Influence of sub-clinical mastitis on milk quality in cows

Sergey V. Fedotov*, *Natalya S.* Belozertseva, *Evgeniia S.* Latynina, and *Sergey V.* Akchurin

Federal State Budgetary Educational Institution of Higher Education "Russian State Agrarian University - Moscow Agricultural Academy named after K.A. Timiryazev", Moscow, Russia

Abstract. All animals underwent express-diagnosis of udder health with the California Mastitis-Test and based on the result obtained was formed two groups of animals to 15 animals in each group. Animals of the first group had the dubious reaction to California express method, and the second animal – weakly positive. The total protein content in the I-th group was 3,23%, while the II-nd group changed slightly and was 3,21%, but decreased the content of casein in the II-nd group by 6,7% and amounted to 2,50%. In turn, increased elk serum proteins in the II-nd group and was 0,65 % albumin and 0,06 % new globulins. Density of milk cows first group also conform to the standards as provided by the guests, and the cows from second group slightly below normal and reached 1026,5 kg/m^3. Somatic cells per 534 tys./sm^3 higher in animals II-nd group compared with the first group, which indicates the presence of inflammation in the udder.

1 Introduction

Subclinical mastitis has an adverse impact on the qualitative composition, physico-chemical properties, health indicators and technological properties of milk. In such a milk dry matter content decreases by reducing the amount of milk fat, casein, lactose, calcium, and increases the amount of whey protein and somatic cells [1, 2, 3].

For many decades in Russia and abroad under active scientific research and development on the issue of reducing the incidence of bovine mastitis, the disease most often affects highly productive animals at different stages of lactation. Over 20% of broodstock are rejected from the herd after the disease due to atrophy of one or more quarters of the udder. According to statistics, from 40 to 60 % of cows in the herd suffer subclinical form of mastitis and loss of milk on average 10-15 % of the annual milk yield, causing considerable enough damage to the dairy cattle-raising [4].

The presence of milk with mastitis leads to changes in the chemical composition of the collected milk, which disrupts the biochemical and microbiological processes of its processing. Such milk does not coagulate well using rennet and has low heat sensitivity. Beneficial lactic acid bacteria are underdeveloped in it. In addition, the structural and mechanical properties of acid and acid-rennet clots change: they become more viscous, have a lower density and separate whey worse [5].

A comprehensive study was conducted at Pravda LLC in the Dzerzhinsky District of the

* Corresponding author: S.Fedotov@rgaumcxa.ru

Kaluga Region under contract No. 08-06 dated June 14, 2019 on black-and-white cows with a live weight of 520 kg. The average productivity of animals in the herd was 8100 kg of milk, fat content - 3.82%, protein - 3.23%. The conditions of keeping, feeding and operating livestock comply with zoohygienic standards. The experimental farm uses loose housing with a milking parlor [6].

The aim of our study is to determine the quality of milk with a questionable and weakly positive reaction to the California Mastitis Test and compare these indicators with the permissible levels of somatic cells established in the technical regulations for milk and dairy products.

2 Materials and Methods

All animals underwent express-diagnosis of udder health with the California Mastitis-Test and based on the result obtained was formed two groups of animals to 15 animals in each group. Animals of the first group had the dubious reaction to California express method, and the second animal – weakly positive.

Studies included quality control of raw milk according to GOST R 52054-2003 and technical regulations on milk and dairy products from July 22, 2010 № 163 – FL (Federal law) [7]. Organoleptic, physico-chemical, sanitary indicators of milk by conventional methods [8].

Organoleptic milk obtained from animals first and second groups meet the requirements of GOST R 52054-2003.

3 Results

Early diagnostics of mastitis and timely initiation of treatment of animals at the initial stages of the mammary gland disease are of great importance, as this helps to avoid a decrease in milk productivity. According to Table No. 1, the milk yield of cows of the first group for 305 days of lactation was 1030 kg higher than that of cows of the second group ($P < 0.01$**). Also, the yield of dry matter, milk fat, milk protein and lactose in animals of the first group were significantly higher: 753.35 kg (dry matter), 1,233.02 kg (milk fat), 197.03 kg (milk protein) and 3,296.46 kg (lactose) compared to 545.53 kg (dry matter), 150.58 kg (milk fat), 162.75 kg (milk protein) and 209.40 kg (lactose) in the second group.

The most valuable component in the milk is dry matter, which is based on milk fat, milk protein, milk sugar and of mineral substances, vitamins, enzymes, hormones, immune bodies, and pigments [9].

Table 1. Milk yield of cows during lactation, n = 15

Group of cows	Index				
	Milk yield for 305 days of lactation, kg	The yield of dry matter, kg	Yield of milk fat, kg	Milk protein yield, kg	Exit lactose, kg
I	6100.00±209.72	753.35±34.47	233.02±14.37	197.03±6.45	296.46±16.21
II	5070.00±290.62	545.53±28.34	150.58±16.21	162.75±6.39	209.40±18.36
Difference	1030.00**	207.82***	82.44***	34.28**	87.06**

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$.

The key element in the production of milk and curd is not only the total protein content, but also its components: casein and whey proteins, which determine rennet coagulation and the yield of the final product. The level of total protein in the first group was 3.23%, while in the second group it changed insignificantly and was 3.21%. However, the casein content in

the second group decreased by 6.7%, reaching 2.50%. At the same time, the level of whey proteins in the moose calves of the second group increased and was 0.65% albumin and 0.06% new globulins.

Table 2. Physico-chemical characteristics of milk, n = 15

Group of cows	Index							
	The content in milk,%							
	Dry matter including	SOMO	Fat.	Total protein				Lactose
				casein	albumins	globulins	total	
I	12.35±0.15	8.53±0.17	3.82±0.19	2.68±0.04	0.50±0.02	0.05±0.02	3.23±0.02	4.86±0.11
II	10.76±0.22	7.79±0.13	2.97±0.21	2.50±0.03	0.65±0.03	0.06±0.04	3.21±0.02	4.13±0.13
Difference	1.59***	0.74**	0.85**	0.18**	0.15***	0.01	0.02	0.73***

Note: * – P < 0,05, ** – P < 0,01, *** – P < 0,001.

In conducting research breast disease manifested in lowering the dry matter content in the change in the ratio between the components of milk. Table 2 shows that the dry matter content of the cows I-th group was 12.35% and in the II-nd – 10.76%. Animals II-nd group showed decrease in milk fat, milk sugar, and was 2.97%, 4.13% compared to the I-th – 3.82%, 4.86%.

When heated milk from sick cows, some whey proteins destabilized. Daylight destabilized whey proteins out of solution into an insoluble accompanied by their deposition [10].

It is known that if the number of serum proteins exceeds the maximum value, the excess of serum proteins deposited on the walls of thermal installation. This milk was not stable and coagulated by heating [11].

Table 3. Health indicators of milk, n = 15

Group of cows	Index		
	Acidity, °T	Density, kg/m3, least	Somatic cells cm3, max.
I	16.85±0.24	1028.70±0.15	$3.27 \cdot 10^5 \pm 0.19 \cdot 10^5$
II	13.59±0.21	1026.70±0.19	$8.61 \cdot 10^5 \pm 0.29 \cdot 10^5$
Difference	3.26***	2.00***	$5.34 \cdot 10^5$***

Note: * – P < 0.05, ** – P < 0.01, *** – P < 0.001.

The titratable acidity of milk from animals in the first group was within the limits established by the standards, while in cows in the second group it decreased to 13.8°T, which indicates possible inflammatory processes in the mammary gland. The density of milk from cows in the first group also corresponded to the norms established by the standards, while in cows in the second group it was slightly below the norm and amounted to 1026.5 kg/m³. The number of somatic cells in animals in the second group exceeded the indicators of the first group by 534 thousand/cm³, which also indicates the presence of an inflammatory process in the udder. The heat resistance of milk is an important technological parameter that determines its suitability for high-temperature processing, which is especially important in the production of baby food, sterilized milk and canned milk. The heat resistance of milk from the experimental and control groups of cows was assessed using an alcohol test.

Table 4. Assessment of the quality of milk by thermal sensitivity in the alcohol sample, n = 15

Index	I group					II group				
	volume of ethyl alcohol, %					volume of ethyl alcohol, %				
	80	75	72	70	68	80	75	72	70	68
Alcohol sample:								4	6	
➢ rumber of samples	8	7	–	–	–	–	–	4	6	5
➢ %	46.6	53.3	–	–	–	–	–	26.7	40.0	33.3

Table № 4 shows that milk cows in first group – 53,3% (8 heads) is undenatured 80% ethyl alcohol and 46.6 % (7 animals) withstanding 75% aqueous solution of ethyl alcohol can conclude that the milk but the suitability for high-temperature processing. In the second group of 26.7% milk animals were resistant to 72% aqueous alcohol solution, and 40.0% stably to the influence of 70% aqueous alcohol solution and 33.3% – resistant to 68%-tion of a solution of alcohol, such milk is not suitable for the production of baby food, sterilized milk and canned milk.

Rennet coagulation of milk is an important factor influencing its suitability for cheesemaking. The time it takes for proteins to coagulate and the density of the resulting curd depend on the acidity of the milk. As this indicator increases, the process is faster, which leads to an increase in the density of the curd due to the increased activity of the rennet enzyme. The rate of coagulation of milk proteins and the density of the curd also depend on the casein content of the milk.

Table 5. Assessment of the quality of milk by rennet-fermentation trial, n = 15

Index	I group			II group		
	Class of milk*			Class of milk*		
	I	II	III.	I	II	III.
Assessment of the quality of milk	Good	Satisfactory	Bad.	Good	Satisfactory	Bad.
Rennet-fermentation trial:						
➢ number of samples	4	11	–	–	–	15
➢ %	26.7	73.3	–	–	–	100

Note: *Class I – clot with a smooth surface, an elastic feel, without eyelets longitudinal section, floating in a transparent serum which does not extend; Class II – the clot is soft to the touch, with single eyes (1-10) ripped, but not look big; Class III – clot with numerous eyes, spongy, soft to the touch, have form bigger than it should be, floated up or clot formed instead of flake mass.

Table 5 shows that the milk of animals from first group refers to I (26,7%) and II (73,3%) classes and is considered suitable for the production of cheese. Milk cows of the experimental group has a class III (100,0%), this milk is not suitable for the production of cheese. Density clot, formed during inflammation of the udder, low, due to the decline in the acidity and casein.

Density clot generated from cows, mastitis cases is low, due to a decrease in the content of casein and milk acidity reduction.

4 Conclusions

In a production environment changes in the qualitative composition of the milk appears due subclinical forms of breast disease, lead to deterioration in the quality of milk produced from such products as a result of:

1. reduced ability of the casein to coagulate under the action of rennet (decreases the

amount of the serum was separated , in the production of worsening ripening cheeses);

2. decreases the thermal stability of milk (condensed milk in the sterilization formed flakes or sediment at the bottom);

3. SNF content decreases (reduced output of finished product in the production of lactose).

As a result of this experiment it can be concluded that animals with a slightly positive reaction to the California Mastitis-Test are less productive and get milk from their lower quality, which practically is not suitable for further use for technological purposes. Nevertheless, technical regulations, this milk can meet the first or second grade.

Milk is one of the most valuable animal products in human nutrition. Exceptionally high biological value and the degree of assimilation of basic components of milk and dairy products make it indispensable in the diet of people of all ages.

One important reason, significantly reducing the qualitative composition of milk and drastically impairs its technological and hygienic properties are breast disease.

The incidence of subclinical mastitis cows leads not only to a decrease in quality of the milk, but also to a decrease in average daily milk yield and milk shortfall in the recovery period in milk production, which greatly hinders the development of dairy farming.

References

1. V.S. Avdeenko, S.V. Fedotov, N.S. Belozertseva, A.V. Filatova, I.M. Yakhaev, Izvestia TSHA, **3**, 107-121 (2020).
2. S.V. Fedotov, N.S. Belozertseva, G.M. Udalov, Veterinary, **5**, 37-40 (2013).
3. S.V. Fedotov, Regan Reddy Gade, Sidnev N.I., Fouad Sakr and Zherebtsov I.S.
4. S.V. Fedotov, N.S. Belozertseva, A.V. Derinov, V.A. Boltenkov, Bulletin of the Altai State Agrarian University, **5,** 104-108 (2013).
5. S.V. Fedotov, N.S. Belozertseva, I.M. Yakhaev, Bulletin of the Altai State Agrarian University, **2**, 102-107 (2018).
6. N.S. Belozertseva, S.V. Fedotov, G.M. Udalov, Veterinary, **2**, 34-37 (2018).
7. Technical regulations for milk and dairy products. Federal Law of July 22 (2010), No. 163 - FZ.
8. G.N. Krus, A.M. Shalygina, Z.V. Volokitina, *Methods for the study of milk and dairy products* (M.: Kolos, 2000) 368.
9. G.V. Tverdokhleb, R.I. Ramanauskas, *Chemistry and physics of milk and dairy products* (M.: DeLi print, 2006) 360.
10. K.K. Gorbatova, *Chemistry and physics of milk* (St. Petersburg: GIORD, 2004) 288.
11. V.V. Rogozhin, *Biochemistry of milk and dairy products* (St. Petersburg: GIORD, 2006) 320.