is important to note that the increase in the SCC leads to a decrease in their yield. Additionally, the yield of cheeses is influenced by the production process, added culture, salt and moisture loss during the ripening process [2].

Table 2

Changes in yield as a result of increasing total SCC

SCC/ml	Average amount of daily processed milk (*l*)	Average daily production of cheese *(kg)*	Yield (*kg*)
SCC≤ 400.000/mL	1601.07	155.07	9.69
SCC≥ 400.001/mL	1477.17	141.45	9.58

Parallel to the increase in the SCC in raw milk (SCC≥400.001/mL) decrease in the average sensory scores of the analyzed properties of the beaten cheese (Graph 1)

was observed. The increase in the SCC (SCC≥400.001/mL) has the most pronounced effect on the texture of the beaten cheese, i.e. when SCC≤400.000/mL the average sensory score for this parameter is 4.73 and it is reduced when SCC≥400.001/mL (4.23). Similar findings were presented by [4]. The obtained results show that beaten cheese produced from milk in which SCC≤400.000/mL would be better placed on the market because the appearance is an indicator of quality that the consumer uses to accept or reject the product [14]. Increasing the SCC (SCC≥400.001/mL) leads to unwanted changes in appearance [12]. While, the color, taste and smell as sensory properties of beaten cheese, primarily depend on the evaluator [15] and on these parameters the increased number of somatic cells (SCC≥400.001/mL) has no pronounced influence (Graph 1). Additionally, when SCC≤400.000/mL the weighted average value is 4.35 while the percentage of maximum possible quality is 87.09% and 4.23 and 84.64% respectively, when SCC≥400.001/mL.

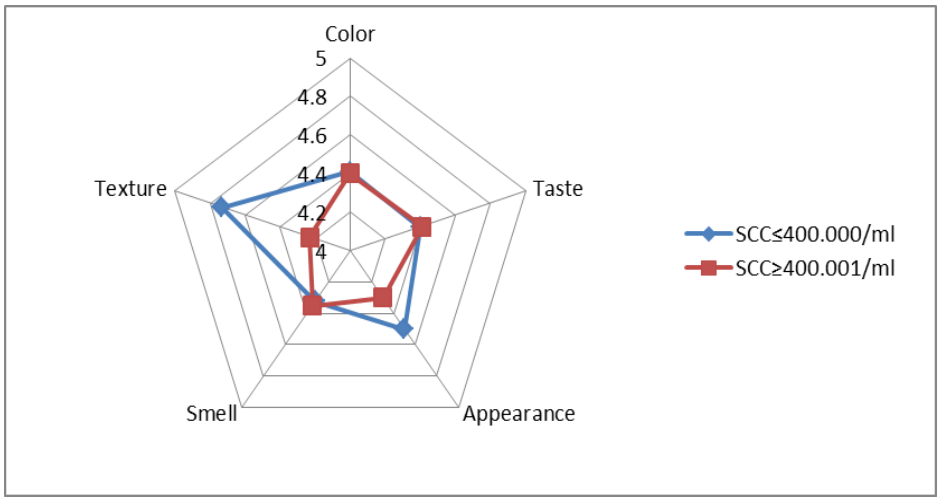

Fig. 1. Sensory analysis of the obtained beaten cheeses

In general, an increase in the SCC (SCC≤400.000/mL) leads to unwanted changes in the physico-chemical composition, reduced yield and lower sensory scores which increase production costs and reduce the profit of milk processing capacities [13]. In addition, in our study no statistically significant differences were found between physico-chemical and sensory characteristics in the groups beaten cheese obtained when SCC≤400.000/mL (Group 1) and when SCC≥400.001/mL (Group 2) which may be due to the smaller number of analyzed samples.

4. Conclusion

Changes in the SCC result with some differences between analyzed groups. On the other hand, there were no statistically significant differences in the parameters from groups 1 and 2 ($p<0.05$) on the physico-chemical composition of industrially obtained beaten cheese. That is, with the increase of the SCC (SCC≥400.001/mL) the percentage of proteins in the beaten cheese decreased from 25.83% to 25.10%, while the percentage of fats decreased from 33.60% of 33.06%. There was also an increase in

the percentage of moisture from 41.79% to 42.93%.

No significant changes were observed in salt and titration acidity. As the SCC increases, the yield decreases from 9.69kg to 9.58kg. Additionally, as a result of the increased number of somatic cells (SCC≥400.001/mL) there is a decrease in the average sensory score for texture from 4.73 to 4.23, and consequently to the percentage of maximum possible quality of 87.09% to 84.64%. No significant changes were found in the other sensory properties analyzed.

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