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Research paper

Prevention of Mastitis and Reduction of Microbial Contamination of Cow Milk

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Abstract

It is necessary to strictly follow the technology, veterinary and sanitary rules of milking, perform well-timed diagnostics and treatment of cows during the production of milk. The main causes of poor quality are high bacterial contamination and high content of somatic cells in milk. In this connection, treatment of cows' udder tits with modern and disinfecting solutions was checked through scientific and industrial experiments in the conditions of a dairy farm. There were three groups of cows (1st and 2nd - experimental, 3rd - control); they consisted of 10 animals, which were uniform in breed (black-and-white), age (3-4 years), calving time, and body weight. The quality of cow milk was also homogeneous in terms of the physical and chemical parameters: the mass fraction of protein and fat, dry matter, acidity and density. At the beginning of the studies, the microbial contamination of milk was 3,800,000 cfu/ml, the number of somatic cells was 400,000 in 1 ml in all groups; this did not meet modern requirements. To reduce microbial contamination and the number of somatic cells in milk, the udder was treated before and after milking. The taken measures led to the improvement of the quality of milk in terms of microbial contamination and the number of somatic cells.

Keywords: *cow, udder, mastitis, treatment, disinfectants, microbial contamination, somatic cells, milk, quality, safety.*

1. Introduction

Inflammation of the teat is a common disease of farm animals, especially cows, which causes significant losses in the cattle production: the loss of milk during cow illness, current and subsequent lactation, consumption of medicines, early culling, diseases and death of young animals. In modern conditions, the requirements to the quality of milk are increasing for the content of somatic cells and microorganisms. In this regard, livestock owners are interested in the prevention of mastitis and improving the quality of cow milk.

The health of the cow's udder is one of success factors in producing high quality milk. Udder diseases are ubiquitous and represent the main problem in ensuring the hygiene of the obtained milk all over the world. Primary contamination of the raw milk by microorganisms begins with the teat canals and udder surfaces, especially in case of the inflammatory process of the mammary gland, in other words, mastitis. In subclinical forms of mastitis up to 10^5 cfu/cm^3 of pathogens can enter the milk, and up to 10^8 cfu/cm^3 pathogens can enter the milk during the clinical mastitis.

The problem of sanitary and hygienic quality of cow milk and a complex of factors affecting the content of microorganisms in cow milk are reflected in the works of many scientists [1, 2, 3, 4, 5, 13, 14, 16, 17, 18].

A significant contribution to the study of the sanitary and hygienic state of cow milk and the level of its contamination by various microorganisms was made in the followings works [15, 16, 17, 18, 21, 22].

The studies related to the development and application of the new solutions for hygiene of the milking are considered in the writings of many scientists [19, 20, 23, 24, 25, 26].

However, the new solutions for milking hygiene "Violit", "Cliovit" and "Lactovit" used before and after the udder treatment had not previously been applied in the production conditions and their effect on the milk quality had not been studied.

The purpose of the research is to make a scientific inquiry about the modern Russian solutions for the treatment of cow udder teats "Violit", "Cliovit" and "Lactovit" developed to prevent mastitis and reduce microbial contamination of milk, as well as to consider their introduction into wide-scale production.

To achieve the goal, the following tasks were set:

1. Conduct a veterinary and sanitary assessment of the cow milk quality.
2. Establish the factors that affect the microbiological safety of cow milk.
3. Justify and introduce into the production the modern solutions "Violit", "Cliovit" and "Lactovit" for treating the teats of the cow udders.

2. Materials and Methods

The experimental work on the topic was conducted in 2011-2016 at the Laboratory of Biotechnology and Nanotechnology of the Federal State Budgetary Educational Institution of Higher Education "Chuvash State Agricultural Academy". Scientific and industrial experiments on the prevention of mastitis and the reduction of microbial contamination with the use of "Violit", "Cliovit" and "Lactovit" for the treatment of the cow udders were carried out in the conditions of a dairy farm with the population of 100 or more milk cows of CJSC Progress, located in Yalchik district, the Chuvash Republic. The results of the study are confirmed by the formal note on the positive impact of the treatment solutions for the cow udders on the quality of the produced milk.

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For the production experiments, 2 experimental groups and 1 control group of Holstein cows of black-and-white breeds were formed according to the method of similar groups, considering the body weight and age of the animals. During the study period, the cows (ten animals in each group) were on the same type of diet and under equal conditions of management and milking. The method of cow management was stall-pasture, using a walking area for exercise. The milk quality of cows was physically and chemically similar.

During the preparatory period, farm workers carried out a veterinary and sanitary assessment of the quality of the produced milk. They revealed an increased number of microorganisms and somatic cells in the cow milk, which made them sell the milk with the first or second quality grades.

During the main period of research work, the teats of the cow udders were treated before and after milking with the universal Russian solutions "Violit", "Cliovit" and "Lactovit" (Table 1).

During the final period, the researchers studied the microbiological safety, physical and chemical properties of cow milk. The zoohygienic methods allowed determining the temperature, humidity, air velocity, carbon dioxide quantity, ammonia and hydrogen sulphide quantity, microbial contamination and dust amount in the room air at the dairy farm. Clinical and physiological methods were used to determine the body temperature, pulse and respiration rate in the control and experimental groups of animals.

Table 1: Diagram of the treatment of the cow udders

Factor	Group		
	1st experimental	2nd experimental	3rd control
Number of animals in the group	10	10	10
Preparatory period (summer), number of days	14		
Cow udder treatment	warm water	warm water	warm water
Main period (summer)			
Cow udder treatment with solutions: before milking	"Violit"	"Violit"	warm water
after milking	"Cliovit"	"Lactovit"	not treated
Year-wise duration of the treatment, number of days: 2013	7		
2014	14		
Intermediate period (summer-autumn)			
Cow udder treatment	warm water	warm water	warm water
Period duration, number of days	126		
Main period (autumn-winter)			
Cow udder treatment with solutions: before milking	"Violit"	"Violit"	warm water
after milking	"Cliovit"	"Lactovit"	not treated
Year-wise duration of the treatment, number of days: 2013	14		
2014	28		

Veterinary and sanitary examination of milk was carried out using the following methods: organoleptic – to determine color, odor, taste and consistency; hydrometric examination – to determine density; titration – for acidity determination, filtration – to determine purity groups. The Gerber acidic method helped to define the mass fraction of fat. The mass fraction of protein was measured in accordance with the Kjeldahl method of total nitrogen mass fraction. The reference method determined the mass fraction of dry matter and nonfat milk solids. To determine the number of somatic cells the following methods were used: the method of counting colonies of mesophilic aerobic and facultative anaerobic microorganisms – QMAFAnM, the method for detecting bacteria of the genus Salmonella - pathogenic microorganisms, including the detection of salmonella by the viscosity change by visual means and using the viscosity analyzer.

3. Results

CSJC Progress in the Yalchik District of the Chuvash Republic is a center of pedigree cattle cultivation, specialized in black-and-white breed. The overall layout of the dairy farm contains: two typical barns for 200 animals with a tie-up housing, herd replacements buildings, maternity barns, milk blocks, calf barns for heifers of 12-18 months old, calf barns for heifers and bulls up to 12 months old. There are walking areas on the territory of the farm, pits for laying silage and haylage, a house for livestock keepers. The dairy farm microclimate corresponds to zootechnical norms. Individual automatic water troughs are equipped for each animal. All types of feed are distributed to the feeding table by mobile or stationary feeders. Animal dung is removed by dung-loading machines.

ZAO Progress is fully provided with feeds of its own production, and uses the necessary feed additives. There are 10 hay pits in the territory, 7 of them contain 1,000 tons and 3 contain 500 tons.

Analyzing the results of ZAO Progress activities for 2011-2014, a positive dynamic in the number of livestock and gross milk production is revealed. The number of cattle by 2014 increased by 293 animals, compared with 2011 and the number of dairy cows increased by 131 animals or 14.4% and 21.8%, respectively. During the study period, the average annual milk yield from one cow was 6,011-6,029 kg, calf crop was 96-98 animals for 100 cows.

The farm uses a stall-pasture system for keeping cows, which implies tie-up keeping of the cattle, alternating with grazing. The walking areas adjacent to the cow barns are used for walking animals during the stall period.

The point of artificial insemination corresponds to zooveterinary requirements. The farm carries out artificial insemination of cows with purebred bulls' sperm of black-and-white Holstein breed.

The dairy farm is equipped with a milk pipe and a cooling tank. Milking machines' washing, disinfection and installation is performed automatically with the use of special alkaline and acid solutions. Test milking of cows is carried out monthly.

One of the important indicators of the dairy farm production efficiency is the quality of the produced milk. The analysis of the obtained data confirms that the stake of the sold highest-grade milk is 0.18-0.97. During the autumn and winter periods the milk grade is higher. However, in the summer period the microbial contamination and the number of somatic cells in milk increase. The amount of the highest quality milk in May-July is reduced to 0. This is the period of the main milk production for selling.

It should be noted that the quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) in milk in the spring-autumn period is 131-361 thousand in 1 cm^3 with the norm for the highest grade milk of 100 thousand in 1 cm^3. The somatic cell count (SCC) is in the range of 280-621 thousand in 1 cm^3, while the SCC of the highest grade milk is no more than 400 thousand in 1 cm^3.

It was revealed that in ZAO Progress the quality of milk does not always correspond to the requirements of the highest and the first

grades for microbial contamination, which was the reason for carrying out studies on the use of modern solutions of hygiene for the cow udder in a dairy farm.

The science of veterinary sanitation developed fundamentally new methods corresponding to the modern system of farming. Among them, we can distinguish the hygiene of milking cows - treating the teats of the udder before and after milking, using modern highly effective detergents and disinfectants.

In 2013-2014 on the dairy farm of ZAO Progress, scientific and production experiments were conducted using concentrated universal solution "Violit" for treating the cows' udder teats before milking and "Cleovit", "Lactovit" were used after milking. The solutions are produced by OOO PC Vortex, located in Izhevsk, the Udmurt Republic.

"Violit" is a highly concentrated special cleansing hygiene product designed to treat the cows' udder teats before milking. It cleans from soiling, softens and does not irritate the skin.

"Cliovit" is a film-forming agent with a restorative effect for the treatment of the udder after cow milking. It is designed for regular protection against mastitis and ensures a healthy skin condition of the cows' udder teats.

"Lactovit" is the solution based on the lactic acid for treating the udder after milking. It is used to prevent mastitis and improve the quality of milk.

3.1 Treatment of the cow udders with the solutions "Violit", "Cliovit" and "Lactovit" in 2013

During the preparatory study period of 14 days, the cows' udders of the 1st, 2nd experimental groups and 3rd control group were washed with warm water, and no udder treatment was performed with special solutions. While investigating the milk quality, the inhibitory substances and pathogenic microorganisms were not detected. The cow milk microbial contamination of the 1st, 2nd experimental groups and 3rd control group was 3.8×10^6 cfu/cm^3, which corresponds to the second grade requirements. SCC in the cow milk met the highest grade requirements and was 4×10^5 in 1 cm^3 (Table 2).

Table 2: Microbiological indicators of cow milk before and after treating of the udders with the solutions "Violit", "Cliovit" and "Lactovit", 2013

Factor	Requirements for the highest-grade milk	Research results, group	
		1st experimental 2nd experimental	3rd control
before the treatment with the solutions «Violit», «Cliovit» and «Lactovit»			
QMAFAnM, cfu/cm^3	no more than 1×10^5	$\frac{(3,8\pm0,05)\times10^6}{(3,8\pm0,04)\times10^6}$	$(3,8\pm0,05)\times10^6$
Somatic cells, in 1 cm^3	no more than 4×10^5	$\frac{(4,0\pm0,12)\times10^5}{(4,0\pm0,14)\times10^5}$	$(4,0\pm0,11)\times10^5$
Inhibitory substances, in 10 cm^3	not detected	not detected	not detected
Pathogens, including Salmonella, in 25 cm^3	not detected	not detected	not detected
after the treatment with the solutions «Violit», «Cliovit» and «Lactovit»			
QMAFAnM, cfu/cm^3	no more than 1×10^5	$\frac{(4,0\pm0,25)\times10^{5***}}{(4,9\pm0,49)\times10^{5***}}$	$(1,8\pm0,04)\times10^6$
Somatic cells, in 1 cm^3	no more than 4×10^5	$\frac{(9,0\pm0,58)\times10^{4**}}{(1,5\pm0,14)\times10^5}$	$(1,5\pm0,11)\times10^5$
Inhibitory substances, in 10 cm^3	not detected	not detected	not detected
Pathogens, including Salmonella, in 25 cm^3	not detected	not detected	not detected

*P≤0,05; **P≤0,01; ***P≤0,001.

That way, according to QMAFAnM, the dairy farm of ZAO Progress produced second-grade milk in 2013. Studies were carried out on the cow udders' treating with hygiene solutions to reduce microbial contamination and increase the milk grade.

The treatment of the cow udders of the 1st and 2nd experimental groups was carried out in the following sequence: the udders were wiped with an individual tissue moistened in warm water and squeezed dry. "Violit" was applied by the method of rubbing a 0.5% solution, using individual wipes. After treating the cow udders, the milking machines were connected, and after milking, the ready-to-use solutions "Cliovit" and "Lactovit" were applied to the teats by dipping them into a non-reusable cup.

During the main summer period of 2013 the cow udders of the 1st and 2nd experimental groups were treated before milking with the solution "Violit" for 7 days. After milking, the cow udders of the 1st experimental group were treated with "Cliovit", the 2nd experimental group was treated with "Lactovit". The animal udders' hygiene of the 3rd control group was maintained by the treatment with warm water before milking.

The QMAFAnM increased by 2.6% in cow milk of the 3rd control group, which is to say, up to 3.9×10^6 cfu/cm^3, while the norm for the highest-grade milk is no more than 1.0×10^5 cfu/cm^3, the first grade is no more than 5.0×10^5 cfu/cm^3 and the second grade is no more than 4.0×10^6 cfu/cm^3, in accordance with GOST R 52054-2003 "Raw cow milk. Technical conditions". Cow milk microbial contamination of the 1st experimental group decreased by 5.3% and was 3.6×10^6 cfu/cm^3 after 7 days of udder treatment, in comparison with the preparatory period. In cow milk of the 2nd experimental group the number of microorganisms remained unchanged with the use of "Lactovit" solution.

As compared with the beginning of the experiment, in cow milk of the 3rd control group the SCC did not change (4.0×10^5 in 1 cm^3), while the norm for the highest-grade milk is no more than 4.0×10^5 in 1 cm^3, for the first and second grades the norm is no more than $1,0 \times 10^6$ in 1 cm^3. After treating the cow udders with hygiene solutions for 7 days the SCC decreased by 25.0% ($3,0\times10^5$ in 1 cm^3) in the 1st experimental group and by 12.5% ($3,5\times10^5$ in 1 cm^3) in the 2nd experimental group, compared with the beginning of the experiment.

It was revealed that cow milk of the 1st and 2nd experimental groups, as well as of the 3rd control group, correspond to the requirements of the second grade for microbial contamination and to the highest grade for SCC.

Thus, the cow udders treatment of the 1st experimental group with "Violit" solution before milking and with "Cliovit" solution after milking for 7 days decreased QMAFAnM by 5.3% and SCC by 25.0%. The cow udders treatment of the 2nd experimental group with "Lactovit" solution reduced the SCC in the milk by 12.5%, and the content of QMAFAnM was not affected.

In the intermediate period for 126 days, the cow udders treatment of the 1st, 2nd experimental groups and 3rd control group was performed with warm water, so in the experimental groups udder treatment was not performed with special solutions, but the sanitary and hygienic requirements for the production of milk were strictly observed.

It was established that in the intermediate period the cow milk microbial contamination of the 1st experimental group decreased in 181.0 times, the 2nd experimental group in 79.2 times, the 3rd control group in 66.7 times (2.1×10^4, 4.8×10^4, 5.7×10^4 cfu/cm^3, respectively).

In cow milk of the 1st experimental group the SCC decreased in 2.0 times and in the 2nd experimental group the SCC decreased in 1.1 times, in other words 2.0×10^5 and 3.5×10^5 in 1 cm^3, respectively. In cow milk of the 3rd control group SCC did not change and was 4.0×10^5 in 1 cm^3.

During the main autumn period for 14 days the cows' udder teats treatment was continued in the following way: before milking with the "Violit" and after milking – in the 1st experimental group with "Cliovit", in the 2nd experimental group with "Lactovit". The determination of the cow milk quality in the main autumn period was carried out twice, after 7 and 14 days.

After 7 days of udder treatment in the autumn period, in the cow milk of the 1st experimental group the QMAFAnM was 9.2×10^4 cfu/cm^3, in the 2nd group it was 1.0×10^5 cfu/cm^3, and in the control group it was 2.8×10^5 cfu/cm^3. The microbial contamination of the milk in the 1st, 2nd and 3rd groups decreased in 41.3, 38.0 and 13.6 times, respectively. The treatment with "Cliovit" of the udders after milking (the 1st experimental group) allowed to improve the milk quality in 3.0 times by microbiological contamination parameters. The treatment with "Lactovit" (the 2nd experimental group) improved the milk quality in 2.8 times by microbial contamination parameters, compared with the milk quality of the animals in the 3rd control group. These measures brought the cow milk to the highest grade.

In the cow milk of the 1st experimental group the SCC decreased in 4.4 times and was 9.0×10^4, the SCC of the 2nd experimental group and 3rd control group decreased in 2.7 times and was 1.5×10^5 in 1 cm^3. The obtained results for the reduction of SCC were stable until the end of the studies in 2013.

After 14 days of the udder treatment with "Violit" before milking and with "Cliovit" after milking, as compared to the beginning of studies in 2013. QMAFAnM in cow milk of the 1st experimental group decreased in 9.5 times, it reached 4.0×10^5 cfu/cm^3 ($P \leq 0.001$), in the 2nd experimental group after "Lactovit" treatment, it decreased in 7.8 times and reached 4.9×10^5 cfu/cm^3 ($P \leq 0.001$), which corresponds to the requirements for the first grade milk. In the control group the QMAFAnM decreased in 2.1 times and reached 1.8×106 cfu/cm^3, which corresponds to the requirements for the second-grade milk. The obtained results for cow milk high contamination of the 3rd control group confirm the relevance of our studies on the treatment of udders by special solutions.

In cow milk of the 1st experimental group the SCC was 9.0×10^4 in 1 cm^3 ($P \leq 0.01$), and the SCC in the 2nd experimental and 3rd control groups was 1.5×10^5 in 1 cm^3, while the norm for the highest-grade milk is 4.0×10^5 in 1 cm^3.

Therefore, the cow milk of the dairy farm ZAO Progress corresponds to the highest grade in terms of the somatic cells number, the content of inhibitory substances and pathogenic microorganisms. However, a high microbial contamination does not allow to sale the milk as the highest-grade product. In this regard, our research continued in 2014.

3.2 Treatment of the cow udders with the solutions "Violit", "Cliovit" and "Lactovit" in 2014

At the end of the preparatory period of 14 days, cow milk of the 1st, 2nd experimental groups and 3rd control group corresponded to the requirements of the highest grade in terms of the somatic cells number, and to the first grade, according to microbial contamination (Table 3).

Table 3.: Microbiological indicators of cow milk before and after treating of the udders with the solutions "Violit", "Cliovit" and "Lactovit", 2014

Factor	Requirements for the highest-grade milk	Research results, group	
		1st experimental / 2nd experimental	3rd control
before the treatment with the solutions «Violit», «Cliovit» and «Lactovit»			
QMAFAnM, cfu/cm^3	no more than 1×10^5	$\frac{(4,5 \pm 0,05) \times 10^5}{(4,5 \pm 0,04) \times 10^5}$	$(4,5 \pm 0,04) \times 10^5$
Somatic cells, in 1 cm^3	no more than 4×10^5	$\frac{(3,5 \pm 0,12) \times 10^5}{(3,5 \pm 0,14) \times 10^5}$	$(3,5 \pm 0,12) \times 10^5$
Inhibitory substances, in 10 cm^3	not detected	not detected	not detected
Pathogens, including Salmonella, in 25 cm^3	not detected	not detected	not detected
after the treatment with the solutions «Violit», «Cliovit» and «Lactovit»			
QMAFAnM, cfu/cm^3	no more than 1×10^5	$\frac{(1,0 \pm 0,02) \times 10^{5***}}{(3,7 \pm 0,15) \times 10^{5***}}$	$(8,3 \pm 0,18) \times 10^5$
Somatic cells, in 1 cm^3	no more than 4×10^5	$\frac{(9,0 \pm 0,50) \times 10^{4*}}{(2,5 \pm 0,20) \times 10^5}$	$(1,5 \pm 0,15) \times 10^5$
Inhibitory substances, in 10 cm^3	not detected	not detected	not detected
Pathogens, including Salmonella, in 25 cm^3	not detected	not detected	not detected

*P≤0,05; **P≤0,01; ***P≤0,001.

In the main summer period of 2014, in order to reduce the number of microorganisms in the milk, the duration of the cows' udder treatment with the solutions "Violet", "Cliovit" and "Lactovit" was increased in 2 times - from 7 to 14 days, in autumn and winter - from 14 to 28 days.

It was found that after 14 days of the treatment in the main summer period the QMAFAnM decreased in 2.1 times in the milk of the 1st experimental group, and in 2.0 times in the 2nd experimental group, that was 2.1×10^5 cfu/cm^3 and 2.3×10^5 cfu/cm^3, respectively. In cow milk of the 3rd control group the decrease in microbial contamination was insignificant, that was 2.3%.

The SCC in cow milk of the 1st experimental group decreased by 1.1% and became 3.3×10^5 in 1 cm^3. The decrease of the SCC in cow milk of the 2nd experimental and 3rd control groups was not found.

Thus, in 2014, cow milk of the experimental and control groups was given the first grade by the dairy farm, and in 2013 the high microbial contamination allowed to give the milk only the second grade. The decrease in QMAFAnM in the milk occurred due to the increase in the duration of cows' udder treatment with special hygiene solutions.

In the intermediate period of 126 days in the 1st, 2nd experimental groups and 3rd control group, the udder treatment was performed with warm water.

At the end of the intermediate period, it was revealed that in cow milk of the 1st experimental group the QMAFAnM decreased in 3.8 times and in 12.2 times in the 2nd experimental group, that was 1.2×10^5 cfu/cm^3 and 3.7×10^4 cfu/cm^3, respectively. The decrease in the microbial contamination was not found in cow milk of the 3rd control group.

The achieved results confirm the necessity of carrying out the sanitary and hygienic measures for treating the cow udders to obtain the high-quality cow milk in the terms of the content of microorganisms.

In cow milk of the 1st experimental group the SCC was 9.0×10^4 in 1 cm^3, which is 3.9 times less than at the beginning of the studies in 2014. In cow milk of the 2nd experimental and 3rd control groups the SCC decreased in 1.4 times and was 2.5×10^5 in 1 cm^3.

Thus, at the end of the intermediate period, the quality of cow milk from the 1st experimental and 3rd control groups corresponded to the requirements of the first grade, and from the 2nd experimental group the milk was of the highest grade.

In the autumn-winter period of 28 days in 2014 the solutions for treating the cow udders in the 1st and 2nd experimental groups were used. The milk quality of the cows was checked at the beginning and at the end of the period after 3, then after 28 days of udders' treatment. QMAFAnM in cow milk of the 1st experimental group decreased in 4.5 times after 3 and 28 days, that was 1.0×10^5 cfu/cm^3 ($P \leq 0.001$), which corresponds to the requirements of the highest grade, compared to the beginning of the experiment. In cow milk of the 2nd experimental group the QMAFAnM decreased in 1.9 times in 3 days and in 1.2 times in 28 days, reaching 2.4×10^5 cfu/cm^3 and 3.7×10^5 cfu/cm^3 ($P \leq 0.001$), respectively. In cow milk of the 3rd control group the QMAFAnM was 8.7×10^5 cfu/cm^3 in 3 days and 8.3×10^5 cfu/cm^3 in 28 days.

The minimum SCC was established in cow milk of the 1st experimental group - 9.0×10^4 in 1 cm^3 ($P \leq 0.05$). In cow milk of the 2nd experimental and 3rd control groups, the SCC was 2.5×10^5 and 1.5×10^5 in 1 cm^3, respectively, while the norm for the highest-grade milk is $4{,}0 \times 10^5$ in 1 cm^3. It should be noted that the treatment with "Cliovit" of the udders' teats after milking in the 1st experimental group led to a more stable decrease in the SCC in the milk. At the beginning of the research the SCC met the requirements for the highest-grade milk in accordance with GOST R 52054-2003 "Raw cow milk. Technical conditions" and at the end of the research the SCC met higher requirements of the European countries - no more than 1.0×10^5 in 1 cm^3.

The fulfillment of sanitary and hygienic requirements at the dairy farm is the main factor in the prevention of mastitis and the production of high-quality milk in the terms of SCC. The use of the treatment solutions before and after milking led to a decrease in microbial contamination and improved the quality from the second to the highest grade of cow milk in the 1st and 2nd experimental groups. The most stable and best results on the quality of cow milk were obtained in the 1st experimental group with the use of "Cliovit" after milking. The cow milk of the control group improved the quality to the first grade in terms of microbial contamination, without the use of udder treatment solutions, but in the conditions of strict adherence to sanitary and hygienic requirements.

3.3 Economic efficiency of the use of "Violit", "Cliovit" and "Lactovit" for treating the cow udders

The treatment of the udders' teats of one cow before milking in the 1st experimental group with "Violit" and after milking with "Cliovit" for 30 days costed 70 rubles 08 kopecks. The treatment of the udders' teats of one cow before milking in the 2nd experimental group with "Violit" and after milking with "Lactovit" for 30 days costed 67 rubles 52 kopecks.

The cost of treating the cow udders' teats before milking in the 1st experimental group with "Violit" and after milking with "Cliovit" on the farm for 30 days was:

10 animals × 70 rubles 08 kopecks = 700 rubles 08 kopecks

The cow teats' treating cost in the 2nd experimental group with "Violit" before milking and with "Lactovit" after milking on the farm for 30 days was:

10 animals × 67 rubles 52 kopecks = 675 rubles 20 kopecks

According to our research, the use of the solutions for treating the cows' udder teats before and after milking led to a decrease in the microbial contamination and to an increase in the milk quality of the 1st and 2nd experimental groups from the second to the higher grade.

In the summer months period, during the mass production of milk and its sale of Yalchik and its neighboring regions - Batyrevsky and Komsomolsk, milk processing enterprises accept raw milk of the highest grade for an average of 14.5 rubles, the first grade - 13.5 rubles, the second grade - 12.5 rubles. for 1 kg.

The economic efficiency using the solutions for treating the cows' udder teats with "Violit" before milking and with "Cliovit" after milking in terms of the difference in the prices for purchasing milk of the highest and second grades is:

10 animals × 15 kg × 14.5 rubles × 30 days – 700.8 rubles = 64549.2 rubles

10 animals × 15 kg × 12.5 rubles × 30 days – 700.8 rubles = 55549.2 rubles

64549.2 rubles – 55549.2 rubles = 9000.0 rubles.

The economic efficiency using the solutions for treating the cows' udder teats with "Violit" before milking and with "Lactovit" after milking in terms of the difference in the prices for purchasing milk of the highest and second grades is:

10 animals × 15 kg × 14.5 rubles × 30 days – 675.2 rubles = 64574.8 rubles.

10 animals × 15 kg × 12.5 rubles × 30 days – 675.2 rubles = 55574.8 rubles.

64574.8 rubles – 55574.8 rubles = 9000.0 rubles.

Thus, the use of the solutions for treating the cows' udder teats before and after milking makes possible the increase of the profit by 14% from the milk sold by the highest grade.

4. Discussion

Dairy cattle breeding is aimed at providing the population with milk. Livestock breeders achieve growth in the productivity of cows with various methods. In this case, the number of dairy cows is usually reduced.

It is known that the profitability of the modern dairy farm is directly related to the milk yield of cows and the sold milk's quality. However, the production of cow milk in Russia is declining [4].

Manufacturers need to do a lot of organizational work to improve the sanitary and hygienic conditions for milk production. In addition, Russia's entry to the WTO and its functioning within the framework of the Customs Union force the Russian producer to take a fresh look at the issues of milk quality and safety. An additional incentive is the introduction of the Customs Union Technical Regulations TP TC 033/2013 "On the safety of milk and dairy products", starting from May 1, 2014.

Our researches in the conditions of the Chuvash Republic allowed us to identify the main reasons for the decline of the milk quality and grade: the violation of the washing modes, veterinary and sanitary treatment of dairy equipment, regimes and storage times for raw materials.

When there are infectious diseases and diseases of the cow udder the pathogens go out with milk, which are partially pathogenic to humans.

To reduce the bacterial contamination of dairy equipment, we recommended additional veterinary and sanitary measures. Together with the leading specialists of ZAO Progress we have developed and recommended measures to improve animal health and hygienic conditions for the production, storage and delivery of milk to the milk processing enterprise. The carrying out of these measures at the dairy farm allowed us to increase the milk grade from the second to the first, according to microbial contamination norms.

The leading scientists [1, 16] confirm that the dominant effect on the quality is the number of microorganisms and somatic cells in cow milk. This is also consistent with the results of our studies [6, 7, 8, 9, 10, 11, 12].

One of the main reasons for the low-quality cow milk is mastitis. A significant increase of the milk's bacterial contamination during cow mastitis is noted in writings. Mastitis causes serious economic damage to farms, associated with forced culling of animals, a decrease in grades and the purchase price of milk. The damage caused to livestock by mastitis is equal to the losses from all non-contagious diseases. According to many authors, cow mastitis

covers from 21 to 70% of the herd, and 8-16% of cows are ill 2 times or more during lactation. Subclinical mastitis occurs 2-20 times more often than clinical, depending on the pathogen which is present in the herd.

Therefore, every effort should be made to prevent cow mastitis. In the technology of milk production, it is necessary to strictly follow the veterinary and sanitary rules of milking, conduct timely diagnostics and organize treatment of cows for mastitis. Prevention of serious economic losses requires timely detection of the disease and animals' treatment. The fight against cow mastitis consists of timely diagnostics, effective cure and prevention.

Special solutions are used to treat the cow udders for the prevention of mastitis on dairy farms. In our studies we used concentrated universal solutions for treating the cows' udder teats with "Violit" before milking and with "Cliovit" and "Lactovit" after milking. The solutions are produced by OOO PC Vortex, located in Izhevsk, the Udmurt Republic. The results of our studies are confirmed by the works of many authors. When treating the udders with Green-Toch solution, the decrease in microbial contamination in 18.6 times for 6 hours was detected. Using the disinfectants [11] in the udders' treatment, the number of bacteria in milk was reduced by a factor of 30. Scientists found that the sanitary treatment of the udder teats with the solution "Ikracept-10A" reduces the total microbial contamination in 89 times, the bacterial contamination of prefabricated milk in 2.5-13.5 times and the number of somatic cells in 1.3-2 times.

It is known that the indirect sign of mastitis is an increase of the somatic cells content in milk due to an increase of the leukocyte number, when microorganisms enter the udder cavity. The primary diagnostics of mastitis is carried out by the control of somatic cells, which themselves do not affect the safety of milk [16, 17, 18, 21, 22]. At the same time, somatic cells are constantly present in milk. The recognized physiological norm of the safe content of somatic cells in milk is 500 thousand in 1 cm^3. However, when milk contains somatic cells, milk is dangerous and becomes a real source of pathogenic microorganisms in dairy products, which is reflected in the work of Lipchinsky A.K., Barkova A.S., Kolchina A.F. [13]. According to the foreign scientists' data of Des Côteaux L., Colloton J., Gnemmi G. [23], Reinemann D., Mein G., Brav D. [24], Fasulkov I.R. [25], Franz S., Floek M., Hofmann-Parisot M. [26] the number of somatic cells is from 10,000 to 100,000 in 1 ml. in the milk from a healthy udder.

A large number of somatic cells causes significant loss of milk. According to Gridin V.F., Gridina S.L. [2], Reshetnikova N., Eskin G., Kombarova N. and others [14], annual cow milk yield is reduced by an average of 250 kg with an increase in the number of somatic cells from 100,000 to 270,000 pcs. in 1 ml. An increase in the number of somatic cells to 500,000 in 1 ml reduces the content of casein, lactose, calcium, magnesium and phosphorus in milk, which limits the production of high-quality dairy products. Consequently, the number of somatic cells in 1 ml is one of the main indicators of the quality of milk [27].

5. Conclusion

ZAO Progress in the Yalchik District of the Chuvash Republic is a pedigree center for the black-and-white breed cultivation and a specialized enterprise to produce cow milk. Livestock occupies the largest part in the structure of the production and the main profit is received from the milk sale.

Positive dynamics of the number of cattle and gross production of milk were established. The number of cattle increased by 293 animals by 2014, compared to 2011, and the number of dairy cows increased by 131 animals or by 14.5% and 27.9%, respectively. The average annual yield from one cow is 6,011-6,029 kg, the calf crop is 96-98 animals per 100 cows.

It was revealed that the cow milk quality of ZAO Progress corresponds to the second grade according to the microbial contamination parameters and QMAFAnM is 3.8 × 105 cfu/cm^3. The main reason for the decline in the milk quality is the violation of sanitary and hygienic requirements for treating the cow udders.

That way, the number of somatic cells is not the only indicator of the udder health, but also it indicates the safety of milk and the productivity of cows. The cow milk of the dairy farm ZAO Progress corresponds to the highest grade in terms of the somatic cells' number, the content of inhibiting substances and pathogenic microorganisms. However, a high microbial contamination does not allow to sale the milk as the highest-grade product.

It is recommended to use the solutions for treating the teats of the cow udders before and after milking to prevent the mastitis and improve the microbiological parameters of the milk quality. The solution "Violit", based on the lactic acid, is used in the form of a 0.5% solution for treating the teats of the cow udders before milking. "Cliovit", based on chlorhexidine, and "Lactovit", based on lactic acid, are ready-to-use solutions for dipping teats after milking.

6. Summery

1. The use of the universal Russian solutions of treating the cow udders with "Violit" before milking and "Cliovit" after milking for 21 days in the summer-autumn period reduces microbial contamination of milk in 9.5 times and QMAFAnM is 4.0×10^5 cfu/cm^3. The treatment of the udder teats before and after milking with the solutions "Violit" and "Lactovit" reduces microbial contamination of milk in 7.8 times and QMAFAnM is 4.9×10^5 cfu/cm^3. The quality of the cow milk after the treatment of the udders was improved from the second to the first grade.

Compliance with sanitary and hygienic requirements to produce the milk without the use of special udder treatment reduces microbial contamination in 2.1 times and QMAFAnM is 1.8×10^6 cfu/cm^3, which meets the requirements of second grade milk. The obtained results for the high contamination of cow milk confirm the relevance of the use of special udder treatment solutions.

2. The doubling of the cow udders' treatment duration by Russian solutions reduces QMAFAnM in the cow milk. When using the treating solutions "Violit" before milking and "Cliovit" after milking, the QMAFAnM is 1.0×10^5 cfu/cm^3 and the quality of cow milk rises from the first to the highest grade. When using "Violit" and "Lactovit" before and after milking, the QMAFAnM in milk is 3.7×10^5 cfu/cm^3, which corresponds to the first grade. The use of warm water to wash the cow udders does not lead to an increase in the grade of milk and QMAFAnM is 8.3×10^5 cfu/cm^3, which corresponds to the second grade.

3. The number of somatic cells in cow milk of the experimental groups is 9.0×10^4 in 1 cm^3, when treating the udders after milking with "Cliovit". When treating the udders with "Lactovit" after milking, the number of somatic cells is 2.5×10^5 in 1 cm^3. In the case without the use of solutions for treating the cow udders, the number of somatic cells is 1.5×10^5 in 1 cm^3, while the norm for the highest-grade milk is $4{,}0 \times 10^5$ in 1 cm^3. The cows' udder teats treatment with "Cliovit" after milking led to a more stable decrease in the number of somatic cells in milk. At the beginning of the research, the number of somatic cells corresponded to the requirements for the highest-grade milk in accordance with GOST R 52054-2003 "Raw cow milk. Technical conditions", and at the end of the research the number of somatic cells was no more than 1.0×10^5 in 1 cm^3, which corresponds to higher requirements of European countries.

4. After using Russian solutions of treating the cow udders before and after milking, the economic efficiency from the sale of milk with the highest grade rises by 14.0%, which allows the enterprise to increase milk production and its competitiveness in the conditions of the imported agricultural products' substitution.

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