Research of the Ricotta made from cheese whey enriched with citrus dietary fiber

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Abstract. Whey is a unique raw material in the production of specialized food products due to the presence of easily digestible proteins and a wide range of minerals. The paper considers the technology of making whey cheese "Ricotta" from cheese whey with the addition of dietary fiber in the amount of 1, 3 and 5% of the raw material weight. The quality of the used cheese whey was assessed. The sequence of technological stages of production of Ricotta cheese enriched with dietary fiber is presented. The results of physicochemical studies of the Ricotta cheese samples showed that with an increase in the added citrus dietary fiber, the fat content decreases from 6.42% in the control sample to 5.02 in the sample with the addition of 5% citrus dietary fiber; the moisture content increases from 63.18% in the control sample to 65.88% in the sample with 5% dietary fiber. The results of descriptor analysis showed that with an increase in the content of dietary fiber, the product develops a citrus smell and taste, the texture becomes denser. The sample with the addition of 3% citrus dietary fiber has the most harmonious sensory indicators. The yield of whey cheese with 10 liters of cheese whey ranged from 496 g - a control sample, to 544 g - a test sample with the introduction of 5% dietary fiber. Thus, the results obtained show the possibility of introducing citrus dietary fiber into whey cheese.

1. Introduction
In recent years, milk whey has been widely used in the production of specialized products in world practice [1]. The products obtained on its basis are distinguished by high biological value, dietary properties, and are recommended in the diet of various groups of the population [1-3].

Ricotta is an Italian type of cheese with a high moisture content, also known as whey cheese. It is obtained after direct acidification of milk or whey and heating for denaturation and aggregation of proteins [4, 5]. In connection with the wide distribution in recent years of products with a reduced fat content, the development of low-fat products based on whey, including whey cheeses with various fillers, is relevant [6]. However, some authors have found that a decrease in the fat content in cheeses leads to a deterioration in taste and texture [7]. At the same time, there are interesting works on correcting the properties of low-fat cheeses, for example, through the use of different coagulants during protein folding [8]. Also, a well-known way to improve the texture of low-fat products is the introduction of dietary fiber [9, 10].

Dietary fiber not only plays a functional and technological role in food production, but is also a functional ingredient. They are widely used to fortify various foods. Functional foods are a growing market segment targeted at consumers who take greater responsibility for their health and well-being
Today, fiber is mainly added to dairy products (such as inulin and oat bran), meat products and cereals, or fiber can be used as additives to change the viscosity and texture of foods [12]. The aim of the work is to research the effect of citrus dietary fiber addition on the quality indicators of Ricotta cheese from cheese whey.

2. Materials and Methods

2.1. Raw material
Ricotta cheese was made from cheese whey obtained from the production of Cachotta cheese from goat's milk.

Herbalcel AQ Plus Citrus-F (Germany) was used as a source of dietary fiber.

Samples of Ricotta whey cheeses were made with addition of dietary fiber to the whey in an amount of 1, 3 and 5% to the raw material weight (sample designations R-1, R-3, R-5, respectively). When making a control sample of cheese, dietary fiber was not added (R-0).

Food citric acid was used to acidify whey.

2.2. Determination of quality indicators of cheese whey
In cheese whey according to GOST R 53438-2009 "Milk whey", sensory (appearance and consistency, taste and smell, color) and physicochemical indicators (mass fraction of solids, lactose, acidity, temperature) were determined using standard methods. All studies were performed in three repetitions.

2.3. Production of the Ricotta cheese samples
The production of Ricotta cheese was carried out as follows: the preparation of dietary fiber was added to the whey heated to a temperature of 38 ± 2 °C and the mixture was stirred in a homogenizer (Gastrorag SB-400) for 5 min. Then the whey was heated to a temperature of 87 ± 2 °C and citric acid was added, kept for 3–5 min without stirring until protein flakes appeared. The flakes were collected in cheese molds and kept for 12 h at a temperature of 8 ± 2 °C to separate excess moisture.

2.4. Research of the Ricotta cheese samples
After 12 hours of aging, the test samples of cheese were examined for sensory and physicochemical indicators using standard methods: the mass fraction of sodium chloride according to GOST 3627, the mass fraction of fat according to GOST 5867, the mass fraction of moisture according to GOST 3626.

Evaluation of the effect of various dosages of citrus dietary fiber introduction on sensory indicators of the Ricotta cheese was carried out according to 14 characteristics using descriptor analysis according to ISO 13299: 2003. Used the following characteristics: two characteristics of appearance (uniform color, cream color); two characteristics of the smell (sour milk smell, citrus smell); five characteristics of taste (sour milk taste, salty taste, bitter taste, sweet taste, spicy taste); four texture characteristics (soft texture, light texture, dense texture, uniform texture) and an overall quality rating.

The yield of the product was determined by the mass of whey cheese obtained from 10 l of cheese whey.

All studies were performed in three repetitions.

3. Results and Discussion
The results of the sensory analysis showed that the cheese whey used is a homogeneous liquid with a small protein sediment of a pale green color. Taste and smell characteristic, without extraneous tastes and smells, sweetish taste. In general, the quality indicators meet the requirements given in GOST R 53438-2009 Milk whey. The results of physicochemical studies of whey showed that the mass fraction of dry substances is 6.9%, the acidity is 18 °T, the mass fraction of lactose is 4.7%, which in all respects meets the requirements of GOST R 53438-2009 Milk whey.

The results of the quality indicators research of the Ricotta cheese are presented in Figures 1-4. In the study of samples of whey cheese Ricotta dependence is observed - with an increase in dietary fiber, the fat content decreases and the moisture content increases. Thus, the moisture content varies...
from 63.18% in the control sample to 65.88% in the test sample R-5 (Fig. 1). Araque et al. (2018) found the moisture content of ricotta when using various coagulants for protein folding from 48.3 to 57.3%. However, the authors used a mixture of whey and milk to make ricotta, which apparently provided a higher dry matter content [8]. Borba et al. (2014) found the ricotta moisture content to be 74 g per 100 g and characterized it as a highly moist cheese [13].

![Figure 1. Moisture content of the Ricotta cheese samples](image1)

The fat content of the ricotta samples ranged from 8.02% in the 5% fiber-added sample to 8.42% in the control cheese sample. Asensio et al. (2014) noted that ricotta has a low fat content - about 14%, in connection with which it can be recommended as a dietary product [14]. This higher fat content compared to our results is due to the fact that a mixture of whey and milk is often used in ricotta production.

![Figure 2. Fat content of the Ricotta cheese samples](image2)
Figure 3. Sodium chloride content of the Ricotta cheese samples

Figure 4. Results of descriptor analysis of the Ricotta cheese samples

The results of sensory evaluation of whey Ricotta cheese samples (Fig. 4) showed that with an increase in dietary fiber content, the softness and tenderness of the product increases, a sweet taste, creamy shade and a pleasant citrus aroma appear. Borba et al. (2014) noted that the use of whey as the predominant ingredient in the production of ricotta did not adversely affect textural parameters, including texture cohesion and elasticity [13]. Asensio et al. (2014) noted that ricotta has a soft, grainy, thick, slightly sour taste and white color [15].
The yield of Ricotta cheese samples, presented in Figure 5, shows that with an increase in the content of citrus dietary fiber, the yield of cheese increases, which can be explained by the high moisture-binding and water-holding capacity of dietary fibers [15]. The mechanism of the water-retaining process is confirmed by the preservation of the fiber structure and a significant increase in the volume of a fragment of dietary fiber due to the absorption of whey [16]. Araque et al. (2018) set the yield of ricotta at 8-12% [8].

![Figure 5. Product yield of the Ricotta cheese samples](image)

4. Conclusion

Thus, the results of the studies carried out showed that the addition of citrus dietary fiber in the production of Ricotta whey cheese has a positive effect on the sensory indicators of the product; at an optimal dosage of 3%, the physicochemical indicators also remain within the normalized values. In addition, the yield of the product increases, which, moreover, can be recommended in the diet of the population as a source of a functional ingredient - dietary fiber.

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