Research of the effect of willow-herb products in the preparation of kefir on the composition of fatty acids

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Abstract. Fatty acids are important for the human body, and are involved in many biochemical processes. Unsaturated fatty acids are considered to be the most preferred. Some unsaturated fatty acids cannot be synthesized in the body and must be supplied with food. These unsaturated fatty acids include the omega 6 and omega 3 groups, the most significant of which are linoleic, arachidonic, and linolenic. Medicinal plants that contain a high amount of biologically active components can serve as a promising source of enrichment of fermented milk products. Willow-herb was selected as a source of enrichment. Herb grass contains a large number of biologically active substances, has many medicinal properties, and there are no references to its use as food fortifiers of animal origin in the literature. The paper shows the possibility of using the extract of willow-herb in the technology of kefir preparation. The extract was added at the starter stage, with its replacement with an equal amount of milk. For fermentation of milk and getting kefir are used mesophilic lactobacilli producer Lactococcus lactis subsp. lactis, Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. biovar diacetylactis, Leuconostoc mesenteroides subsp. cremoris and the yeast Sacharomyces cerevisae. The composition of fatty acids in the obtained enriched kefir samples was studied using gas chromatography. The results obtained when comparing the control and experimental samples showed that the addition of willow-herb extract contributed to an increase in such unsaturated fatty acids as oleic, linoleic, linolenic, arachinic, and saturated fatty acids palmitic and begenic.

1. Introduction

It is known that inferiority nutrition leads to metabolic disorders that are dangerous for human health. For this reason, improving the quality of food is a significant issue around the world. Animal products have a number of features, due to the presence of minerals, vitamins, trace elements, as well as full-fledged proteins, milk and dairy products have the greatest biological value and good digestibility [1].

According to some authors, vegetable raw materials are well combined with milk products. Adding such raw materials to dairy products creates the necessary color, new taste characteristics, and increases the nutritional value. Some researchers describe the use of dandelion root extract in the production of cottage cheese products. At the same time, it is known that in the roots, in
addition to various biologically active compounds, there is a fatty oil, which includes glycerides of palmitic, oleic, linoleic, Melissa and cerotinic acids [2]. These are not the only studies that suggest the use of plant raw materials, medicinal plants as functional additives in the technology of dairy and fermented milk products.

One of the latest trends in the development of new food products is the replacement of animal fats, including milk fat, with food compositions of a protein nature that mimic the organoleptic properties of fat-containing components [3].

The authors of other studies have developed a technology for the production of fermented milk drink. The drink includes milk, kefir, water extracts of dandelion and Linden flowers. The composition of fatty acids in the drink has been studied as shown by the results, the use of plant additives increases the content of unsaturated fatty acids [4].

Fermented milk products have a high content of essential amino acids (7-11 times higher than in fresh milk), magnesium salts, calcium, phosphorus, vitamins A, D, E, which are involved in human metabolism, organic acids have a stimulating effect on the digestive glands, and improve the digestive process [5].

A promising source of plant origin for the enrichment of fermented milk products can be the grass of willow-herb. As shown by the research of I. V. Polezhaeva and co-authors, this plant contains a large number of biologically active compounds, mineral components, and amino acids. The plant is used as an anti-inflammatory, analgesic, and covering agent in the treatment of gastric and duodenal ulcers, and the plant extract has a sedative and anticonvulsant effect [6]. In the article G. R. Bushueva and co-authors indicate the presence of 10 most informative fatty acids in willow-herb: myristic, pentadecan, palmitic, palmitooleic margarine, stearic, oleic, linoleic, linolenic, arachidonic in the aboveground part of willow-herb [7]. The use of willow-herb as an enriching additive in the production of functional food products of animal origin, including dairy products, has not been studied. Taking into account the fact that willow-herb is a source of many biologically active substances and a source of important unsaturated fatty acids, such as linoleic, linolenic, arachidonic, which are not synthesized in the human body and must be supplied with food, the study of the effect of willow-herb extract on the amino acid composition of kefir enriched with it is relevant.

2. The purpose of the study

The purpose of the study was to use the extract of willow-herb in the preparation of kefir and to study its effect on the composition of fatty acids, in comparison with the control.

3. The object of the study

The object of the study was samples of kefir enriched with an extract of willow-herb obtained from the herb of pharmacy collection, and samples of kefir without adding an enriching additive.

4. Materials and methods

4.1 Production of experimental samples of kefir

Preparation of control and experimental samples of kefir was carried out in the laboratory of the Department of commodity science, technology and examination of goods of SUSU.

To obtain samples of yogurt were applied dry bacterial starter culture kefir "Skvaska", the manufacturer of Kaprina, Russia. The starter is packaged in a sachet of 3 g in the form of a dry powder, the number of sachets in the package is 5 PCs. The composition of the starter includes live mesophilic lactobacilli Lactococcus lactis subsp. lactis, Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. biovar diacetylactis, Leuconostoc mesenteroides subsp. cremoris and the yeast Sacharomycyes cerevisiae.

The raw material used was pasteurized milk "Kuryanochka", produced by Limited Liability Society "The Kursk milk" with a fat content of 3.2%. To obtain a control sample of kefir in 1 liter
of milk at room temperature, a dry starter in the amount of 3 g was added, mixed and left in an electric dry-air thermostat TS-1/80, at a temperature of +28 °C for 14 hours. After the product acquired a thick consistency, the kefir sample was placed in the refrigerator at a temperature of +2 °C for 3 hours.

To obtain a prototype, in the technology of preparation of kefir, at the stage of fermentation, an aqueous extract of willow-herb was added. The extract was added to the product with the replacement of part of the milk in an amount of 15% of the total weight. Willow-herb extract was obtained from the herb willow-herb of narrow-leaved pharmacy collection produced by Lekra-set, Russia.

To prepare 150 cm$^3$ of water extract from the leaves, flowers and stem of willow-herb, 15g of the medicinal plant was taken and distilled water was added in a volume of 200 cm$^3$. The mixture was heated in a boiling water bath for 20 min followed by cooling for 45 min then filtered. The timing of effective extraction was selected by the results of the experiments, the authors of the experiments indicated 20 min of infusion of fireweed herb, the amount of solids in the extract is growing after a 20 min extraction; the concentration of solids remains constant. Therefore, the optimal infusing time is 20 minutes, which corresponds to the recommended time indicated on the package of the medicinal plant [8].

In the experimental sample, the choice of replacing milk with willow-herb extract in an amount of 150 cm$^3$ or 15% of the total mass is due to the recipe for preparing the extract for maximum transition to the extract of biologically active substances.

4.2 Investigation of the composition of fatty acids in kefir enriched with willow-herb using a gas chromatograph
The study of the composition of fatty acids in the obtained kefir samples was conducted in Kursk regional veterinary laboratory.

The Chromatek – Crystal 5000 gas chromatograph was used for analysis with flame ionization detector (PID-1) and capillary column Supelco SP-2560, 100m×0.25 mm, ID 0.2 microns. Preparation of samples for analysis and their study were performed in accordance with GOST 32915-2014.

5. Discussion of the results
Table 1 presents the results of a comparative study of the composition of fatty acids in kefir, with the extract of willow-herb, and without the extract.

According to the study, 16 major fatty acids present in the product were identified in the test samples.

Among the fatty acids, limit and unsaturated fatty acids are defined. Limit and unsaturated fatty acids are present in the control and experimental samples of kefir. In the experimental sample of kefir, there is a decrease in the mass fraction of almost all marginal fatty acids except palmitic and begenic, which increased.

It was found that unsaturated fatty acids increased significantly in the test sample. Among them, groups of fatty acids belong to omega 9, 6, 3 unsaturated fatty acids. At the same time, the increase in essential polyunsaturated fatty acids of linoleic, linolenic, and arachinic acids is significant in experimental samples.

There are also studies describing the tendency to obtain modified dairy products with an increased content of unsaturated fatty acids by adding fish oil and vegetable additives. Some new dairy products partially replace the fat with vegetable fat or a mixture containing fish oil. According to researchers, this will lead to an increase in the level of omega-3 fatty acids, with subsequent benefits for the prevention of cardiovascular diseases [9].
Table 1. The content of fatty acids in kefir samples.

| Symbol of fatty acid | Name of a fatty acid according to the trivial nomenclature | Mass fraction of fatty acid, % of the amount of fatty acids in the control sample | Mass fraction of fatty acid, % of the amount of fatty acids in sample with extract of willow-herb |
|----------------------|----------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| C4:0                 | Oil                                                      | 2.676                                                                          | 0.801                                                                           |
| C6:0                 | Nylon                                                    | 1.944                                                                          | 0.554                                                                           |
| C8:0                 | Caprylic                                                 | 1.282                                                                          | 0.325                                                                           |
| C8:0                 | Caprine                                                  | 3.027                                                                          | 0.687                                                                           |
| C1:0                 | Decene                                                   | 0.293                                                                          | 0.062                                                                           |
| C1:1                 | Lauric                                                   | 3.535                                                                          | 0.992                                                                           |
| C1:2                 | Myristic                                                 | 11.612                                                                         | 3.240                                                                           |
| C1:4                 | Mirandolina                                              | 0.974                                                                          | 0.176                                                                           |
| C1:4                 | Palmitic                                                 | 30.727                                                                         | 30.800                                                                          |
| C1:6                 | Palmitoleic                                              | 1.718                                                                          | 0.501                                                                           |
| C1:6                 | Stearic                                                  | 11.809                                                                         | 7.612                                                                           |
| C1:8                 | Oleic                                                    | 22.169                                                                         | 28.793                                                                          |
| C1:8                 | Linoleic                                                 | 3.010                                                                          | 23.231                                                                          |
| C1:8                 | Linolenic                                                | 0.181                                                                          | 0.740                                                                           |
| C2:0                 | Arachidic                                                | 0.180                                                                          | 0.322                                                                           |
| C2:0                 | Begenova                                                 | 0.072                                                                          | 0.239                                                                           |
| C1:1                 | Other                                                    | 4.791                                                                          | 0.926                                                                           |

It is believed that saturated fatty acids are less useful for the human body, especially if they are excess in the diet. Scientists from China have conducted studies that establish a link between the amount of limit fatty acids consumed and the risk of strokes. Studies have shown that increased consumption of saturated fatty acids is associated with the occurrence of strokes [10]. A group of scientists from Canada and the United States conducted a similar study to identify the effect of saturated fatty acids on the risk of increased mortality and the occurrence of strokes and heart attacks among the elderly population, and obtained results that confirm these assumptions [11].
Polyunsaturated fatty acids (Pufas) have attracted a lot of attention due to their health benefits and antioxidant capacity. These fatty acids must be consumed from the diet or dietary supplements, since their synthesis is limited in the human body [12,13,14].

6. Conclusion
The influence of willow-herb products on the composition of fatty acids in the preparation of kefir was studied. The results obtained show the feasibility of using the extract of willow-herb in the technology of producing fermented milk products, in particular kefir.

The main advantage is to increase the essential unsaturated fatty acids in the resulting product, and reduce the content of saturated fatty acids. This is directly related to the content of these acids in the raw material - the ground part of the willow-herb grass, and is confirmed by studies of the chemical composition of this plant [7]. The decrease in the content of saturated fatty acids is associated with the replacement of part of the milk with the extract of willow-herb at the fermentation stage.

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