IMPAKT OF THE NUMBER OF SOMATIC CELLS ON MILK QUALITY

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Abstract: *One of the indicators of the hygienic quality of milk is the number of somatic cells, which is an internationally recognized parameter for the health condition of the udder. The increased number of somatic cells over 400.000/ml causes changes in the secretion and the chemical composition of the milk. In this research, based on the number of somatic cells, the milk is categorized in three categories. In milk from the first category the average number of somatic cells equals 444.780/ml, 825.560/ml in the second and 1,242.220/ml in the third category. In milk from the first category the average contents of milk fat, proteins, lactose, dry matter, casein and whey proteins are 4.206%, 3.268%, 4.723%, 12.127%, 2.910%, 0.8610% respectively. In the second category 4.106%, 3.192%, 4.349%, 11.647%, 2.665%, 0.9680%, and 3.989%, 3.139%, 3.964%, 11.092%, 2.386%, 1.1820% in milk from the third category. The pH value of milk in the first, second and third category is 6.627, 6.799 and 6.897 respectively. Between the three categories of milk, significant differences, at the level of ($p < 0.01$), are determined in the number of somatic cells and average contents of milk components. A positive correlation in all three milk categories exists between somatic cells and the whey proteins, and a negative correlating dependency exists between the other chemical parameters and somatic cells.*

Keywords: *milk, quality, chemical composition, somatic cells.*

1. INTRODUCTION

The quality of raw milk intended for processing is determined by the physico-chemical and hygienic properties. Somatic cells are a basic indicator for the hygienic quality of milk and for the health condition of the udder, which as biological structural elements of milk pass through during the normal secretory process. An increase in the number of somatic cells occurs with intramammary bacterial infection, which leads to a change of milk quality, i.e. in the secretion of milk, accompanied with qualitative and quantitative changes in the milk components, which mainly concern the reduction of the milk fat content, lactose and casein, and the increase of whey proteins [6, 7]. Changes in composition and physico-chemical properties of milk are correlated with the number of somatic cells [5]. According to [10], the variation in the compositions and properties of raw milk affects certain technological operations in milk processing that reflect the composition, properties, quality and yield of the dairy products.

2. MATERIAL AND METHODS OF WORK

For this research, cow's milk from farms in the Kichevo region was used. The determination of the number of somatic cells and analysis of the physico-chemical composition was performed on samples from the aggregate milk.

The analysis of the chemical composition of the milk which determines the content of fat, protein, lactose and dry matter, was done with Milkoscan infrared analyzer according to the IDF 141C:2000 standard, while determining the proportion of casein and whey protein was performed according to the Kjeldahl method according to the AOAS standard, 1995. The pH value of the milk was measured with pH meter - Mettler Toledo. The number of somatic cells was determined with a fluoro-optic electronic counter - Fossomatic 5000.

Milk - enumeration of somatic cells according to standard ISO 13366/2:2006. The principle of operation of Fossomatic 5000 consists of coloring and electronic counting of the somatic cells. According to the number of somatic cells the milk was categorized in three categories: first category milk with up to 600.000/ml somatic cells, second category milk from 600.000-1.000.000/ml somatic cells and third category milk with above 1.000.000/ml somatic cells.

3. RESULTS AND DISCUSSION

The average number of somatic cells in the milk is shown in Table 1.

Table 1. Average number of somatic cells in the milk from first, second and third category

Indicators	$\bar{x}$	Sd	min	Max	Cv (%)
first category	444.780	84.735	339.000	586.000	19.051
second category	825.560	89.208	690.000	972.000	10.806
third category	1.242.220	47.232	1.172.000	1.306.000	3.802

From the results presented in Table 1 it is noted that average the number of somatic cells in the milk from the first category is 444.780 (min.339.000 up to max.586.000), 825.560 (min.690.000 up to max.972.000) in the milk from the second category and in the milk from the third category the number of somatic cells is 1.242.220 (min.1.172.000 up to max.1.306.000).

The results for the active acidity (pH) of milk from the three categories is presented in Table 2.

Table 2. Average pH values of the milk from the three categories

Indicators	$\bar{x}$	Sd	min	max	Cv (%)
First category	6.627	0.024	6.610	6.680	0.356
Second category	6.799	0.052	6.720	6.870	0.761
Third category	6.897	0.027	6.840	6.940	0.387

From the presented results in the table, certain variations in the pH values between the three milk categories can be observed. In the milk from the first category the pH value is 6.627 (min.6.610 up to max.6.680) and 6.799 (min.6.720 up to max.6.870) in the milk from the second category. The highest pH value of 6,897 (min.6,840 up to max. 6,940) was found in the milk from the third category.

According to [2] with an increase in the number of somatic cells in the milk, the pH value is increased above the normal and is approximately (pH = 7). The rise in pH value is due to an increase in the flow of blood constituents in the alveoli which then cross into the milk.

The average chemical composition of milk from the three categories is shown in Table 3.

Table 3. Chemical composition of milk from first, second and third categories

Milk category	Indicators	Fat	Proteins	Casein	Whey proteins	Lactose	Dry matter
First	$\bar{x}$	4.206	3.268	2.910	0.8610	4.723	12.197
	Sd	0.044	0.046	0.067	0.0232	0.062	0.151
	Min	4.14	3.20	2.789	0.8213	4.62	11.96
	Max	4.28	3.30	2.991	0.8931	4.80	12.42
	Cv (%)	1.058	1.412	2.311	2.6946	1.313	1.240
Second	$\bar{x}$	4.106	3.192	2.665	0.9680	4.349	11.647
	Sd	0.031	0.035	0.069	0.0225	0.129	0.188
	Min	4.06	3.15	2.523	0.9310	4.17	11.41
	Max	4.16	3.26	2.774	0.9981	4.54	11.94
	Cv (%)	0.763	1.083	2.620	2.3247	2.971	1.612
Third	$\bar{x}$	3.989	3.139	2.386	1.1820	3.964	11.092
	Sd	0.022	0.014	0.063	0.0340	0.094	0.110
	Min	3.96	3.12	2.291	1.1053	3.81	10.91
	Max	4.03	3.16	2.482	1.2243	4.10	11.25
	Cv (%)	0.559	0.462	2.652	2.8930	2.375	0.988

The results shown in Table 3 indicate certain variations in the chemical composition of the milk from the three categories, which are correlated with the number of somatic cells. The average content of fat in the milk from the first category is 4.206% (min. 4.14% up to max. 4.28%), 4.106% (min. 4.06% up to max. 4.16%) in the milk from the second category and 3.989% (min. 3.96% up to max. 4.03%) in the milk from the third category. From the results a certain decrease in the fat content can be noted, which corresponds with the increase in the number of somatic cells in the milk.

The average content of protein in the milk from the first category is 3.268% (min. 3.20% up to max. 3.30%), 3.192% (min. 3.15% to max. 3.26%) in the milk from the second category and 3.139% (min. 3.12% to max. 3.16%) in the milk from the third category. No larger variations were observed in the amount of protein in the milk from the three categories, and it can be concluded that the increase in the number of somatic cells in the milk does not significantly affect the total protein content [4].

Unlike the total protein content of the milk, the results in Table 3 indicate a significant decrease in the content of the main milk protein casein. In the milk from the first category the average content of casein is 2.910% (min. 2.789% up to max. 2.991%), 2.665% (min. 2.523% up to max. 2.774%) in the milk from the second category, and the decrease in the casein content is most pronounced in the milk from the third category 2.386% (min. 2.291% to max. 2.482%), where the number of somatic cells is greatest. The

differences in the percentage of casein among the three milk categories are significant at the level of ($p < 0.01$). The decrease is due to the reduction of synthesis and secretion of casein, and predominantly due to its post - secretory degradation under the influence of the proteolytic enzyme - plasmin.

The results show a significant increase in the content of whey protein in the three milk categories, corresponding to the increase in the number of somatic cells [1, 8]. In the milk from the first category, the average content of whey protein is 0.8610% (min. 0.8213% up to max. 0.8931%) and 0.9680% (min. 0.9310% up to max. 0.9981%) in the milk from the second category. The highest content of whey protein, 1.1820% (min. 1.1053% up to max. 1.2243%) was determined in the milk from the third category. Highly significant differences in the content of whey protein were determined among the three categories of milk ($p < 0.01$). As the content of whey protein increases as a result of altered vascular permeability, the milk's thermostability decreases [3]. Greater variation was found in the content of lactose among the three categories of milk. The amount of lactose decreases respectively with the increase of the number of somatic cells in the milk. In the milk from the first category, the average lactose content is 4.723% (min. 4.62% up to max. 4.80%), 4.349% (min. 4.17% to max. 4.54%) in the second category and in the milk from the third category, the average lactose content is 3.964% (min. 3.81% to max. 4.10%). In the three categories of milk, highly significant differences in the lactose content were found ($p < 0.01$). According to [9], the physiological minimum of lactose is 4.55% and each reduction indicates an increase in the number of somatic cells in the milk [10].

The results show a decrease in the dry matter content of the three categories of milk, which is understandable and in relation to the reduction of the content of the milk components. In the milk from the first category, the average content of dry matter is 12.197% (min. 11.96% up to max. 12.42%), 11.647% (min. 11.41% up to max. 11.94%) in the milk from the second category and the smallest content of dry matter was determined in the milk from the third category and amounts to 11.092% (min. 10.91% up to max. 11.25%).

During the research, the correlations between the number of somatic cells and certain parameters for the chemical composition of the milk from the three categories were examined, and the results obtained are shown in Table 4.

Table 4. Correlations between the number of somatic cells and certain parameters for the chemical composition of milk

Parameters	r	r	r
Somatic cells and fat (%)	- 0.966	- 0.972	- 0.785
Somatic cells and proteins (%)	- 0.989	- 0.804	- 0.336
Somatic cells and lactose (%)	- 0.997	- 0.871	- 0.655
Somatic cells and dry matter (%)	- 0.995	- 0.910	- 0.654
Somatic cells and casein (%)	- 0.901	- 0.961	- 0.952
Somatic cells and whey proteins (%)	0.943	0.872	0.909
Somatic cells and yield (%)	- 0.969	- 0.922	- 0.966

From the examined correlation relationships between the somatic cells and the chemical parameters in milk from the three categories, negative values were found between somatic cells and fat, proteins, lactose, dry matter and casein, while a positive correlative dependence was found between somatic cells and whey proteins ($r=0.943$), ($r=0.872$), ($r=0.909$).

4. CONCLUSION

Based on the results obtained from this research, it can be concluded that there are significant differences in the physico-chemical composition of the milk from the three categories corresponding to the increase in the number of somatic cells.

The increase in the number of somatic cells in milk affects the changes in certain milk components, especially in reducing the content of lactose and casein, which leads to an increase in the content of whey protein.

The changes in the chemical composition of the milk correspond to the increased number of somatic cells and are more pronounced in the milk from the second category, but most of all in the milk from the third category, where the number of somatic cells is 1.242.220 / ml. In this milk category the lactose content is quite low, amounting to 3.964%, the average content of casein amounts to 2.368%, while the whey proteins have the greatest average value and are 1.1820%.

Changes in the chemical composition and properties of milk caused by an increased number of somatic cells, lead to a decrease in the quality and yield of dairy products from its processing, and thus to economic losses in the dairy industry.

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