Technological properties of cow’s milk depending on the season of the year

S Yu Harlap¹, A S Gorelik¹,², E V Kvarditsky³, N D Vinogradova⁴, A S Batalov¹ and S A Tamaev⁵

¹Ural State Agricultural University, 42 Karl Liebknecht str., Yekaterinburg, Russian Federation
²Ural Institute of the State Fire Service of the EMERCOM of Russia, 22 Mira str., Yekaterinburg, Russian Federation
³Russian State Agrarian Correspondence University, 50 Shosse Entuziastov, Balashikha, Russian Federation
⁴Saint-Petersburg State University of Veterinary Medicine, 5 Chernigovskaya str., Saint-Petersburg, Russian Federation
⁵Closed joint stock Company “Sadko”, Batetsky District, Novgorod Region

E-mail: proffuniver@yandex.ru

Abstract. Provision of the population with a sufficient amount of domestically produced food, including milk and dairy products, is directly related to advances in breeding of dairy cattle as the main supplier of raw materials for dairy processing enterprises. Along with increased requirements for the quality of milk – raw material in production of dairy products – the focus is placed on its technological properties, namely the possibility of its effective use for processing into certain products: fermented milk, cheese, butter, etc. It is known that milk is affected by many factors, including the season of the year, which impacts not only supply of raw materials to the dairy industry but also its quality. The study aimed to investigate the impact of the season of the year on raw milk intended for processing into various dairy products. The study revealed that sensory properties of milk met the requirements of the regulatory documents. The milk color changed depending on the season of the year. A more intense yellowish hue could be observed in summer and autumn milk, which is related to the carotene content in feed. The highest content of dry solids, milk solids-not-fat, fat and protein in milk was found in winter, while in summer these indicators were lowest. In spring, mechanical contamination of milk increased up to group 2. In general, the bulk of the milk was of the highest grade. The study of rennet coagulation of milk showed the superiority of milk produced in spring, as evidenced by a phase of coagulation of milk, which was shorter by 0'05"–2'35" (P <0.001). A clot formed faster in the presence of rennet in summer milk. Thermal stability of milk was high throughout the year.

1. Introduction

Provision of the population with a sufficient amount of domestically produced food, including milk and dairy products, is a priority for development of agriculture in general and animal husbandry in particular. Increased production of high-quality products is one of the most important tasks in animal husbandry development worldwide, since it is the main supplier of raw materials for processing enterprises of the food industry, including milk processing. The relevance of the dairy cattle breeding all over the world is associated with importance of milk as a food product, on the one hand, and as a raw material for...
processing, on the other hand [1–6]. An increase in milk production of cows is closely related to improvement in milk quality, which has a significant impact on the quality of finished dairy products [7–15]. Many factors affect milk production of cows and milk quality indicators. The production qualities have been markedly improved; however, improvement in the quality of milk, including its suitability for processing into specific products, is crucial and requires revision of technologies for production of raw milk and preventive measures aimed at improving its quality [16–18].

One of the problems is seasonality of milk production, which destabilizes the processing enterprises due to both quantity of raw milk and its quality. Violations in maintenance technology, change of feeding and other factors cause changes in sanitary and hygienic, physical and chemical parameters and technological properties of milk, which ultimately decreases the efficiency of the industry and its profitability [17–19]. The situation can be changed, especially in a market economy, through strengthened control on the part of both the manufacturer and the processor.

The aim of the study was to investigate seasonal impact on quality indicators, including technological properties of raw milk for processing into various dairy products.

2. Materials and methods
The study was conducted at one of the commercial farm units in Sverdlovsk region.

Milk was produced by Holsteinized black-motley cattle of the Ural type. The studies were carried out monthly within a year in three replications.

Dry solids, protein, milk solids-not-fat (MSNF), density and fat content in milk were determined using the Klever-1M device; acidity was evaluated by titrometric method in compliance with Turner.

Technological properties of milk were assessed with respect to suitability of milk for cheese making – rennet coagulation, rennet-fermentation test, and to quality indicators of milk in accordance with GOST R 52054 – 2003 as amended in 2015.

3. Results
Evaluation of milk as a dairy raw material starts with sensory evaluation, namely its taste, flavor, color and consistency. In our case, sensory properties of milk met the requirements of GOST R 52054-2003. The milk was white or slightly yellowish in color with specific flavor and taste corresponding to cow’s milk, and of liquid consistency. The milk color changed depending on the season. A more intense yellowish hue was observed in summer and autumn milk, namely, from June to mid-October. This is likely due to the presence of carotene in feed. Green fodder, which replaces part of the feed, contains more carotene than silage and haylage used for feeding in late autumn and winter, and in early spring.

The milk composition was found to be season-dependent (figure 1).
Figure 1. Chemical composition of milk, %.

The highest content of dry solids, milk solids-not-fat, fat and protein in milk was noted in winter, whereas in summer these indicators were lowest. In our opinion, this is due to a certain change in feeding, namely replacement of part of the fodder with green one as well as higher milk production. The quantitative and qualitative indicators of milk production are known to have an inverse relationship – the higher the yield of milk, the lower the fat and protein content in milk. Our study revealed a similar pattern. Thus, the season of the year affects milk quality in terms of its physicochemical properties.

When evaluating milk, much attention is paid to physicochemical properties, since they are indicators of the naturalness and freshness of the product. The pH, an indicator of active acidity, has been used in recent years for technochemical control in cheese production. The study shows that changes in these indicators depend on the season, chemical composition of milk, and environmental conditions (figure 2).

Figure 2. Physicochemical properties of milk.
As can be seen in Figure 2, the most significant changes were observed in milk density, which ranged from 28.8 °A in summer to 30.2–30.4 °A in winter and spring. In our opinion, this is primarily due to changes in the chemical composition of milk, which are also associated with the season of the year.

In terms of sanitary and hygienic indicators, namely bacterial contamination and the presence of somatic cells, milk in all seasons, except for spring, was of the highest grade (figure 3).

In spring, mechanical contamination of milk increased up to group 2 which is often associated with climatic changes, that is temperature and humidity conditions. This suggests that the udder and the animal itself are more soiled in spring than in other seasons of the year. This is confirmed by other sanitary and hygienic quality indicators – bacterial contamination and the presence of somatic cells in milk during this period of the year. In this regard, spring milk belonged to the 1st grade. Within a year, 85% of the highest grade milk and 15% of the 1st grade milk were sold.

In the production of cheese, milk, as a raw material, is subject to additional requirements related to its specific technological properties, and the ability to curdle under the impact of rennet and lactic acid starter.

The study of rennet coagulation of milk showed that it curdled within a time period from 15 to 40 minutes, which corresponds to the 2nd grade, most suitable for cheese production (figure 4).

It was noted that the shortest coagulation phase was in spring shorter by 0'05"–2'35" (P<0.001), and in winter the phase was longer with a total duration of less than 40 minutes. This is likely due to the structural elements of milk and their amount.

The duration of the gelation phase, which determines the curd quality, indicates the suitability of milk for cheese making – the shorter the gelation phase, the denser the clot. The shortest gelation phase was characteristic of cow milk in summer, and in spring it was longer.
Figure 4. Milk rennet coagulation, min, sec.

The rennet fermentation test is used to evaluate the qualitative composition of milk microflora. It was found that milk quality was high throughout the year. Thermal stability of milk was high and met the requirements for processing milk into baby food, canned milk, etc.

4. Discussion
The quality of milk and its physicochemical indicators depend on many factors, including the season of the year, despite the creation of optimal feeding and housing conditions, in our case, one type feeding and year-round stall housing. The physicochemical characteristics and technological properties of milk from Holsteinized black-motley cows of the Ural type change depending on the season of the year. Winter milk showed the best nutritional and biological indicators; summer milk had the best technological properties for the production of cheese. Similar studies were carried out by A. Belookov, O. Belookova, V. Zhuravel, S. Gritsenko, and E. Ponomarev [5]; O. Gorelik, Y. Shatskikh, M. Rebezov, and E. Okuskhanova [3]; S. Gridina, V. Gridin, and O. Leshonok [8].

5. Conclusion
The season of the year affects the quality of milk, although it remains of the highest and first grade and exhibits high technological properties in all seasons. The season of the year has an effect on the sensory properties of milk. Thus, a more intense yellowish hue was noted in summer and autumn milk. The highest content of dry solids, MSNF, fat and protein in milk was observed in winter, while in summer these indicators were lowest. In terms of rennet coagulation, milk corresponded to the 2nd grade, which is most suitable for production of high quality cheese.

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