DEVELOPMENT AND INTRODUCTION OF NEW DAIRY TECHNOLOGIES

L. M. Zakharova

Kemerovo Institute of Food Science and Technology
bul`v. Stroitelei 47, Kemerovo, 650056 Russia,
phone: +7(3842)39-68-58, e-mail: zaharova_lm@mail.ru

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Abstract: Recently the Russian dairy industry has undergone large changes, predetermined by the increasing use of nondairy raw materials (vegetable fats and proteins, natural fruit and vegetable fillers, etc.). This is associated with the increased demand for new products that not only have traditional nutritive properties but also make up for the deficit of certain nutrients in the ration. Practically all types of dairy products can be combined with various vegetable components. This article attempts to solve the problem of creating healthy foods by considering natural ingredients and technological specifics of functional food production.

Keywords: scientific developments, functional food products, biologically active substances, milk, cheese products, nutritive and biological value, essential nutrients, dietary fibers, galacto-oligosaccharides, probiotics, dairy products

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INTRODUCTION

At the Kemerovo Institute of Food Science and Technology (Russia), a scientific school has formed that solves important scientific and technical problems of the development of the dairy industry. The founder of this scientific school is Lev Aleksandrovich Ostroumov, who has dedicated more than 50 years of his life to the development of the dairy industry. He is known in Russia and abroad as a scientist who deeply understands trends in the global practices of dairy engineering and technology.

Ostroumov's scientific school is universally recognized, and his scientific works in the sphere of milk processing have a great impact on the formation and development of the industry's scientific potential. Ostroumov was awarded the Honored Worker of Science and Technology for excellence in scientific research.

Many doctors of sciences and professors at the Kemerovo Institute of Food Science and Technology have passed through the school of Prof. Ostroumov. Among his disciples are Anatolii M. Popov, Irina A. Smirnova, Lyubov' V. Tereshchuk, Aleksandr Yu. Prosekov, Aleksei M. Osintsev, Lyudmila M. Zakharova, Irina V. Buyanova, and Svetlana M. Lupinskaya.

Investigations of Ostroumov's scientific school are aimed at the implementation of topical problems of the dairy industry and are undertaken in the following areas.

– Improving the technology of large rennet cheeses and developing the concept of the biotechnology of these cheeses, thus facilitating the production of cheeses of accelerated ageing and guaranteed quality. The research findings have been introduced into practice to clarify production processes, as well as the storage modes for hard rennet cheeses, to improve consistency, reduce cheese-ripening times, and improve salting modes. Research has helped to intensify high-temperature cheesemaking processes of curd scalding and to design new technologies.

– The development of theoretical and practical basics of soft cheese production, which is promising for the industry.

AN OVERVIEW OF NEW DAIRY TECHNOLOGIES

Cheese with its high nutritive and biological value, balanced composition of the main components, and wide spectrum of organoleptic indicators refers to widespread foods. Cheeses should comprise the daily ration of various categories and age groups of people. The problems of increasing production and expanding and adjusting the assortment of cheeses produced in Russia have been topical for many years. It is unlikely that cheese production will be increased in the near future due to limited primary resources, milk suitable for cheesemaking.

In recent years the production of soft cheeses has gained wide acceptance. The technological specifics of these cheeses are the processing of milks of a certain degree of maturity, the use of high temperatures of milk pasteurization, acid–rennet clotting of milk, soft modes of granular curd production and processing, lengthy cheese mass self-pressing, granular curd salting, and the absence of the ripening stage. Soft cheeses are characterized by a short production cycle, reduced raw-material consumption per unit of output, and a more rational use of milk components.

A promising way of soft cheese production is the use of raw materials nontraditional for cheesemaking alongside milk raw materials, in particular, vegetable additives. Soft cheeses are a good basis for the creation of new-generation foods. First, they refer to protein products; therefore, the adjustment of their composition improves the biological and nutritive value of a product. Second, the production process of soft cheeses

makes possible a wide use of nondairy raw materials, introducing them at the stages of milk preparation for coagulation and for granular curds before molding, at the pressing stage, and at the stage of the finished product. The third condition to ensure the creation of soft cheeses is a good compatibility of the fermented-milk taste of cheese mass with the taste of introduced components. Fruit, vegetable, and wild-growing raw materials, as well as marine products and vegetable oils are used to enrich cheeses. The use of nondairy components is of a polyfunctional nature due to the presence in them of many biologically active ingredients (vitamins, minerals, amino acids, polyunsaturated fatty acids, dietary fibers, and other essential nutrients).

The production of cheeses with vegetable components is quite widespread in Southeast Asian and Western European countries, as well as on the American continent. Japan, China, Korea, and other countries make cheeses with added soybean products, isolates, concentrates, or curds (tofu). Germany manufactures potato cheese, and France, cheeses with onions, pepper, and fruit. Cheeses with nuts, fruit, vegetables, and spice plants are popular in Greece, Italy, Spain, and Portugal.

In Russia the assortment of cheeses in which the milk base is combined with plant additives is limited. The analysis of economic and technological features of making various cheeses shows that the production of soft cheeses is promising. Their production is more economical because 1.5-times less milk is consumed to produce them. Moreover, no specific requirements are imposed on milk fitness for cheesemaking and on expensive cheesemaking equipment. The production of such cheeses ensures a quicker turnover of committed finances and smoothes the seasonality of cheesemaking. The cheeses of this group have good consumer properties and a high nutritive value. Production may be organized practically at any dairy factory. A social advantage is that the cheeses of this group are cheaper and accessible to low-income groups. In addition, the use of nondairy raw materials, nontraditional for cheesemaking, makes it possible to enrich the nutritive balance with large amounts of vegetable components that are currently not used or used inefficiently.

Taking into account the topicality of this problem, the Kemerovo Institute of Food Science and Technology (Russia) has conducted a number of integrated studies on the development of various soft cheese technologies with complex feed compositions, widely using local vegetable raw materials (berries, vegetables, wild-growing plants, oil-bearing crops and products processed from them, legumes and products processed from them, and grains and products processed from them). It has been established that vegetable additives blend well with dairy raw materials and are characterized by a high content of biologically valuable substances, such as indispensable amino acids, micro- and macroelements, vitamins, dietary fibers, and polyunsaturated fatty acids. A computer database has been created, Classification and Composition of Nontraditional Raw Materials Used in Dairy Production. Requirements to nontraditional raw materials used in soft cheese production and their preparation methods that ensure the preservation of their biochemical composition, sanitary reliability, and extended storage life, have been established.

Computer software has been developed for designing products of complex primary compositions, which uses preset specifications for essential substances, can determine the type and relative content of the feed components, calculate their energy values, and recalculate their formulas accordingly. Mathematical models of cheeses with chemical compositions adequate to biomedical requirements that take into account the necessary balance of indispensable amino acids, vitamins, as well as dietary fibers, and the preset ratio of saturated, monounsaturated, and polyunsaturated fatty acids, as well as individual minerals, have been developed. A good sensory compatibility of vegetable additives with the dairy feed stock in the ratio obtained by mathematical design has been confirmed experimentally.

Scientific approaches to the production of new cheeses of complex composition have been developed. The physicochemical and technological regularities of cheesemaking have been studie. The mechanisms and regularities of interaction between dairy and nondairy feed components during acid–rennet coagulation have been considered and established. The influence of the main technological factors (mix-curdling temperature; curd-processing temperature; self-pressing duration; and salting, ripening, and storage conditions) on the efficiency of the primary components used and on the formation of quality indicators for soft cheeses of complex compositions has been revealed. Rational production parameters have been determined for guaranteed-quality products. Their nutritive, energy, and biological values, as well as physicochemical, microbiological, and organoleptic indicators during storage, have been analyzed.

Research undertaken in this area has allowed us to create a galaxy of cheese products, over 20 names of new soft cheeses with complex feed compositions.

Technologies have been created that make it possible to enrich cheeses with vitamins and minerals. As is known, cheeses contain practically all vitamins but in low amounts. Thus, 100 g of cheese meet less than 5% of the average daily demand for vitamins B_1, B_6, PP, C, E; about 10% of vitamins B_{12} and D; 16% of vitamin A; and 17.5% of vitamin B_2. Good results have been obtained using vegetable raw materials (buckthorn, chokeberry, viburnum, currant, garlic, celery, etc.) as the sources of these vitamins. The inclusion of representatives of this promising feed group in the cheese composition can adjust the contents of individual amino acids, carbohydrates, vitamins, macroelements, essential oils, and other compounds in cheeses.

Methods of enriching cheese mass with these components have been developed. The components can be introduced in their natural or conserved forms, as well as in the form of various vitamin preparations made from these raw materials. A practical result of the

research is the creation of the following cheeses: *Lesnoi* with fern; *Ryabinka* with chokeberry; *Chesnochnyi* with garlic; *Vesennii* and *Sibirskii* with parsley, dill, and celery; etc. These cheeses best combine traditional consumer properties with the requirements of positive nutrition by containing physiologically valuable natural ingredients.

Integrated studies have been conducted on the use of grain-processed products in the production of soft cheeses in order to enrich them with essential nutrients. Grain and cereal processors that deal with wheat, rye, barley, oats, corn, rice, etc., have large amounts of secondary products whose biological value is unquestionable, and at the same time not all of them are used fully in food production.

The bran share from processing wheat grain into flour reaches 26% of the total amount of the raw material, and the amount of protein in bran is 25–30% of its total content in the raw material; during grain milling, wheat bran retains 65% of minerals, 40% of fat, and 100% of dietary fibers. Wheat bran usually consists of an aleurone layer, characterized by a specific chemical composition. Bran contains more vitamins (PP, 9.47–14.01; B_1, 0.97–1.14; B_2, 0.22–0.28; B_6, 0.83–1.05; E, 31.7–35.78 mg/100 g) and minerals (potassium, 1121–1498; magnesium, 371–447; phosphorus, 900–950; calcium, 97–123; sodium, 46–55; and iron, 1.2–1.3 mg/100 g) than various grades of wheat flour. The proteins of wheat bran are richer in their amino acid content. A higher amount of deficit amino acids (lysine, threonine, and methionine) in the bran proteins is predetermined by their specific fractional makeup and a relatively high content of albumins and globulins. In addition, bran contains more than 50% of dietary fibers. The nutrient materials of fiber texture comprise second-order polysaccharides (cellulose, cellular tissue, hemicellulose, pentosan, lignin, pectic substances, etc.).

Thus, relatively high amounts of protein (14–16%), vitamins, minerals, and ballast substances that go into wheat bran during grain milling make it possible to use this raw material not only for feed but also for food purposes. The use of wheat bran in food production makes it possible:

– to increase the food protein resources;
– to improve the efficiency of grain processors;
– to create functional additives that contain valuable components for improving the quality of traditional foods and for creating new foods; and
– to develop foods with a balanced composition of their main components.

A soft cheese technology has been proposed using wheat and rye bran. The *Zernovoi* acid–rennet soft cheese is made using wheat bran, and the *Tryufel'nyi* cheese, using rye bran.

The *Zernovoi* and *Tryufel'nyi* cheeses are biologically wholesome products, containing indispensible amino acids, vitamins, macro- and microelements. Thanks to bran addition, cheeses are enriched with dietary fibers, whose content is 5–6 g in 100 g of cheese. As a result of mixing vegetable and animal proteins, which complement one another by their amino-acid composition, cheeses are enriched with sulfur-containing amino acids (methionine + cystine) and lysine, which are most valuable for humans. The score of these amino acids increases by 2.1 and 1.8%. Thanks to bran addition, the vitamin contents increase in the raw product: thiamin by 4.7, pyridoxine by 2.8, niacin by 4.1, and tocopherol by 7 times. Moreover, the content of dietary fibers in cheese increases substantially its value as a dietary and therapeutic product. Cheese products have a good sour-milk flavor and odor with a taste of bran, as well as a flexible consistency.

A reduced consumption of milk raw materials in production and an increased product output due to bran addition are the main economic advantages of the soft acid–rennet cheese products, like *Zernovoi* and *Tryufel'nyi*.

Of certain interest were studies on cheese products using wheaten germinal flakes, which are a promising vegetable raw material with a wide range of therapeutic (antioxidant, antitoxic) properties, a unique biochemical composition, and a set of biologically active substances. The use of wheat germs is especially topical in the current environmental conditions, in which the food ration should necessarily contain biologically active substances that improve human resistance to unfavorable environmental impacts. Thanks to their unique composition, wheat germs, if taken regularly, have bracing, restorative, and antiradiation effects; increase working capacity and resistance to various infectious diseases; and normalize the activity of the gastrointestinal tract. In addition, a number of latest studies show that wheat germs also have a hypoallergic effect.

In this respect, we have studied the physicochemical indicators of wheat germs that were produced at OAO Mel'korm, Kemerovo, from high-grade wheat, which complies with the GOST 9353-85 requirements, using the Buhler (Switzerland) processing equipment, which complies with the TU 9295-001-00932169-96 specifications.

The studies of the chemical composition of wheat germs have revealed that they contain 21.5–28.3% of proteins, 8.5–11.2% of lipids, 8.6–10.4% of mono- and disaccharides, 18.6–24.2% of starch, and 4.6–5.1% of ashes.

Note that the analysis of the lipid fraction of the germs under study has revealed that its composition is characterized by high contents of polyunsaturated fatty acids (linoleic acid, 49.2% and linolenic acid, 15.2%) and tocopherols (265 mg/100 g), among which both general-vitamin (α-tocopherols, 75–80 mg/100 g) and antioxidant (γ- and δ- tocopherols, 185–190 mg/100 g) forms have been identified.

The study of the vitamin complex of wheat germs has revealed contents of thiamin, 1.6–4.1; riboflavin, 0.9–1.9; niacin, 3.3–4.8; and pyridoxine, 0.8–1.0 mg/100 g.

The mineral composition is represented by phosphorus, 210–230; potassium, 320–400; calcium, 245–265; magnesium, 248–254, sodium, 6–13; iron, 12–15; manganese, 1.0–1.2 mg/100 g; and other elements, the contents of heavy metals not exceeding the permissible rates.

Along with the chemical composition of wheat germs, we have studied their functional properties. A water-absorbing ability (200%) of the product has been identified, its maximum value being obtained at (85 ± 2)°C.

These studies have laid the foundation for the development and approval of technical documentation for the *Pshenichnyi* acid–rennet soft cheese.

Assessing the quality of the amino acid composition of the *Pshenichnyi* cheese, note that its proteins are well balanced in the content of indispensible amino acids and have a high biological value.

The use of wheat germs in the production of the *Pshenichnyi* cheese changes significantly its fatty–acid composition. Our estimations show that the amount of linolenic acid in the *Pshenichnyi* cheese increases by 5–8 times compared to regular soft cheeses and the amount of linolenic acid, by 3–4 times.

Of special notice is the enrichment of the *Pshenichnyi* cheese with vitamin E. In 100 g of this cheese, the average content of tocopherols is from 5.0 to 7.0 mg, which meets 50% of the daily demand of the human organism for this vitamin. We have proved experimentally the stimulating effect of wheat germs on the growth of bifidobacteria.

Soybean and its processed products have been considered as a potential protein source in the production of soft cheese products without ageing. As is known, partial or full replacement of animal proteins with soybean proteins in the human ration leads to largely reduced cholesterol contents in the blood, which, in turn, reduces the risk of cardiovascular diseases. Acid–rennet and thermal acid cheeses with soybean have been developed, *Soft Combined Cheese*, *Novinka*, *Ideal,* etc.

In order to create new cheeses balanced by their fatty–acid composition, we have studied the composition and properties of the most widespread vegetable oils, sunflower, corn, cameline, olive, soybean, etc. The addition of vegetable oils increases the content of polyunsaturated fatty acids in cheese, and their necessary presence in the human ration is well known.

The comparative analysis of the new products shows their higher nutritive value compared to traditional cheeses, which, in turn, depends on vegetable additives in them. Thus, we have modeled the compositions and developed the technologies of new cheese products, which allow us to economize on milk raw materials, use valuable vegetable inputs, and simultaneously extend the assortment of competitive products with improved organoleptic, nutritive, and functional properties, so attractive for the Russian consumer. The newly developed soft cheese products meet the state-of-the-art food hygiene requirements for various strata and neutralize the negative environmental effects on the human organism.

A currently large research area is the integrated processing of milk raw materials and the development of principally new technologies and milk-based functional foods. Research in this area is carried out in the Department of Milk and Dairy Products Technology under the leadership of Prof. Ostroumov, Dr. Sci. (Eng.). Postgraduate students, masters of sciences, students, and specialists of the dairy industry are actively engaged in research in the following fields:

– the improvement of traditional milk technologies by more efficient use of raw materials, longer storage life, higher nutritive and biological values;

– the adjustment of the fatty–acid and amino–acid composition of dairy products by partially replacing milk raw materials with vegetable and animal raw materials; and

– the creation of scientific and practical basics for the development of principally new functional foods, enriched with biologically active components, capable to reduce the negative effects of hazardous food factors on human health and to improve the general condition of the human organism.

The past decade is characterized by an increase in diseases related to nutritive disorders. Sound nutrition ensures the normal growth and development of the human organism and contributes to higher working capacity and immunity, disease prevention, and human adaptation to the worsening environmental conditions.

Domestic producers are constantly expanding the assortment of products, improving their production technology, packaging and wrapping materials, and trying to meet consumer needs more fully. However, unfortunately, functional foods with high nutritive and biological values and enriched with vitamins, minerals, and ballast substances are few in the Russian food market, and these products are mainly of foreign makes.

Sound nutrition is perceived as a major element of a healthy lifestyle. For individual consumers, healthy nutrition is a rule that they try to stick to every day. Such people use mainly natural products, include the maximum of fruit and vegetables into their ration, and watch their daily norms of food consumption. For other consumers, this is rather a declaration of a healthy way of life.

In order to reveal the general perception of the category of milk-based functional products in Kemerovo, a market research of the functional food market was conducted using depth interviews.

Women aged from 25 to 45 years who are regular consumers of dairy products were chosen as a target audience. The majority of the participants in the survey characterized their lifestyle as active, i.e., a full working day and family chores. The tense daily routine of the respondents may tell negatively on their nutrition. For many participants in the survey, the use of cultured milk foods during the day is a way to neutralize nutrition faults (diet violations, heavy foods) and the effects of negative external factors (lack of vitamins, bad environment, stresses, etc.). Among the most important life priorities of the Kemerovo consumers are the health of close relatives (especially, children), a good psychological atmosphere in the family, good living conditions (material security, permanent employment, etc.), the balance of mind, the preservation of attractiveness (especially topical for more aged women), and self-development. Many participants in the survey noted their own or their children's digestion problems at present or in the past.

Proceeding from the above, we may distinguish the following motives for using functional dairy products at the rational level:

– digestion normalization (from the preventive or curative point of view);
– the diet and desire to normalize weight;
– the purification of the body and waste removal;
– the supply of additional vitamins; and
– the appeasement of hunger (it largely refers to drinking yogurts with various flavor additives).

At the emotional level, the use of functional products contributes to the meeting of the following needs:

– tonicity arousal, good spirits (as a result of well-being), stress management; and
– the opportunity to look attractive.

The survey has revealed the following main factors that affect the choice of a new brand of dairy products: brand distinction; colorful and attractive packaging; the prefix BIO in the product name; the statement of the nutritive effect of the product on its packaging; the presence of special ingredients (bifidobacteria, a vitamin complex, etc.); a short shelf life, which indicates the absence of preservatives and the naturalness of the product; and a low fat content. An additional incentive for sales is an affordable price. Such factors as the volume of packaging and the manufacturer are less important for the consumers of functional products. The most optimal in terms of convenience is packaging functional products in volumes of 0.3–0.4 L. Packages of 1 L are bought exclusively for household use.

Overall, the survey has shown that the category of functional products is well formed in the consumer consciousness. The term *functional* is associated with the presence of "useful additives." Unlike traditional cultured milk foods, they are ascribed the following properties: a large amount of useful "living" bacteria and the ability to normalize digestion. In addition, it has been revealed that elderly women are more perspicacious in the category of functional products compared to young consumers.

In the present living conditions with unfavorable factors, large attention is paid to the creation of directional products, which can stimulate the human immune system and which can be used to prevent a number of diseases.

Among nutritive factors that are of special importance for health support, a major role belongs to the full-fledged and regular supply of the human organism with all the necessary vitamins and minerals. Especially great is the role of vitamins and minerals in children's and adolescence ages, which is associated with the intensity of growth processes, the formation of the child's organism, and the strain of exchange processes during this period.

The creation of new foodstuffs that can reduce the negative effects of the environment on the human organism and correct various physiological disorders, that are designed for the mass prevention of many diseases, and that meet the current requirements of nutrition hygiene of various strata is a major problem for food research institutes, food higher education establishments, and food processing technologists.

An area of the design of such products is the use of natural components in their production.

Secondary products of wheat processing have a great future in the production of baked goods, and now many goods have been developed and produced with bran for preventive and dietary purposes. Wheat bran as food products and biologically active additives is used increasingly widely in the perfume and medical industries. However, it is still not widespread in the dairy industry.

The Department of Milk and Dairy Products Technology has conducted research into the composition and technological properties of wheat bran, found rational methods of technological processing, studied the synergic effect in the use of food ingredients that has made it possible to reduce the component doses and the production cost of products, developed recipes and technologies for products with higher biological and food values and enriched with ballast substances, and studied the quality indicators of new products.

Protein products have been created on the basis of combination of milk and the main milk ingredients with wheat dietary bran.

A new protein product, Laktoaleiron, has been developed for mass consumption, as well as for dietary and preventive nutrition. The product is made from normalized milk mixture with the addition of a vegetable component, viz., wheat dietary bran. The use of wheat bran in the production of milk-protein products saves milk raw materials: the introduction of wheat bran before milk pasteurization increases the curd yield almost by 18%. In addition, the bran intensifies the souring process, because the acidity of the milk–vegetable mixture increases much faster. The raw-material components are selected by method of mathematical modeling with preset limitations to the function magnitude and adjustable indicators: the energy value of the designed product is minimal; the optimal ratio of the three most deficient amino acids, tryptophan : methionine : lysine is 1 : (2–4) : (3–5); the optimal consumption of indispensible amino acids is (25–26) g/day; the optimal ratio of minerals, Ca : P : Mg is (0.8–1) : (1.0–1,5) : (0.3–0.5); the optimal supply of ballast substances is 25 g/day; the balance of the main components, protein : fat : carbohydrates is 1 : 1.2 : 4. The finished product has a clear sour-milk taste and odor with a pleasant flavor and bran aroma, a uniform and tender consistency, and a cream-white color; the mass fraction of fat is no more than 5%; that of moisture, 75%; and that of saccharose, 3%. It should be noted that the ratio of leucine to isoleucine is 1.81, which indicates a high biological value of the proteins of the curd product enriched with wheat bran. We should specially consider the enrichment of the curd product with dietary fibers (7%). They are the basic category of functional nutrition; they affect positively the digestion processes and, consequently, reduce the risk of diseases associated with these processes. As is known, the dietary fibers of wheat bran bind most actively cholic acid and other products of cholesterol exchange; they

are capable of excluding the conjugates of foreign substances from the hepatoenteric circulation, reducing the frequency of large intestine tumors, and of lowering diabetic sugar. Due to wheat bran, the average vitamin E content in 100 g of the curd product is 4.0–5.0 mg.

Studies on the functional–technological (water-binding) properties of wheat germs show their wide use not only as an additive but also as stabilizers in ice-cream production. A technology has been designed for new ice-cream types, *Zernyshko-1* and *Zernyshko-2,* using processed-wheat products based on a cream mix.

The first option is an ice-cream with roasted wheat germ flakes added directly into the product after freezing, which makes it possible to reduce the product cost by increasing the output, increase the nutritive and biological values of the ice-cream, and create a greater variety of products.

The second option is an ice-cream with roasted ground wheat germ flakes as an additive. This makes it possible to reduce the content of an expensive stabilizer and, at the same time, to obtain a well-structured product.

The *Zernyshko-1* technology includes the following stages: the formulating of the ice-cream mix, the preparation of the formulation components, mix filtering, heating, pasteurization, homogenization, cooling, mix aging, mix freezing, the introduction of roasted wheat germ flakes, filling and hardening, and ice-cream storage.

The *Zernyshko-2* process uses roasted ground wheat germ flakes that are introduced in the amount of 2% of the mix mass before pasteurization, which significantly increases the mix viscosity and positively affects the quality of the finished product. The rest of technological stages are similar to those of the *Zernyshko-1* process.

Organoleptically and physicochemically, this is a cream-colored product with a sweetish nutty taste and a light nutty aroma; the content of fat is no more than 10%; that of dry substances, 34%; that of saccharose, 14%; and the acidity is no more than 22°T.

A functional ingredient for the production of functional foods is probiotics, which include microorganisms, in particular, milk microflora, for example, acidophilic lactate bacilli, bifidobacreria, etc. Experts of the International Dairy Federation call them *health products*. At present, special attention is paid to the production of cultured milk foods with probiotics. Such products have increased contents of vitamin C and fat-soluble vitamins A, E, and D. These cultured milk foods contain a large number of bifidobacteria and lactobacilli, capable of developing in the human organism and suppressing the development of pathogens. Regular consumption of such products within the food ration agrees with the principles of healthy nutrition, improving the state of human health and significantly reducing the risk of diseases.

Currently, the development of new synbiotic cultured milk foods for functional purposes is topical, since the creation of such products helps meet the physiological needs of the human organism for nutrients and energy, adapt to unfavorable environmental conditions, and ensure the prevention of many diseases. In this context, the enrichment of food products with probiotics and prebiotics, which are well balanced against each other, looks promising.

Taking the above into account, the Kemerovo Institute of Food Science and Technology has developed technologies of functional products enriched with probiotics and prebiotics.

A major problem faced during the creation of new products for functional nutrition is the choice of the optimal dose of an additive that confers the necessary properties and does not affect negatively the quality of finished products.

Within the development of the technology of functional lactoprotein products, research has been conducted to find out the effect of doses of introduced prebiotics (dietary fibers) on the acid formation process. The properties of dietary fibers in the human organism are diverse: they are not hydrolyzed and are not adsorbed in the upper gastrointestinal tract; they are a bifidogenic factor; they control the cholesterol level, bind and remove part of toxic substances from the human organism, and improve the assimilability of calcium and magnesium.

The dose of dietary fibers introduced varied from 1.2 to 8.7% in increments of 2.5%. For fermentation, we used a culture consisting of bifidobacteria (Bifidobacterium bifidum and Bifidobacterium longum) and a lactic streptococcus at a ratio of 1 : 3. Souring lasted for 4 h until pH 4.6–4.7 was reached.

These studies have shown that acidity increases with the increase of the dietary fiber dose. This is explained by the fact that they are supplemental feeding for souring microorganisms, and the larger the dose introduced, the faster the lactic fermentation occurs. The highest acidity was in a sample in which the dose of dietary fibers was 8.7%.

Dietary fibers, being a prebiotic, selectively stimulate growth and improve the biological activity of the useful intestinal microflora. The combination of a probiotic (bifidobacretia) and a prebiotic (dietary fibers), which mutually amplify the effect on the physiological functions of the human organism, allows us to view the resultant lactoprotein product as a synbiotic product. The developed product, owing to its introduction into the composition of dietary fibers and probiotic microorganisms, has a functional effect and may be recommended for use by all population groups.

Cottage cheese is becoming increasingly popular among the consumers due to its good organoleptic indicators. However, the technology of this product is associated with certain difficulties. A major factor that affects the quality of the finished product is the quality of the raw material used.

Since the content of protein and nonfat milk solids in raw milk is insufficient, it was proposed to adjust its composition by introducing milk protein, obtained by microfiltration and dried by the spray drying method. The protein additive is introduced into fat-free milk before pasteurization and before the nonfat milk solids reach a mass fraction of 9.0–9.5%.

In order to make cottage cheese acquire functional properties, the product is enriched with probiotics and prebiotics. Bifidobacteria, which represent the normal

intestinal microflora and perform numerous and important protective functions in the human organism, are used as a probiotic. Dietary fibers are used as a prebiotic. The distinctive feature of the developed technology is that dietary fibers and bifidobacteria are introduced into cream. Therefore, the optimal dose of dietary fibers was established to stimulate the development of probiotic microflora. Such a dose of dietary fibers (3.0%) ensures the necessary growth of bifidobacteria during cream souring and does not affect negatively the organoleptic properties of the finished product. The amount of viable cells at the chosen dose is $4 \cdot 10^9$ CFC/g.

The dietary fibers contribute to obtaining a thicker cream consistency and allow producing a less caloric product by simulating a higher fat content in cream, as well as by its water-binding ability, and extend the shelf life and increase the output of the finished product.

Organoleptically, the developed product has a clear, lactic taste and odor; a nonuniform consistency with clearly distinct granules of various sizes, covered with cream; and a white color with a cream tint.

Taking into account the importance of the creation of products with probiotic properties, the possibility of enriching sour-milk drinks with whey protein, viable bifidoflora has been studied. The high antagonistic activity of bifidobacteria, their ability to destroy toxic metabolites, accumulate amino acids, produce volatile fatty acids, and synthesize vitamins indicate the practicability of these microorganisms in the production of dairy products for infusing them with functional properties. A high viability of the vegetative cells of bifidobacteria during the storage of a product enriched with whey protein has been established, no less than $2.0 \cdot 10^6$ CFC/g. Considering the above, we may state that the addition of whey protein during the production of sour-milk drinks influences favorably the development of bifidoflora.

Technical documents for the above products have been developed, approved, and duly registered. The developed assortment is produced at the enterprises of the Russian agroindustrial complex.

The advantages of the developed technologies are the production of dairy products of high biological and nutritive values, enriched with essential nutrients and possessing functional properties, the increased output of products owing to the use of rational raw materials and commercially available equipment. The compatibility of these developments is ensured by their topicality, scientific validity, and technological and economic practicability. Their broad promotion will contribute to the introduction of the ideas of positive nutrition into the minds of consumers.

The introduction of functional products into nutrition practices is regarded from the medical point of view as an important link in the program of government measures aimed at the formation of a healthy lifestyle. These products are to improve the nutrition structure of various population groups with their specific needs for foodstuffs. The provision of the country's population with high-quality products is inseparable from the development of progressive technologies that take into account the latest achievements in basic and applied research in the science of food. Note that recently the problem of foodstuffs of predicted and guaranteed quality has increasingly been coming to the fore compared to the problem of the amount of food produced. In addition, the most urgent problem is the creation of products with preset chemical compositions and with account for biomedical recommendations (functional products).

Overall, there are sufficiently ample grounds to assume that the field under consideration in the production of functional products will develop very dynamically in the years to come.

REFERENCES

1. Zakharova, L.M., *Nauchno-prakticheskie aspekty proizvodstva funktsional'nykh produktov iz moloka i zlakov* (Scientific and Practical Aspects of Making Functional Products from Milk and Cereals / Laboratoriya Mnozhitel'noi Tekhniki KemTIPP, Kemerovo, 2005).
2. Ostroumov, L.A. and Zakharova, L.M., Soft cheese production: A promising direction, *Syrodelie maslodelie (*Cheesemaking Buttermaking), 2006. № 1. P. 29–30.
3. Zakharova, L.M., Ovchinnikova, T.A., and Shaposhnikova, E.Yu., Consumer demand for functional dairy products, *Molochnaya prom–st'* (Dairy Industry), 2006. № 8. P. 8–9.
4. Zakharova, L.M., The scientific school of L.A. Ostroumov, *Obrazovanie. Kar'era. Obshchestvo* (Education. Career. Society), 2009. № 1 (23). P. 108–110.
5. Zakharova, L.M. and Zakharchenko, S.G., Cottage cheese for functional purposes, *Molochnaya prom–st'* (Dairy Industry), 2009. № 7. P. 62.
6. Zakharova, L.M. and Mazeeva, I.A., The technology of new functional milk-based foodstuffs, *Khranenie pererabotka sel'khozsyr'ya (Storage Processing Agric. Raw Mater.)*, 2010. № 11. P. 63–67.
7. Zakharova, L.M., Orekhova, S.V., Zakharchenko, M.A., and Lozmanova, S.S., The study of technological parameters of making a functional fermented milk product, in *Tekhnika i tekhnologiya pishchevykh proizvodstv* (Food Production Techniques and Technology) (Kemerovo, 2012), pp. 37–42.
8. Zakharova, L.M., Lozmanova, S.S., and Krokhaleva, L.V., The study of the technological characteristics of a functional fermented milk product and its nutritive value, *Aktual'naya biotekhnol.* (Topical Biotechnol.), 2014. № 1 (8). P. 12–15.