The use of plant proteins in the technology of fermented dairy-free products

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Abstract. It is proposed to use plant raw materials in the production of fermented products that do not contain milk. The possibility of using oats and buckwheat as milk substitutes is shown. Experimental samples of fermented products were obtained and their sensory, physical and chemical and microbiological parameters were studied.

Keywords: free-milk dairy products, vegetable milk, fermentation

1. Introduction

Today, there is a trend in the field of healthy nutrition associated with the production of products with a multicomponent composition, which includes not only macronutrients, but also vitamins, minerals and biologically active substances necessary for the human [1]. This is evidenced by the growth of the Russian and world markets for healthy food.

The Russian market is beginning to actively move towards meeting new consumer demands, which are formed under the influence of various factors [2]. Along with the traditional criteria of consumer choice of food products (price, taste, quality, etc.), new groups of criteria are emerging today, most of which are indicators of the formation of new patterns of consumer behavior. For example, a healthy lifestyle, product safety [3]. Gradually, a healthy lifestyle is becoming not just a “fashionable” trend, but an everyday lifestyle all over the world.

According to the results of studies in this area in the Russian Federation, about 70% of consumers actively monitor their diet in order to prevent various diseases, and more than 35% of respondents limit the amount of sugar and fat in their diet.

Thus, the search for new sources of raw materials, the development of methods for their processing is one of the priority tasks in the field of improving the quality of life of the population.

Fermented milk products are traditionally an important component of the nutrition of both children and adults [4]. For most Europeans, the era of their widest use began in the first half of the 20th century after I.I. Mechnikov discovered the positive role of fermented milk flora on the processes taking place in the human body. Until recently, in Russia were popular traditional fermented milk products - yogurt, kefir, fermented baked milk. Today, the trend for healthy nutrition in its various forms continues to dominate the milk and dairy products market, and yogurt is the most dynamic category in terms of launching new products, especially in Russia [5].

For many centuries, cow's milk has been the traditional basis for the production of easily digestible, most complete and affordable food products. Milk contains over 100 valuable components such as amino acids, fatty acids, minerals, as well as micronutrients and vitamins. Milk proteins contain all the amino acids the body needs, including 8 essential amino acids. In addition, all of the above components
are in an accessible form for assimilation [6]. At the same time, one cannot assert about the complete “idealality” of milk as a food product. This is due to the specific reaction of the human body to some components of milk, first of all, milk sugar (lactose) and milk protein (casein). Allergy to milk develops due to lactose or casein intolerance, dairy products must be removed from the human diet [7].

Currently, in Russia and abroad, an active search is underway for possible options for unconventional raw materials that are not inferior, and perhaps even superior in their properties, to cow’s milk. Such raw materials can partially replace animal milk (helping to reduce the content of food allergens, or reduce the cost of more expensive milk) or completely exclude milk from the recipe [8].

Plant materials that are promising for use can be classified into several large groups:
1) Cereals, herbaceous plants and products of their processing.
2) Legumes: soybeans, peas, chickpeas, lupines.
3) Fruit and vegetable crops: pumpkin, carrots, Jerusalem artichoke, zucchini, etc.
4) Wild-growing raw materials: cranberries, sea buckthorn, raspberries, lingonberries, blueberries, wild rose, hawthorn, wild garlic, sorrel, etc. The presented list of plant raw materials can be continued and expanded.

2. Materials and Methods

2.1. Preparation of lactic acid fermentation products
The preparation of lactic acid fermentation products was carried out according to the recommendations for the production of yoghurts [9, 10]. Vegetable beverages based on soy, oats, and buckwheat were used as the basis for the production of laboratory samples (1.5 % fat, Nemoloko, Russia).

2.2. Physical and chemical analysis
Physical and chemical analysis of samples of raw materials and products of lactic acid fermentation was carried out according to the recommendations [11, 12].

3. Results and discussion
At the Department of Technology of Meat and Dairy Products, KNRTU, work is currently planned and underway to study the possibility of using vegetable raw materials in the technology of products obtained by biotechnology methods.

We have selected the following types of plant materials: oatmeal, pearl barley and buckwheat, spelled. It seems advisable to choose exactly cereals, and not cereals in their pure form, because cereals in this case are more convenient to use. Cereals do not need to be pre-cleaned from shells, impurities and contaminants. It has a more stable chemical composition, good and long shelf life. Oatmeal is a product obtained from the processing of cereal - oats. Groats contain vitamins A, E, K, group B, as well as potassium, calcium, magnesium, phosphorus, sodium, zinc. It is rich in vegetable protein and fiber. Oatmeal contains high-quality, easily digestible vegetable protein (fairly balanced in amino acid composition), which is necessary for building body cells. Oat-based products have an important feature - the ability to envelop the walls of the stomach with a protective film and reduce the acidity of gastric juice, which is important for problems with the gastrointestinal tract: gastritis, peptic ulcer, flatulence.

Buckwheat is the seeds of common buckwheat. Buckwheat proteins contain many amino acids: lysine, tryptophan, which are necessary for the synthesis of their own proteins in the body. Buckwheat is one of the few cereals that contains choline, which is essential for the nervous system. It contains a lot of flavonoids with strong antioxidant properties that protect against malignant tumors and premature aging, and organic acids that stimulate digestive processes. Compared to other cereals, buckwheat is rich in iron involved in hematopoiesis, contributing to the normalization of blood pressure, cleansing blood vessels from excess cholesterol. Nicotinic acid, present in sufficient concentration in the product, supports heart function.

Soy products have long and successfully proven themselves as an alternative to animal protein and are widely used in the production of various products, including milk substitutes. Soy milk contains over 30% protein of natural origin and includes all essential amino acids, which distinguishes it from other
plant sources of protein. Fats are represented by unsaturated acids, and soy products also contain a number of vitamins and minerals necessary for the normal functioning of the human body. Subsequently, we carried out primary studies of the fundamental possibility of using non-traditional plant components in the technology of new products based on lactic acid fermentation.

As a base, instead of cow's milk, we used drinks of plant origin (conventionally called “milk”) based on soybeans, oats and buckwheat (the characteristics are presented in Table 1).

| Table 1. Characteristics of milk replacers |
|------------------------------------------|
| **Index**               | **Soybean “milk”** | **Buckwheat “milk”** | **Oatmeal “milk”** |
|-------------------------|--------------------|----------------------|---------------------|
| Protein, %              | 4.0                | 1.0                  | 1.0                 |
| Fat, %                  | 1.5                | 1.5                  | 1.5                 |
| Carbohydrates, %        | 7.0                | 6.5                  | 6.5                 |
| Energy value, kcal      | 60                 | 45                   | 45                  |
| Ingredients             | Water, refined soybeans (8%), sugar, calcium (calcium carbonate), acidity regulator (potassium phosphates), flavor, sea salt, stabilizer (gellan gum), vitamins (B2, B12, D2) | Water, buckwheat flour, rapeseed oil, calcium (tricalcium phosphate), flavor, sea salt, stabilizer (gellan gum), vitamins (B2, B12, D2) | Water, oat flour, rapeseed oil, calcium (tricalcium phosphate), flavor, sea salt, stabilizer (gellan gum), vitamins (B2, B12, D2) |

Samples of products of fermented milk fermentation were developed according to the classical technology for the production of yoghurt products and an assessment of their main parameters was carried out (Table 2, 3).

| Table 2. Physicochemical properties |
|-------------------------------------|
| **Samples** | **Fat, %** | **Protein, %** | **Moisture, %** | **Dry matter, %** | **Ash, %** | **Carbohydrates, %** | **Acidity, °T** |
| sample 1    | 1.3        | 3.4          | 88.3            | 11.7            | 0.7       | 6.3               | 87.4           |
| sample 2    | 1.5        | 0.9          | 88.3            | 7.65            | 0.7       | 6.1               | 79.6           |
| sample 3    | 1.5        | 0.9          | 88.2            | 8.36            | 0.7       | 6.2               | 75.3           |

| Table 3. Sensory assessment of fermentation products |
|-----------------------------------------------------|
| **Indicators** | **Sample 1** | **Sample 2** | **Sample 3** |
| Appearance and consistency                          | 1.3 | 2.5 | 2.8 |
| Taste and smell                                     | 3.4 | 4.1 | 4.2 |
| Color                                               | 1.5 | 1.8 | 2.0 |
| Total points                                        | 6.2 | 8.4 | 9.0 |

sample 1 is a product with soy “milk”, sample 2 is a product with oat “milk”, sample 3 is a product with buckwheat “milk”.

Evaluation of the chemical composition showed that in test samples 2 and 3, a slight decrease in acidity was noted. Nevertheless, all samples fully met the requirements of regulatory documents.

It was found that the best organoleptic characteristics were possessed by a sample of a fermented milk product obtained from buckwheat “milk”. This product was distinguished by a milky white with a cream shade, a uniform color throughout the mass, a neutral taste with hints of buckwheat “milk”. It should be noted that the consistency of this sample was more typical for a drinking yoghurt drink, which makes it possible to use it for the production of this category of products. It was this sample that became the basis for the development of the formulation of the plant-based fermented milk fermentation product: drinking and thermostatic.
At the final stage of the work, based on the research carried out, as well as on the previously obtained results, we have developed formulations of fermented products. Buckwheat “milk” was used as the main raw material, which was selected on the basis of a combination of sensory and physicochemical evaluation.

The analysis showed the compliance of the images obtained with the requirements of the normative and technical documentation for organoleptic and physicochemical quality indicators (Table 4, 5).

Table 4. Sensory assessment of fermentation products

| Indicators          | Drinkable fermented product | Thermostated fermented product with intact curd |
|---------------------|-----------------------------|-----------------------------------------------|
| Appearance and consistency | Homogeneous consistency, moderately viscous | Homogeneous, moderately viscous, with an undisturbed clot. Slight separation of whey is allowed on the surface of the product (no more than 3.0% of the product mass) |
| Taste and smell | Pure, fermented milk, with a pronounced taste and smell of the plant component | Milky-creamy, uniform throughout the product mass |
| Color | Milky-creamy, uniform throughout the product mass |

Table 5. Physicochemical properties of fermentation products

| Index             | Value         |
|-------------------|---------------|
| Fat, %            | 1.5           |
| Protein, %        | 3.4           |
| Titratable acidity, ºT | 75–110       |
| pH                | 4.6–4.2       |
| Phosphatase       | not found     |

Microbiological analysis of the resulting product showed the content of starter microorganisms in the amount of 107 CFU in 1 g of the product, which meets the requirements of regulatory documents for fermented milk products, in particular for yoghurts.

Based on the results obtained, it can be concluded that, if all the necessary storage conditions are observed in the lactic acid fermentation product (fermented buckwheat milk), St. aureus, BGKP (coliforms), pathogenic microorganisms, including salmonella and L. monocytogenes and yeast, and the mold content found in 1 g of products does not exceed the permissible level.

The number of lactic acid microorganisms during storage increased by 0.6–0.8 CFU / cm³, which may be associated with the continued development of lactic acid bacillus, introduced into yogurt with sourdough.

The results of this study made it possible to establish the shelf life of new types of fortified yoghurts, which was 7 days, which is the most acceptable and safe from the point of view of consumers.

The conducted studies allow us to positively assess the prospect of using plant raw materials in the production of fermented drinks based on lactic acid fermentation. The resulting products have an original taste, while fully meeting the requirements for lactic acid drinks. The composition of the obtained product allows it to be consumed by persons with lactase deficiency, as well as overweight and in need of products with the effect of postabsorptive saturation.

Further work will be aimed at finding and developing technological methods and techniques for processing the above raw materials to obtain new types of food products, including biotechnology methods that meet modern requirements and ideas about healthy eating and consumer market demands.

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