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THE INFLUENCE OF SOMATIC CELLS ON MILK COMPONENTS

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Abstract

The aim of this research was to determine the influence of somatic cells on all milk components. Somatic cell count (SCC) is an indicator of the quality of milk. White blood cells known as leukocytes constitute the majority of somatic cells in question. The number of somatic cells increases in response to pathogenic bacteria like *Staphylococcus aureus*, a cause of mastitis. The SCC is quantified as cells per ml. If the number of somatic cell is bigger than 400.000/ml, that milk is with bad quality, and has a lot of changes in its components. If the number of somatic cells in milk is less than 400.000/ml, than we have normal milk, with appropriate amounts of milk components and normal characteristics.

Key words: somatic cells, milk components, mastitis;

Introduction

Somatic cells are natural milk components. They don't change milk components, its physical properties and bacteriological convenience. Today the number of somatic cells in milk is internationally recognized parameter for udder health, and we determine them to control the health of dairy gland, prevention of mastitis and improving milk quality. The number of somatic cell is increased as a result of inflammation of the udder, and manifests itself in a change of secretion and chemical composition of milk, physical, bacteriological and technological milk properties.

According to the official Gazete of the Republic of Macedonia 151/2007, Regulations for safety and hygiene and manner of performing the official controls on milk and dairy products, raw cow's milk should not contain more than 400,000 somatic cells / ml **.**

Somatic cells are combination of epithelial cells (70%) from secretory tissue of the udder

and leukocytes (30%) from the bloodstream, which consist of polymorphonuclear neutrophils (35-40%), lymphocytes (20-25%), macrophages (20%) and other cells. Harmon, 1994. There are several factors that affect the number of somatic cells in milk such as: race, stages and number of lactation, year periods, the way of milking, way of holding, nutrition, stressful situations and etc. The influence of these factors is minimal if mammary gland is not infected. The number of leukocytes in healthy cow's milk is equal in each quarter from the udder. If the number of leukocytes increases in some udder's quarter, that's a sign for mastitis. Harmon, 1994. According to *Petersson-Wolfe (2010),* mastitis causing microorganisms are following: *Staphylococcus aureus, Staphylococcus* spp., *Streptococcus uberis, Streptococcus dysgalactiae, Streptococcus agalactiae*, *Corynebacterium bovis, Escherichia coli*, *Klebsiella* spp., *Enterobacter* spp.*and etc.*

The most common cause for mastitis is inflammatory processes caused by microorganisms (95%), Makek, 1995.

Results and discusion

The increased number of somatic cells in milk affects milk production, the chemical composition of the milk, milk fat, protein, lactose, mineral matter, vitamin, ferments, the physical properties of the milk, the organoleptic properties of the milk, the technological properties of the milk in cheese production, relative casein relation, pH-values, coagulation milk ability, randman and cheese quality.

Milk production. The average decrease in milk production per lactation is 15-40%, and that depends on: infection type, duration of infection and the degree of infection**.** By increasing the number of somatic cells from 200,000 to 400,000 and more, the number of pathogen microorganisms is increased too, from 11.7 to 23%. By increasing the number of somatic cells over 250 000/ml, the amount of daily milk production is reduced for 1 kg in first lactation and 3 kg in the next lactation period (Jones,1984)

Changes in the chemical composition of milk. Significant change in the chemical composition of the milk comes when the number of somatic cells is greater than 250 000/ml (Rogers, 1989), and the more pronounced change comes when the number is greater than 750 000/ml (Steffer, 1994). Changes in certain ingredients of milk with high number of somatic cells, compared with normal milk can be seen in the following summary:

Table: Changes in the chemical composition of milk associated with an increase in number of somatic cells

Milk component	Normal milk	Milk with high number of somatic cells
Milk fat	**3,5**	**3,2**
Lactose	**4.9**	**4.4**
Dry matter (no fat)	**8,9**	**8,8**
Proteins	**3.61**	**3.56**
Casein	**2.8**	**2.3**
Whey proteins	**0.8**	**1.3**
Serum albumin	**0.02**	**0.07**
Immunoglobulin	**0,1**	**0,6**
Sodium(Na)	**0,057**	**0,105**
Chlorine(Cl)	**0,091**	**0,147**
Potassium(K)	**0173**	**0.157**
Calcium (Ca)	**0,12**	**0,04**

Milk fat. Milk with increased number of somatic cells, has changes in amount of fat. According to the results, the amount of fat is reduced from 5 to 12 % or 2 to 5 grams fat/kg milk. At the beginning the changes in composition of milk fat in milk from mastitis infected heifer are relatively small, but in the case of longer udder infection they are important. The activity of lipase in mastitis milk is increased by 10%, which leads to oxidative changes in the composition of milk fat. That process increases the amount of free fatty acid from 0.64 mg /g (in normal milk) to 1,17 mg/g (milk from mastitis infected heifer) which gives the milk strange taste (Harmon, 1994).

Protein. The amount of total protein is unchanged, in milk with an increased number of somatic cells. The amount of protein synthesized in the gland cells of the alveoli i.e β and k-casein is reduced by 18%.

Lactose. The increased number of somatic cells in milk reduces lactose in milk from 10-20%. The reason for this is the passage of lactose in the extracellular fluid (blood) and and reduction in synthetic activity due to damage of secretory cells. The average amount of lactose in milk from healthy heifer is 4-8%. Milk that contains less than 4,6 % lactose comes from heifer with infected udder. Milk with less than 4.6% lactose has a larger number of somatic cells and vice versa, which means that the amount of lactose in milk can be an indicator of the health of heifer udder.

Mineral matter. The infected heifer has greater transfer of sodium and chloride from blood into milk, up to 38%, (milk with an increased number of somatic cells) the same receive salty taste, the amount of K and Ca is reduced because of their movement outside from the alveolus lumen, and casein synthesis is stopped.(Kitchen, 1981).

Vitamins. From water-soluble vitamins, the amount of thiamine is reduced for 10%, riboflavin for 6-20%, vitamin C for 20-40%. From fat-soluble vitamins, the amount of alpha and beta carotene is increased because the composition of milk is similar to the composition of blood serum..

Ferments. The milk from mastitis infected heifers has increased amount of plasmin, acidic alkaline phosphatases, catalase, lipase, xanthine-oxidase, esterase and lactate dehydrogenase (Kitchen 1981; Harmon 1994). Increasing the activity of plasmin in mastitis milk is up to 82%. Plasmin decreases the amount of beta-casein, which is responsible for the curd strength.(Politis and Ng-Kwai hang, 1998).

Changes in the physical properties of milk. The milk with increased number of somatic cells has changes in physical properties: Titratable acidity and pH values. The acidity of mastitic milk is 4.8-5.6 ^{o}SH. The determination of pH diagnoses the presence of mastitis. Mastitic milk has increased pH from 6.8-6.9, but in some situations(more diseased cattle) pH is higher than 7,0 (Harmon 1994). The increase of pH comes due to increased permeability of glandular tissue for blood components. This change in pH negatively affects the coagulation ability of milk.

Changes in the organoleptic properties of milk. The modifications in organoleptic properties of milk are expressed with taste changes which becomes bitter due to the increased presence of free fatty acids, i.e. it is salty because of the increased presence of sodium and chlorine.

Changes in the technological properties of milk in cheese production . Strongly expressed negative changes in milk for cheese production with an increased number of somatic cells. Disadvantages are manifested in terms of unfavorable relative relations of casein fractions, increased pH values, changes in coagulation properties, radman reduction and reduction of quality of final product.

Relative casein relation. In mastitic milk we have changes in relations between micellar and soluble casein. That relation for healthy heifer is 95% / 5%, and for mastitis infected heifer is 46% : 54% (Ali и сработниците 1980). Increasing the soluble casein, and reducing micellar casein, has a direct influence on the ability of cheese production. This relation depends on the pH value of the milk temperature and mineral composition of milk. The amount of β-casein and α-s-casein is reduced, and the amount of k-casein is increased (Munro and 1984).

pH-values. One of the reasons for poor fermentation ability of milk for cheese production is an increase of pH value and reducing of titrable acidity of milk in heifer with inflamed mammary glands (Grandison and Ford 1986).

Coagulation milk ability. The increased number of somatic cells in milk reduces its coagulation abilities. Whey protein are absorbed on casein micelles and they reduce the ability for coagulation and curd formation. Coagulation time is prolonged by 25% when milk has more than 500,000, and 50% when milk contains over 1 000 000 somatic cells (Rogers and Mitchell, 1944).

Randman and cheese quality. The reduced amount of cheese produced from milk which contained more than 500.000 somatic cells/ml was 0,89 kg/10 kg cheese, compared with milk containing less than 250,000 somatic cells/ml. Cheese produced from that milk is with poor quality, because of large quantity of water non-fat matter of cheese, has increased adhesivity, reduced elasticity, strength and texture.(Grandison and Ford 1986).

Conclusion

Somatic cells are a natural component of milk, and their number in cow's milk should not be higher than 400 000/ml. Their number can be increased due to infection of mammary gland. Depending on the cause and the degree of infection the number of somatic cells can be up to 5000 000/ml. The reduction in milk production, changing of the chemical content, physical and processing properties of milk are present when milk has more than 400 000 ml somatic cells. The suitability of milk from infected mammary glands cannot be improved with any procedure. If inflammation of the udder is diagnosed on time, the quality of raw milk will be improved. Determining the number of somatic cells in milk are recommended as a obligatory measure for assessing the suitability of milk.

References

-Makek, Z.(1995): Osvrt na dijagnostiku, terapiju i preventivu upala mliječne žlijezde u krava, Mljekarstvo 45 (4) 275-282;

-Harmon, R.(1994): Somatic cell counts: A primer;University of Kentucky-Lexington, Kentucky;

-Politis and Ng-Kwai hang (1998): Fundamentals of cheese science;

-Petersson,W.et al (2002):Impact of two coliform mastitis vaccination schedules on milk production and dry matter feed intake of dairy cattle. Pp. 168-169 in Natl. Mastitis Counc. Annu. Mtg. Proc., Orlando, FL.