The influence of plant components on physicochemical and structural-mechanical properties of curd dessert

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Abstract. The article presents results of a research on the quality parameters of raw cow milk and a curd product developed. The parameters of raw cow milk were evaluated according to the following methods: sensory aspects according to GOST R ISO 22935-2-2011, the protein weight fraction by the Kjeldahl method (GOST R 53951-2010), fat by the acid-butyrometric method (GOST 5867-90), acidity by potentiometric method (GOST R 54669-2011), and density by hydrometric method (GOST R 54758-2011). The physicochemical parameters of the curd product samples were studied according to the generally accepted methods, i.e. the protein weight fraction by the Kjeldahl method (GOST R 54662-2011), fat by the acid-butyrometric method (GOST 5867-90), and pH by the potentiometric method (GOST 32892-2014). The developed product samples were examined for their storage capacity; the nutritional and biological values were determined using the reference tables developed by I.M. Skurikhin. According to the research results, a plant component, namely, blackcurrant jam added to the product to enrich its composition and impart certain sensory properties to the product has been considered appropriate. There has been revealed the optimal concentration of a plant component that improved the sensory characteristics of the curd dessert, i.e. jam of 15% of the curd base and dihydroquercitin of 0.05% of the curd base. The research has also found that blackcurrant jam in the recipe increased the weight fraction of protein by 0.3% and the weight fraction of fat in dry matter by 1.3% in the cottage cheese dessert. Dihydroquercetin in the product composition favorably affected the shelf life of the curd dessert in comparison with Control sample, since this additive leveled oxidative reactions, contributing to the spoilage of the curd dessert in storage of the product. According to the research results, all the components added into the curd dessert recipe had a positive effect not only on sensory and physicochemical indicators, but also on biological and nutritional value.

1. Introduction
The development of technologies and an increase in the pace of life stimulates the need for nutrient intake. Unfortunately, most available products are not rich in vitamins, macro or microelements, or amino acids. Therefore, the development and production of fortified food products are important today [2].
Milk is a product of normal physiological secretion of the mammary glands in the period of lactation and is obtained during milking, without any substances being added or extracted. Milk is rich in calcium, magnesium, potassium, sodium, phosphorus, chlorine, sulfur, phosphates, citrates, and chlorides. Dairy products contain a huge amount of macro- and microelements, essential amino acids, and vitamins [5]. Regular consumption of milk strengthens joints, nails, and teeth, improves the quality of sleep, and has a positive effect on the heart and blood vessels [7].

In addition to biological benefits, plant ingredients added into the recipe can reduce the cost of the product and make it more affordable for different segments of the population [1]. Blackcurrant jam is a very promising raw material for these purposes, since it contains a huge amount of vitamin C and K, manganese, and copper, while their lack in the body leads to various diseases.

2. Materials and methods
The purpose of the research study was to develop a recipe for a curd product enriched with plant components and analyze the composition and properties of the product obtained.

The objects of the research included raw material—raw cow milk and its products—cottage cheese desserts with blackcurrant jam (Test samples) and cottage cheese dessert without filler (Control sample). The samples were analyzed with respect to their sensory and physicochemical parameters in the laboratory of the department “Technology of food production” at Volgograd State Technical University and in the integrated analytical laboratory at Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production.

The capability of blackcurrant jam and dihydroquercetin being added into the product was determined by their chemical composition and the vitamin C content, as well as the effect of the dietary supplements on the shelf life of the product. Fats are known to be the most labile macronutrients limiting the storage duration of dairy products. The quality of products containing milk fat is provided by antioxidants [2]. Products intended for everyday consumption must have adaptogenic properties due to biologically active supplements. Dihydroquercetin is a drug that possesses both an antioxidant and an adaptogen [3]. The advantage of jam is its positive effect not only on the sensory characteristics of the finished product, but also on its nutritional and biological value. Blackcurrant jam contains a large amount of vitamin C and K, manganese, and copper.

The parameters of raw cow milk were determined according to the following methods: sensory aspects according to GOST R ISO 22935-2-2011, the protein weight fraction by the Kjeldahl method (GOST R 53951-2010), fat by the acid-butyrometric method (GOST 5867-90), acidity by potentiometric method (GOST R 54669-2011), and density by hydrometric method (GOST R 54758-2011). The physicochemical parameters of the curd product samples were studied according to the generally accepted methods, i.e. the content of the protein weight fraction by the Kjeldahl method (GOST R 54662-2011), fat by the acid-butyrometric method (GOST 5867-90), and pH by the potentiometric method (GOST 32892-2014).

The developed product samples were examined for their storage capacities; the nutritional and biological values were determined using the reference tables developed by I.M. Skurikhin.

3. Results and discussion
The quality indices of raw milk are given in table 1. The production method for curd dessert was based on acidic coagulation of proteins by fermenting skim milk with lactic acid bacteria, which was followed by heating the curd to remove excess whey. Blackcurrant jam based on vegetable sweetener was used as a flavoring and aromatic additive, since it is a source of fiber and has low calorie content. The sugar substitute is practically not absorbed by the body. To achieve better texture of the curd part of the dessert, a gelatin solution developed on skim milk was used. The finished product was dosed in layers into 250 ml containers, cooled, and stored until sale.

The deterioration of curd products is associated with free radical oxidation of both water-soluble and fat-soluble substrates of the product. Dihydroquercetin added into the curd product made it possible to neutralize oxidative reactions, contributing to the spoilage of the curd dessert during the storage. It was
also a positive fact that dihydroquercetin is a dietary supplement and is able not only to increase the shelf life of the product, but also has disinfecting and hepatoprotective properties.

Table 1. Milk quality in curd dessert production.

| Indicator             | Standard                                      | Test                                      |
|-----------------------|-----------------------------------------------|-------------------------------------------|
| Appearance and texture| homogeneous liquid with no sediment or flakes | homogeneous liquid with no sediment or flakes |
| Taste and smell       | clean, with no foreign tastes or odors        | clean, with no foreign tastes or odors    |
| Colour                | from white to slightly yellow                 | white                                     |
| Weight fraction of protein, % | 2.8                                        | 2.8                                      |
| Weight fraction of fat, %  | 3.1                                         | 3.3                                      |
| Acidity, °Т   | 16-18                                        | 17.5                                     |
| Density              | 1027.0                                       | 1027.0                                   |

First of all, the recipe ingredients for the curd product were selected, and the optimal amounts of added blackcurrant jam and dihydroquercetin were experimentally determined. Table 2 shows the values of the components in four samples produced.

Table 2. Concentrations of plant components in the product.

| Plant raw materials | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---------------------|----------|----------|----------|----------|
| Jam, % of the curd base | 5        | 10       | 15       | 15       |
| Dihydroquercetin, % of curd base | 0.025    | 0.05     | 0.05     | 0.075    |

In total, there were produced 4 samples with different concentrations of the filler. They were subjected to sensory analysis; the results are presented in the form of a profilogram (figure 1). Sample 3 possessed the best sensory characteristics, specific taste, and no dihydroquercetin aftertaste at a given concentration of jam. The taste of jam was insufficient in Samples 1 and 2; dihydroquercetin was not completely dissolved in Sample 4.

Overall comparative sensory assessment of Control and Test samples developed was conducted and resulted in a profilogram (figure 2). According to the sensory analysis, the jam added to the recipe had a beneficial effect on the taste, smell, and texture of the product. The filler imparted a berry aroma and flavor to it; therefore, the filler concentration was correct. The sensory characteristics of Test samples are represented in table 3 in more detail.
Figure 2. Profilogram of sensory aspects of samples.

Table 3. Sensory indicators of samples.

| Indicator | Characteristic | Control | Test |
|-----------|----------------|---------|------|
| Surface   | even distribution of curd | even distribution of curd and jam | |
| Texture   | homogeneous, spreadable, without perceptible protein particles | homogeneous airy texture without perceptible particles of protein or lactose, jam was evenly distributed over the surface of the curd | |
| Taste     | delicate curd taste, sweetish | clean, berry-curd taste, without foreign aftertastes | |
| Smell     | clean, fermented milk flavor | clean, berry-curd flavor | |
| Colour    | white | clearly separated layers, white, typical for flavoring filler | |

The analysis of physical and chemical properties of Control and Test samples included the following indicators: the weight fractions of protein and fat, pH, and nutritional and biological values. The analysis results are shown in table 4.

Table 4. Physicochemical indices of Control and Test samples.

| Indicator                      | Actual value |            |        |
|-------------------------------|--------------|------------|--------|
|                               | Control      | Test       |        |
| Weight fraction of protein, % | 10.7         | 11         |        |
| Weight fraction of fat, %     | 12.9         | 14.2       |        |
| pH                            | 5.2          | 5.2        |        |

The analysis of physical and chemical indicators found that the protein and fat weight fractions were by 0.3% and 1.3% higher in Test sample than in Control sample, which significantly increased the nutritional value of the product. Since the curd was produced using the same technology, the pH of the samples was the same.


**Figure 3.** Growth of active acidity in Test samples during storage.

The acidity growth rate in the product considerably affected the spoilage rate; therefore, the storage capacity of the products was determined by an increase in the acidity index during storage (figure 3). In accordance with the diagram, it can be concluded that dihydroquercetin added into the formulation had a beneficial effect on the storage capacity of the samples.

4. Conclusions

According to the study results, the expediency of raw cow milk as a dairy raw material and blackcurrant jam as a vegetable one was proved. The experiments confirmed that the plant material in a curd product had a positive effect on its consumer properties and contributed to an increase in their nutritional and biological value. The authors found that due to jam in the recipe, the protein weight fraction increased by 0.3% and the fat weight fraction in dry matter by 1.3%. Dihydroquercetin had a beneficial effect on the shelf life of the Test product in comparison with Control sample.

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