INFLUENCE OF SOMATIC CELL COUNT IN RAW MILK ON CHEESE PRODUCTION

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ABSTRACT
The purpose of this study is to determine the qualitative and quantitative changes of milk components due to the increased number of somatic cells and their influence on cheese production. During the study milk is categorized in three categories depending on the number of somatic cells.
The average number of somatic cells in milk from I category is 444.780/ml, II category 825.560/ml and in III category 1.242.220/ml.
The average contents of milk: fat, proteins, lactose, dry matter, casein and whey proteins in milk from I category is 4,2%, 3,3%, 4,7%, 12,1%, 2,9%, 0,9%, respectively. In II category 4,1%, 3,2%, 4,3%, 11,6%, 2,7%, 1,0%, respectively, and 4,0%, 3,1%, 4,0%, 11,1%, 2,4%, 1,2%, respectively in milk from III category.
The pH value of milk in I, II and III category is 6,627, 6,799 and 6,897, respectively.
There is a positive correlation in all three milk categories between somatic cell count and the whey proteins, while negative correlating dependency was found between the other chemical parameters and somatic cell count.
Key words: quality, milk, chemical components, somatic cells, cheese.

INTRODUCTION

The quality of milk intended for processing is determined by its physical-chemical and hygienic properties. A basic indicator of milk hygienic quality is the number of somatic cells, which are passing through the normal secretor process of the milk either from blood or from the epithelium, as normal biological structural elements.

Somatic cells increase when intramammary bacterial infection is present which causes change in milk secretion followed by qualitative and quantitative milk changes. These changes generally decrease the content of milk fat, lactose and casein and increase whey proteins.

The alterations in the physical and chemical properties of the milk are in correlation with the number of somatic cells (Katic and Stojanovic, 1998). According to (Srbinoska, 2007) the variation of the composition and the properties of raw milk affect certain technological operations in the processing of milk which affect the composition, properties, quality and yield of dairy products.

MATERIAL AND METHOD OF WORK

The cow milk used for the purpose of the research was from farms from the region of Kicevo. Analysis of the physical and chemical composition and somatic cell count was carried out on the samples of the bulk milk.
The analysis of the chemical composition of the milk means determining milk fat content, proteins, lactose and dry matter using an infrared analyzer Milcoscan in accordance with

the IDF 141C:2000 standard, while the determining of the casein content in percentage and the whey proteins is done by using the Kjeldahl method in accordance with the AOAS, 1995 standard.
The pH value was measured with a pH meter- Metller Toledo.
The cell count was determined with Fossomatic 5000 and milk-enumeration of somatic cells was done according to ISO 13366/2:2006 standard. The working principle of Fossomatic 5000 consists of staining and electronic counting of somatic cells. According to SCC milk is categorized in three categories:

1. I Category milk with up to 600.000/ml somatic cells,
2. II Category milk from 600.000 to 100.000/ml somatic cells,
3. III Category milk with more than 100.000/ml somatic cells.

RESULTS AND DISCUSSION

The results in Table 1 show that the average somatic cell count in the first category milk is 444.780 (min. 339.000 up to max. 586.000), in the second category 825.560 (min. 690.000 up to max. 972.000) and in the third category 1.242.220 (max. 1.172.000 up to max. 1.306.000).

Table 1. Average number of somatic cells in category I, II, III

Indicators	n	$\bar{x}$	S_d	min	max	Cv (%)
I category milk	9	444.780	84,735	339.000	586.000	19,051
II category milk	9	825.560	89,208	690.000	972.000	10,806
III category milk	9	1.242.220	47,232	1.172.000	1.306.000	3,802

Table 2. Average value of the chemical composition of the milk from I, II, III category

Milk category	n	Fat	Protein	Casein	Whey proteins	Lactose	Dry matter
I	9	4,206	3,268	2,910	0,8610	4,723	12,197
II	9	4,106	3,192	2,665	0,9680	4,349	11,647
III	9	3,989	3,139	2,386	1,1820	3,964	11,092

The results in Table 2 indicate certain variations in the chemical composition among the three categories of milk, which are in correlation with the number of somatic cells. The average content of milk fat in I category milk is 4,206%, in the II category 4,106% and in the third category 3,989%. It can be noticed that certain decrease of the content of milk fat occurs with the increase of the number of somatic cells of the milk.
The average content of protein in the first category milk is 3,268%, in the second 3,192% and in the third 3,139%. The results show no significant variations. The increase of SCC in milk does not significantly affect the total protein content (Katić et al., 1994).
The results in Table 2 indicate significant decrease of the content of the casein- the main milk protein. In the 1st category milk it is 2,910%, in the 2nd 2,665% and the decrease of

the content of the casein is significantly evident in the 3rd where SCC is the highest 2,386%. The difference in the percentage of casein among the three categories are significant at the level of (p<0, 01). The decrease is a result of the reduction of the synthesis and secretion of the protolithic protein called plasmin.

The value of the whey proteins increases in all three categories. In the 1st category it is 0,8610%, in the 2nd 0,9680% and the value of the whey proteins in the 3rd category is 1, 1820%. Significant differences in the content of the whey proteins was observed among the three categories of milk (p<0, 01). The increase of the whey proteins as a result of the change of the vascular permeability decreases the thermo stability of the milk (Jones and Bailey, 1998).

The obtained results show great variation of the content of the lactose among the three categories of milk. The average content of lactose is decreased as the SCC in milk is increased. In 1st category of milk it is 4,723%, in 2nd 4,349% and in the third category the average content of lactose is 3,964%. Highly significant differences were observed in the content of lactose (p<0, 01). According to Rupic and Havranek (2003), the physiological minimum is 4,55% and any decrease of it refers to increase of somatic cell count in the milk.

The obtained results show a decrease of the content of dry matter in all three categories of milk, which is in accordance with the decrease of the content of the milk components. The average content of dry matter in the 1st category milk is 12,197%, in the 2nd 11,647% and the least content of dry matter in the third category is 11,092% (min.10, 91% up to max.11, 25%).

Table 3. Yield of the cheeses from I, II, III category

	I category			II category			III category		
Weighing of the cheese	$\bar{x}$	S_d	Cv (%)	$\bar{x}$	S_d	Cv (%)	$\bar{x}$	S_d	Cv (%)
1st day	20,350 [a]	0.356	0,175	19,486	0,270	1,388	18,790	0,115	0,613
15th day	19,123 [b]	0,095	0,495	17,976	0,437	2,432	17,096	0,257	1,506
30th day	17,643 [c]	0,201	1,138	15,893	0,028	0,180	14,787	0,119	0,805

* The differences of the values with different superscript letters are significant at the level:
a:b statistical significance at the level of (p<0, 01)
b:c statistical significance at the level of (p<0, 01)
a:c statistical significance at the level of (p<0, 05)

Table 3 shows the yield of the three categories of cheeses. The measuring of the yield of the cheese was carried out three times during ripening period as follows: d 1 immediately after cutting it, d 15 and d 30 of the ripening of the cheese. The results obtained lead to the conclusion that the yield of first category milk the first day of ripening is 20,350 kg, of the second category 19,486 kg and of the third category 18,790 kg. The coefficient of variation in the cheese from the first category is (Cv=0,175), the second (Cv=1,388) and the third (Cv=0,613).

On the fifteenth day of ripening the yield of the 1st category is 19,123 kg, the second category 17,976 kg and the third category 17,096 kg. The standard deviation in the first category is (Sd=0,095), in the second category (Sd=0,437) and in the third category (Sd=0,257). The coefficient of variation of the cheese from the first category is (Cv=0,495), from the second category (Cv=2,432) and from the third category (Cv=1,506).

On the thirtieth day of ripening the rendement of the cheese from the first category is 17,643 kg, from the second 15,893 kg and from the third 14,787 kg. The standard deviation in the cheese from the first category is (Sd=0,201), from the second category (Sd=0,028) and from the third (Sd=0,119). The coefficient of variation of the cheese from the first category is (Cv=1,138), from the second category (Cv=0,180) and from the third category (Cv=0,805).
The rendement difference in the three categories of cheese according to statistical data indicates significant change on the level of ($p<0,05$).
The rendement and the abatement are a key element for an economical cheese production. According to Kapac- Parkaceva (1988) several factors affect the rendement of cheese such as the quality and chemical composition of the milk, especially the fat and casein concentration, the technological process and the way the cheese is stored.

Table 4. Total abatement ($\bar{x}$) of the cheese during ripening

Category	Total abatement	
	kg	%
I category	$2,707^{a}$	13,30
II category	$3,593^{b}$	18,44
III category	$4,003^{c}$	21,30

* The differences of the values with different superscript letters are significant at the level:
a:b statistical significance at the level of ($p<0,01$)
b:c statistical significance at the level of ($p<0,01$)
a:c statistical significance at the level of ($p<0,05$)

As can be seen from the data in Table 4 of our study the cheese from the three categories after thirty days of ripening has different rendement which is lower in the categories with higher somatic cell count. According to the results the rendement of the cheese of the first category after ripening was 17,643 kg, the rendement of the second category 15,893 kg and the rendement of the cheese from the third category was 14,787 kg. The difference of the rendement among the three categories of cheese are significant at a level of ($p<0,05$).
Taking in consideration that the cheese from the three categories is produced under the same technological conditions (same quantity of milk, same pasteurization and coagulation temperature of the milk, curd processing, pressing, salting/brining and ripening of the cheese), it can be said that the difference in the rendement of cheese is due to the change of the milk composition (change of the quality of the milk) which ultimately affects the end goal - the rendement of cheese.
Mihailov (2005), examined the influence of somatic cells on the rendement of white soft cheese and his findings were as follows: the rendement of cheese from milk with 100.000 somatic cells is 18,20 kg, the rendement of cheese from milk with 800.000 ml somatic cells is 17,77 kg, and the rendement of cheese from milk with 1.300.000 somatic cells is 17,48 kg. Bruhn (1983) researched the influence of the somatic cells on the rendement of Cheddar cheese and came to the following findings: he rendement of cheese obtained from 100 liters of milk with 240.000 somatic cell count was 9,748 kg, the rendement of cheese obtained from milk with 496.000 somatic cell count was 9,686 kg, and the rendement of cheese obtained from milk with 640.000 somatic cell count was 9,430 kg. The results shows that the cheese made of milk with higher SCC have a lower rendement. The research carried out at the Cornell University for the purpose of establishing the quantitative ratio between the increase of the somatic cells and the rendement of cheddar

cheese concluded that the increase of somatic cells of 100.000/ml dramatically reduces the rendement by 1%, and the increase of somatic cells of 100.000-1.300.000 lowers the rendement by another 1-2% (Dairy center News, 1991).
One of the aims of our research was determining the abatement in the ripening process. The results obtained show that the total abatement after the ripening period of 30 days in the cheese from the first category is 2,707 kg or (13,30%), in the second category the wastage rate is 3.593 kg or (18.44%). The abatement in the third category cheese is the highest at 4,003 kg or (21,30%). The differences in the total abatement in the three categories are significant at a level of ($p<0,01$).
The abatement was determined even in the phases of the ripening of the cheese, i.e. the abatement that appears in 1-15 day and the abatement of the cheese that appears in 15-30 day. The difference in the abatement between 1-15 day and 15-30 day in the first cheese category is at the significant level of ($p<0,05$), and in the second and third category the abatement between 1-15 day and 15-30 day is significant at a level of ($p<0,01$).
Many authors, in the available literature, conclude from the data that the number of somatic cells affects the rendement of cheese, but only few are with precise indicators. The infection of the mammary gland results in both a decrease of milk production in the cells of the secretory epithelium and quantitative and qualitative changes in the composition of the milk followed by a decrease in the content of the casein, lactose, milk fat and an increase of the composition of the whey proteins and enzymes. According to Auldist et al. (1996), the change in the composition of the milk with increased somatic cells has a negative effect on its suitability for cheese processing, and is the result of the influence of the enzymes on the proteins and fat. The negative effect of higher levels of somatic cells in the milk intended for cheese making means decreased hardness of the coagulum and a loss of a substantial amount of casein and fat in the whey, whereas the increase of the content of the whey proteins results in a decrease of the thermostability of the milk. The change in the ratio of the casein fractions occurring in the milk with higher somatic cell count results in a decrease of the rendement, altered sensory properties, decreased shelf life due to higher water retention and low profitability during the processing of the milk into cheese. According to Mazal (2007), the cheese made of milk with high levels of SCC contains more water, and during the ripening process there is higher protheolytic activity endangering the typical sensory quality of the cheese.

CONCLUSION

The results of this trial indicate that there are significant differences in the physico-chemical content of the three categories of milk, i.e. the increase of SCC in the milk alters certain milk components, especially decreasing the percentage of lactose ant the main milk protein-casein and increasing the content of the whey proteins. The alterations in the chemical content are more noticeable in the second category milk and they are significant in the third category milk where the average SCC is 1.242.220. In this milk category the content of lactose is pretty low 3,964%, the casein 2,386%, whereas the whey proteins have the highest value 1,1820%. The alteration of the chemical content and properties of the milk due to high SCC, during its processing leads to lower dairy quality and rendement, and thus brings out economic losses in the dairy industry.
The rendement of cheese in the three categories after the ripening of 30 days is as follows: cheese from I category milk 17,643kg, cheese from II category milk 15,893, and the

rendement from III category 14,787kg. Although the cheese was manufactured using the same technological processes the rendement in cheese from II and III category decreases.
We can conclude that nevertheless the cheese is made under the same technological conditions the rendement is lower in the cheese made from the milk from category II and III along with the proliferation of somatic cells and their impact to change in milk components.
The total abatement (mass loss) that occurs in all three categories during the ripening period from 1 to 30 days is: cheese obtained from category I milk 13,30%, cheese from category II milk 18,44%. The abatement in the cheese produced from category III milk is the highest at 21,30 %.
The differences occurring in the total abatement among all three categories are significant at level ($p<0,01$).

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