# Veterinary and sanitary examination of milk from subsidiary farms of the republic of Mari El

*Sergey* Smolentsev[1*], *Ivan* Ivanov[2], *Elena* Maksimova[2], *Nadezhda* Isupova[2], *Vyacheslav* Milaev[2], *Anastasiya* Chirkova[2], *Olga* Trudolyubova[2], *Marina* Gugkaeva[3], *Irina* Ktsoeva[3], *Tatyana* Agaeva[3], and *Aza* Urtaeva[3]

[1] Mari State University, Lenin Square 1, Yoshkar-Ola city, 424000, Russia
[2]Udmurt State Agricultural University, Studencheskaya street 11, Izhevsk city, 426069, Russia
[3]Gorsky State Agrarian University, Kirova street 37, Vladikavkaz city, 362040, Russia

**Abstract.** At present, in order to avoid buying adulterated milk, some consumers buy the whole milk from private farms. However, when purchasing this product, there is a risk of harm to health. This is due to the fact that some cattle owners may improperly exercise health care and comply with conditions for keeping the animals. Purpose: To conduct a veterinary and sanitary assessment of raw milk samples from subsidiary farms of the Republic of Mari El. The material for this assessment was three raw milk samples from different subsidiary farms. In the selected samples, we determined the organoleptic, physico-chemical and microbiological properties. Standardized methods were used to determine these parameters. All test samples were a homogeneous white liquid free of sediment and flakes with a clean pleasant taste and smell, which met the requirements of GOST 31449-2013. The values of all samples for physico-chemical properties were also within the limits specified in the standard, which indicates the milk naturality. However, when determining the QMA&OAMO (quantity of mesophyll aerobic and optional-anaerobic microorganisms), the obtained results greatly exceeded the established limits. The study of the sample cultures for coliform bacteria showed that, unlike samples 1 and 3, sample 2 has no bacteria of this group. The results of the microbiological quality demonstrated that either animals from which milk was obtained were kept in improper sanitary and hygienic conditions, or the milk obtained was contaminated with microorganisms at the consumer packaging stage. This study showed that all samples meet the requirements of GOST 31449-2013 for organoleptic and physico-chemical properties.

## 1 Introduction

There are currently many adulterated products on the dairy market. To reduce production costs, unscrupulous manufacturers dilute whole milk with water, add preservatives or soda to lower the acidity of milk, replace milk fat with vegetable oils or cheaper beef fat [1,2,3]. Also, the actual fat fraction in the product may be less than stated on the packaging [4].

* Corresponding author: Smolentsev82@mail.ru

According to statistical data, almost all categories of dairy products fall can be adulterated, including drinking milk and cream, fermented milk drinks, sour cream, cottage cheese, etc. [5,6]. Data from various official sources (Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing [Rospotrebnadzor], the Ministry of Agriculture of the Russian Federation, and the National Milk Producers Union 'Soyuzmoloko') show that the proportion of adulterated products in the dairy product structure is 10–90%. According to the Federal Service for Veterinary and Phytosanitary Surveillance (Rosselkhoznadzor), adulterated dairy products occupy 1% to 90% in the market [7].

In this regard, some consumers have more confidence in farm products. However, this has both advantages and disadvantages. The advantages of whole milk from private farms include a higher fat fraction and the real natural milk, which is not qualitatively altered and not subjected to high-temperature processing at manufacturing plants [8].

The disadvantages of these products include the unknown conditions of keeping the cows and the unknown health status of the animals from which the milk is obtained. Despite the benefits of milk and dairy products, unprocessed milk obtained from sick animals can be a carrier of dangerous diseases that are easily transmitted to humans. Thus, pathogens transmitted through milk include brucellosis, tuberculosis, anthrax, salmonella, typhoid fever, and dysentery [9]. When pathogens enter milk, they multiply and accumulate toxins, which leads to the occurrence of foodborne toxic infections when drinking the infected milk. The enterprises have own laboratories that daily evaluate the quality of incoming milk and do not allow raw materials for processing that do not meet existing quality and safety requirements. Unfortunately, in private farms, these assessments cannot be carried out. Therefore, the conduction of the veterinary and sanitary assessment of the quality of raw milk from some private farms of the Republic of Mari El is of interest [10].

Agriculture is the one of the leading industries in the economy of the Republic of Mari El. The main sectors of agriculture in the Republic are livestock and crop production. Over the past years, in conditions of increasing demand for domestic products, the livestock is one of the priorities in the Republic. This region is self-sufficient in terms of food supply: every year the volume of food imports into the Republic is decreasing and export outside its borders is growing dynamically. For example, in 2016, the level of self-sufficiency of the Republic in milk and dairy products was 99.9% [11,12]. In the Republic, since 2015, the number of cows in farms of all categories has remained at approximately the same level of 29.9–31.9 thousand heads. There was a slight increase in the number of cows in some years and a slight decrease in other years. In spite of this, milk production in the Republic has been gradually increasing since 2017. Growth is facilitated by increased animal productivity. Detailed information is provided in Table 1.

**Table 1.** Milk production in the Republic of Mari El (thous. tons)

| | 2015 | 2017 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| **Farms of all categories** including: | 181.7 | 171.5 | 175.6 | 188.4 | 195.2 |
| Agricultural organizations | 96.6 | 102.7 | 110.3 | 122.3 | 129.1 |
| Households | 82.4 | 63.6 | 57.7 | 54.7 | 54.2 |
| Peasant (private) farms | 2.672 | 5.189 | 2.005 | 2.222 | 2.872 |

Analyzing Table 1, it should be mentioned that during the studied period, milk production is gradually decreasing in households due to a reduction in the number of livestock animals in this group. On the contrary, milk production in agricultural

organizations and peasant (private) farms is increasing.

To conduct a veterinary and sanitary assessment of the quality of raw milk from households.

## 2 Materials and Methods

The quality of raw milk was evaluated in the Laboratory of Technology and Examination of Foods of Animal Origin of the Department of Meats and Dairy Foods Technologies of the Federal State Budgetary Educational Institution of Higher Education "Mari State University". During the study, three raw milk samples were selected from different households. For their veterinary and sanitary assessment, organoleptic, physico-chemical and microbiological properties were determined. The data obtained were compared with the requirements of GOST 31449-2013 "Raw cow's milk. Specifications." When determining the properties, we used the methods described in the following standards:

GOST 3624-92 Milk and dairy products. Titrimetric methods of acidity determination.

GOST R 54758-2011 Milk and milk processing products. Methods for determination of density.

GOST 5867-90 Milk and dairy products. Methods of determination of fat.

GOST 8218-89. Milk. Method of purity determination.

GOST 23453-2014. Raw milk. Methods for determination of somatic cells.

GOST 25179-2014. Milk and dairy products. Methods for determination of protein.

GOST 28283-2015. Cow's milk. Method for organoleptic determination of odour and taste.

The freezing point of milk, the mass fraction of non-fat milk solids, as well as the mass fraction of lactose and mineral salts in milk were determined using an Expert Standard milk analyzer.

The quantity of mesophyll aerobic and optional-anaerobic microorganisms was determined by counting colonies growing on the solid QMA&OAMO nutrient medium at (30±1) °C for 72 hours. The fourth dilution was selected for microbial count. Determination of coliform bacteria was carried out by inoculation on Kessler medium and exposure at a temperature of (37±1) ˚C for 24 hours [8]. This criterion is used to assess the sanitary and hygienic parameters of milk.

## 3 Results and Discussion

First of all, during the veterinary and sanitary assessment of raw milk, attention is paid to its organoleptic properties (consistency, taste and smell, color) [10]. Data on the test samples are provided in Table 2.

**Table 2.** Organoleptic properties

| Parameter | Result | | | |
|---|---|---|---|---|
| | Requirements of GOST 31449-2013 | Sample 1 | Sample 2 | Sample 3 |
| Consistency | Homogeneous liquid free of sediment and flakes | Homogeneous liquid free of sediment and flakes | Homogeneous liquid free of sediment and flakes | Homogeneous liquid free of sediment and flakes |
| Taste and smell | Clean smell without foreign odours and tastes not typical of fresh milk | Clean smell without foreign odours and tastes | Clean smell without foreign odours and tastes | Clean smell without foreign odours and tastes |
| Color | White or light cream | White | White | White |

In terms of organoleptic properties, all samples complied with GOST 31449-2013. The consistency of all samples was a homogeneous liquid free of sediment or flakes. The samples were white and had a pure milky taste without any foreign odours or tastes. The physico-chemical properties of the test raw milk samples are presented in Table 3.

**Table 3** Physico-chemical properties

| Parameter | Result | | | |
|---|---|---|---|---|
| | Requirements of GOST 31449-2013 | Sample 1 | Sample 2 | Sample 3 |
| Mass fraction of fat, % | Not less than 2.8 | 4.08±0.05 | 4.9±0.02 | 4.23±0.05 |
| Mass fraction of protein, % | Not less than 2.8 | 3.58±0.01 | 3.47±0.02 | 3.40±0.01 |
| Mass fraction of non-fat milk solids (NFMS), % | Not less than 8.2 | 9.46±0.02 | 9.15±0.04 | 8.96±0.04 |
| Mass fraction of lactose, % | – | 5.08±0.01 | 4.90±0.03 | 4.80±0.02 |
| Mass fraction of mineral salts, % | – | 0.79±0.01 | 0.76±0.01 | 0.74±0.01 |
| Acidity, °T | 16.0 to 21.0 incl. | 19.43±0.41 | 18.67±0.41 | 16.33±0.41 |
| Purity group | II and above | II | II | II |
| Density, kg/m$^3$ | Not less than 1027.0 | 1032.04 ±0.10 | 1029.98 ±0.12 | 1030.28 ±0.09 |
| Freezing point, °C | Not higher than minus 0.52 | minus 0.60±0.01 | minus 0.58±0.00 | minus 0.57±0.00 |
| Number of somatic cells in 1 cm$^3$ | Not more than $4.0\times10^5$ | (2.4±0.47) $\times10^5$ | (2.31±0.07) $\times10^5$ | (1.65±0.45) $\times10^5$ |
| QMA&OAMO, CFU/cm$^3$ | Not more than $1.0\times10^5$ | (6.18±0.61)× $10^5$ | (5.26±0.34)× $10^5$ | (8.52±0.46) $\times10^5$ |
| Coliform bacteria (presence/absence) | – | + | – | + |

The study of physico-chemical properties showed that all samples meet the requirements stated in the standard. Thus, the mass fraction of fat in all samples was more than 4%, with a minimum requirement of 2.8%. The highest fat content was noted in Sample 2, which amounted to 4.9%.

According to the requirements stated in the standard, the mass fraction of protein should be at least 2.8%. All samples corresponded to this parameter, and their values ranged slightly. The highest mass fraction of protein was observed in Sample 1 (3.58%) and the lowest one was noted in Sample 3 (3.4%). These values for the mass fraction of protein are good indicators for the Republic of Mari El.

The highest mass fraction of non-fat milk solids was noted in Sample 1, and the lowest one was observed in Sample 3. The value of this parameter is related to the content of proteins, lactose and minerals in milk [4]. Thus, Sample 1 contains the most of these components, and sample 3 has the lowest amount. The NFMS parameter can help to determine the adulteration of milk. It has been established that immediately after milking, milk contains at least 8% of non-fat milk solids; if the NFMS is below this value, then the

milk is probably diluted with water [8]. When analyzing the data obtained, we can conclude that the milk purchased from subsidiary farms was not adulterated.

GOST 31449-2013 do not regulate the mass fraction of lactose. However, this component affects the organoleptic properties of milk. The highest lactose content was noted in Sample 1 (5.08%), the lowest one was observed in Sample 3 (4.8%). The Sample 2 contained 4.9%. It should be noted that in terms of lactose content, the results of all three samples were higher than the average statistical value of 4.7% for the bulk cow's milk.

Milk is a source of calcium, phosphorus, and magnesium. A human covers their need for calcium precisely through the consumption of milk and dairy products [9]. The mass fraction of mineral salts is also not regulated by the standard. In the test samples, this parameter did not differ much, so the mass fraction of mineral salts in Sample 1, Sample 2 and Sample 3 was 0.79%, 0.76% and 0.74%, respectively.

The acidity of Sample 1, Sample 2 and Sample 3 was 19.43 °T, 18.67 °T and 16.33 °T, respectively. All values of milk acidity meet the requirements of GOST, however, Sample 1 and Sample 2 have a slightly higher acidity than the average for freshly drawn milk; these milk samples were probably not cooled immediately after milking. The purity group of all samples was determined to be II, since several foreign particles were detected on the filter.

The density of milk is related to the content of proteins, fats and carbohydrates in it. The highest density is noted in Sample 1, it was 1,032.04 kg/m3. In Sample 2 and Sample 3, the density of milk was 1,029.98 kg/m3 and 1,030.28 kg/m3, respectively. These values are very good indicators.

The lowest freezing point was observed in Sample 1, and the highest one was noted in Sample 3. This parameter depends on the mass fraction of lactose and mineral salts in the samples. The Table shows the dependence, since Sample 3 has the lowest content of lactose and mineral salts. The cryoscopic temperature of milk is constant and should not be higher than –0.52 ˚C. If the value is increased, this indicates possible adulteration of milk, since when it is diluted with water, the freezing point increases in proportion to the amount of added water. In the test samples, the cryoscopic temperature was lower than that stated in the standard. This fact confirms once more that the test milk samples were not adulterated.

The number of somatic cells in all three samples was within the limits. The maximum somatic cell count were observed in Sample 1, and the minimum number was noted in Sample 3.

However, in terms of microbiological quality, the test samples did not meet the requirements of this standard. The quantity of mesophyll aerobic and optional-anaerobic microorganisms was grossly overestimated. In Sample 1, Sample 2 and Sample 3, this parameter was exceeded 6 times, 5 times and 8 times, respectively.

In addition to counting QMA&OAMO, the content of coliform bacteria in the samples was also determined. These bacteria are the key sanitary-indicatory microorganisms. During the study, it was revealed that Sample 1 and Sample 3 contained Escherichia coli, but in Sample 2, these bacteria were absent.

Milk could be contaminated with microorganisms both directly in the udder and from external sources: animal skin, bedding materials, feed, air, water, milking equipment and utensils, as well as hands and clothing of dairy farm workers. Therefore, exceeding these values for microbiological quality indicates inadequate sanitary and hygienic conditions for keeping animals in subsidiary farms or subsequent contamination of milk when packaged in consumer containers that were not sufficiently sterilized.

## 4 Conclusion

All test samples met the requirements of GOST 31449-2013 for organoleptic and physico-chemical properties. When assessing microbiological quality, a strong excess of values was

identified. When studying this group of parameters, it was revealed that in Sample 2 the quantity of mesophyll aerobic and optional-anaerobic microorganisms was less than in other samples, and there were no coliform bacteria. Based on the results of the study, the need for heat treatment of raw milk purchased from individuals should be noted in order to prevent food poisoning or infection with diseases. Raw milk may not cause consumer concerns regarding visual inspection and organoleptic properties, however, more detailed studies may detect the values that exceed the limits of microbiological quality, which can lead to serious consequences for human health.

## References

1. Khristoforovich P.K., Ravilevich K.I., et.al., Research Journal of Pharmaceutical, Biological and Chemical Sciences, **7(4)** 2214-2221. (2016)
2. Lenchenko E, Lenchenko S, Sachivkina N, Kuznetsova O, Ibragimova A. *Interaction of Cyprinus carpio Linnaeus with the biofilm-forming Aeromonas hydrophila,* Veterinary World, **15(10)** 2458–2465. (2022)
3. Potekhina RM, Tarasova EYu, et.al., Veterinary Medicine International, **2023**, 5281260 (2023).
4. Rudenko P, Sachivkina N, et.al., Veterinary World, **14(1)** 40-48. (2021)
5. Sachivkina N, Podoprigora I, Bokov D. Veterinary World, **14(6)** 1608-1614 (2021)
6. Sachivkina N, Senyagin A, et.al., Veterinary World, **15(4)** 848-854. (2022)
7. Sachivkina NP, Lenchenko EM, Marakhova AI. Farmatsiya (Pharmacy), **68(7)** 26–30. (2019)
8. Sachivkina, N, Vasilieva E, et,al., Animals, **12**, 489. (2022)
9. Smolentsev S.Yu., Volkov A.H., et.al., International Journal of Research in Pharmaceutical Sciences. **11(2).** 1481-1485. (2020)
10. Smolentsev S.Yu., Yusupova G.R., et.al., International Journal of Research in Pharmaceutical Sciences. **11(2).** 1511-1514 (2020).
11. Smolentsev SYu, Rudakova NL, Bulmakova DS, et.al., Poultry Science Journal, **10(1)** 83-90. (2022)
12. Yakupov T.R., Valiev M.M., et.al., International Journal of Research in Pharmaceutical Sciences. **11(1)** 290-293. (2020)