РОЗДІЛ 4. СУЧАСНІ ЄВРОПЕЙСЬКІ ТА СВІТОВІ ТЕНДЕНЦІЇ РОЗВИТКУ ХАРЧОВОЇ ПРОМИСЛОВОСТІ

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INNOVATIVE TECHNOLOGICAL ASPECTS OF PRODUCTION OF FUNCTIONAL PURPOSES SAUZES WITH DIETARY SUPPLEMENTS

According to the results of the analysis of scientific and patent sources, the urgency of developing technologies of sauces of high nutritional value *through the use of dietary and food supplements is substantiated and proved, which allows to expand the range of functional products. The formation of structures characteristic of sauces occurs due to the complexation in the system of gum arabic-pectin-lactate calcium, the intensity of which increases with decreasing pH of the medium from 7.3-7.7 to 4.9-5.1. Complex formation in model systems is evidenced by an increase in the molecular weight of the complexes (gum arabic-pectin-calcium lactate) from 89 to 671 kDa. According to the results of studies of physicochemical properties of BJD, gum arabic, pectin, calcium lactate, their rational ratios in dry composite mixtures for sauces were determined as 5: 6: 2: 2. The studied physicochemical properties of model sauce systems (the share of free moisture decreased by 15.7-27%, bound – increased by 4.7-5.1%). A comprehensive assessment of the quality of the developed sauces, the complex quality of which exceeds the corresponding values of control (100 units) by 62.4 units. ("Solar"), 71.4 units. ("Balance"), 64.2 units. ("The Highlander"), 71.6 units. ("Rainbow"), which corresponds to high quality food products. The introduction of new technologies of functional sauces will expand the range of restaurant products and functional products.*

Introduction

At the present stage of development of the restaurant industry, the production of functional sauces by enriching them with biologically active components is promising. The scientific strategy and methodology of designing functional foods involves the modification of traditional technologies, which provides an increase in the content of essential ingredients in products to a level consistent with physiological norms of consumption.

The development of functional foods is based on scientific principles developed by the World Health Organization and harmonized with domestic science. These principles cover the main medical, biological and technological aspects and take into account new data from modern science on the role of nutrition and certain nutrients in maintaining human health and life, the body's needs for certain nutrients and energy, the real structure of nutrition and actual supply of vitamins. macro– and microelements of the population of Ukraine, as well as take into account the experience of production, use and evaluation of the effectiveness of functional foods in Ukraine and abroad.

Scientific bases of creation of functional food products include:

– medical and biological aspects, which include the choice of carrier, the choice of additives that adjust the chemical composition of the product, the level and safety of enrichment;

– technological aspects that consider the issues of product quality, preservation of micronutrients and compatibility of micronutrients with food mass, as well as their interaction with individual components of food systems;

– clinical efficacy, which should confirm the use of evidence-based medicine bioavailability of the enrichment component, as well as the reliability of the correction of deficiency and improve health when using functional foods.

1. Modeling of a composite mixture of dietary supplements and food systems as the basis of functional sauces

Due to an unbalanced, polydeficient diet, polymacro-polymicronutrient deficiency is widespread in the population of Ukraine due to a deficiency in the diet of a number of nutrients. Studies show that priority should be given to preventive measures aimed at overcoming vitamin deficiencies, insufficient essential amino acids, polyunsaturated fatty acids of the ω3 family in cis-form, dietary fiber, minerals: calcium, potassium, magnesium, phosphorus, iron [1].

Based on scientific data on the relationship between calcium, potassium, magnesium, phosphorus, iron and dietary fiber deficiencies in human nutrition and health, as well as data on the effectiveness of calcium absorption in the presence of phosphorus and magnesium, it is planned to choose these nutrients defining criteria for optimization in the development of functional sauces. Increasing the calcium content in sauces is important because in addition to performing metabolic functions in the body, it will help block the absorption of strontium-90. The protective functions of magnesium are manifested in the fact that it is a link in the formation of a complex between structural, transport and information RNA, which provides protein synthesis, stimulates intestinal motility, affects cholesterol levels and maintains pH balance. Increasing the amount of iron in sauces will have a positive effect on the body's defenses. It is known that the body does not absorb dietary fiber, but in the process of digestion, they play an extremely important role – contribute to intestinal peristalsis; in addition, they are able to form insoluble chemical compounds with toxic substances, radionuclides and remove them from the body [2].

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In this regard, keep in mind that functional sauces must contain calcium, potassium, magnesium, phosphorus, iron, β-carotene, polyunsaturated fatty acids, essential amino acids and dietary fiber, the deficiency of which is quite common and adversely affects human health [3].

Technological studies of the technology of sauces with the use of the developed composite mixture instead of wheat flour and starch, which are the determining factors of rheological and organoleptic parameters. Based on the physiological needs of the human body, the existing deficiency of nutrients in the diets of modern man formulated the basis of the requirements for sauces as functional products (Table 1) [4, 5].

Table 1

Requirements for sauces as functional products

Task	Ways to solve
Enrichment of the product with deficient substances in the diet	1) β-carotene, calcium, potassium, magnesium, phosphorus, iron and dietary fiber. 2) Nutrient content 10-30% of the average daily needs of the human body. 3) Organic sources of minerals.
Maximum absorption of nutrients, taking into account the mutual influence	1) Optimal absorption of calcium with sufficient intake of phosphorus, magnesium and vitamin D. 2) Improving the absorption of nutrients depends on the functioning of the intestine due to the influence of dietary fiber (prebiotics).
High consumer properties of the product	1) High organoleptic properties 2) Shelf life 3) Safety indicators

Summarizing the above, it is determined that the natural sources of functional ingredients (dietary fiber, minerals, vitamins), promising for use in the technology of sauce products, should include gum arabic, pectin, soy products and calcium supplements. Given the high nutritional value and pronounced therapeutic effect of the above dietary supplements, they should be considered a promising raw material for the production of functional foods, including sauces [6].

Composite mixture is a multicomponent system consisting of fine raw materials and characterized by low weight and volume with a high dry matter content. The quality of the composition mixture for sauces is determined by the recipe composition and a number of interrelated processes that occur in the technological flow during the preparation of sauces [7].

An important requirement for the quality of both individual components and mixtures is their active interaction with water and long-term preservation of functional properties. Therefore, for substantiation and development of technology of composite mix rational modes of reception of a basis are established. The simulation found that the composite mixture of dietary supplements and sauces based on it is influenced by various factors: the concentration of hydrocolloids in the aqueous medium, the duration of hydration of polysaccharides and protein-fat additives, temperature and pH of the aqueous medium, duration of heat treatment and others. On the basis of the conducted researches modeling of a composite mix of dietary additives for sauces is carried out [8].

Mathematical and experimental methods based on physicochemical parameters of interaction of hydrocolloids, chemical composition determined the rational ratio in the compositional mixture of protein-fat supplement from soybean "Super" ECO, gum arabic, pectin and calcium lactate as 5:6:2:2.

When developing the composite mixture took into account the conditions and terms of its storage. To determine the shelf life, we took into account the shelf life of individual prescription components specified in the regulations, which were respectively for pectin – 12 months, gum arabic – 12 months, calcium lactate – 12 months, BJD – 6 months. The shelf life of BJD was decisive, under conditions of humidity $\varphi = 75\%$ at a temperature of $t = 18\text{-}20°C$.

Further use of the composite mixture can be carried out in two directions: the production of sauces; packing, packing, marking, storage. The use of composite mixture allows to reduce the technological process of production of sauces, expand the range, improve the quality of finished products. [9]

The composite mixture of dietary supplements is a homogeneous powder mass with a pleasant smell and taste of cream. Organoleptic characteristics of the mixtures are presented in table. 2.

Table 2

Organoleptic characteristics of the composite mixture of dietary supplements

Indicator	Characteristics of composite mixtures
Appearance	Fine dry powder sprinkled with particles of protein-fat additive, the presence of easily destructive lumps is allowed
Color	Belongs to this type of mixture, from white with a cream tint to light yellow
Consistence	Powdered
Taste and smell	The taste of the mixture is pure, sweet with a creamy aftertaste.

The composite mixture is characterized by a significant content of nutrients: protein – 13.46, fat – 6.94, carbohydrates – 58.3, of which 49.8 – dietary fiber; minerals: K – 597 mg, Ca – 1742 mg, P – 217.3 mg, Mg – 81.6 mg, Fe – 5.5 mg, S – 88 mg, Mn – 1009.2 mcg, I – 3.1 mcg, Se – 4.1 mcg); vitamins: β-carotene – 0.03 mg, E – 6.87 mg, B1 – 0.35 mg, B2 – 0.08 mg, B3 – 0.65 mg, PP – 0.82 mg, folacin – 74.8 mcg, choline – 97.3 mg, biotin – 21.8 mg. The amino acid composition of the composite mixture of dietary supplements. [9]

The results of microbiological studies show that the indicators for the composite mixture are within the limits allowed by sanitary norms during storage (up to 6 months at a temperature of 18-20 ° C and relative humidity not exceeding 75%). BGKP, bacteria of the genus Staphyloccocus Aureus, Proteus, Salmonella were not found in the composite mixture.

Due to the unfavorable environmental situation, great importance is attached to indicators that characterize the content of toxic elements. The content of lead (0.2 mg/kg), copper (0.18 mg/kg) and zinc (1.31 mg/kg) is within the permissible concentrations of 0.4, 0.6, 5.0 mg/kg, respectively. Cadmium, arsenic and mercury were not detected.

The results of research have shown that the composite mixture meets the requirements of regulatory documentation, and the actual content of toxic elements is less than the maximum allowable concentrations, which indicates the level of safety and recommends the developed products for implementation in restaurants and food industry [10].

To substantiate the technology of sauces based on the composite mixture, it is necessary to model the conditions of production of milk, white and sweet sauces. To model the technology of new sauces and study the rheological characteristics, we have identified food heterogeneous systems: "milk – composite mixture", "broth – composite mixture", "plum puree – composite mixture", "apple juice – composite mixture".

The dependence of the effective viscosity of the food system for milk sauces at different shear rates at different concentrations (3-18%) of the composite mixture (CS) has been studied.

The studied milk-CS model systems are characterized as non-Newtonian fluids because they change the viscosity at different values of shear rates. A model dairy system with a composite mixture concentration of 3% at a shear rate of 69 s^{-1} has an effective viscosity of 0.41 Pa·s. In model systems with a concentration of the mixture of 6, 9, 12, 15, 18% under these conditions, the viscosity increases by 9, 21, 48, 74, 95%. Accordingly, at a concentration of 3% of the composite mixture at low values of the shear rate of 10 s^{-1}, the effective viscosity is 0.7 Pa·s and increases by 19, 13, 71, 98% and 2.7 times, respectively.

Based on the experimentally obtained data, the dependences of the shear stress on the shear rates for the composite mixture of dietary supplements at different concentrations (3-18%) were constructed.

Shear stress at shear rates of 10 and 69 s^{-1} for the system "milk – CS" with a concentration of the composite mixture of 3% is 7.8 and 20.1 Pa, respectively. When the concentration of the composite mixture increases to 18%, the shear stress increases to 19.8 and 75.2 Pa, ie 2.5 and 3.7 times, respectively.

The dependence of the effective viscosity of the food system for white sauces at different shear rates at different concentrations (3-18%) of the composite mixture was studied.

Broth-CS model systems are also non-Newtonian. The broth-based model system with a composite mixture concentration of 3% at a shear rate of 69 s^{-1} has an effective viscosity of 0.37 Pa·s. In model systems with a concentration of composite mixture of 6, 9, 12, 15, 18%, the effective viscosity increases by 10, 35.2 48.6, 62.2, 86.5%. At a concentration of 3% CS at low values of the shear rate of 10 s^{-1}, the effective viscosity is 0.63 PA·s and increases by 12.7, 42.8, 58.7, 130.4, respectively.

Based on the experimentally obtained data, the dependences of the shear stress of the broth-based system on the shear rates of the composite mixture of dietary supplements at different concentrations (3-18%) were constructed.

Shear stress at shear rates of 10 and 69 s^{-1} for a system based on broth with a concentration of the composite mixture of 3% is 7.1 and

21.7 Pa. When the concentration of the composite mixture increases to 18%, the shear stress increases to 17.1 and 66.3 Pa, respectively.

The dependence of the effective viscosity of the food system for fruit sauces, at different shear rates at different concentrations (3-18%) of the composite mixture. Model systems "plum puree – KS" with a concentration of the latter 3% at a shear rate of 68 s^{-1} has an effective viscosity of 0.09 Pa·s. In model systems with a concentration of composite mixture of 6, 9, 12, 15, 18% under these conditions, the viscosity increases by 2.1, 3.8, 3.9, 4.4, 5.05 times. Accordingly, at a concentration of 3% of the composite mixture at low values of the shear rate of 10 s^{-1}, the effective viscosity is 0.33 Pa·s and increases by 51.7%, 2.0, 2.4, 2.9, 3.6 times, respectively.

Based on the experimentally obtained data, the dependences of the shear stress of the broth-based system on the shear rates of the composite mixture of dietary supplements at different concentrations (3-18%). 3% is 3.1 and 6.1 Pa. When the concentration of the composite mixture increases to 18%, the shear stress increases to 4.5 and 4.6 times, respectively.

The dependence of the effective viscosity of the food system for sweet sauces at different values of shear rates and concentrations (3-18%). Shear stress at shear rates of 10 and 69 s^{-1} for a system based on broth with a concentration of the composite mixture of 3% is 7.1 and 21.7 PA. When the concentration of the composite mixture increases to 18%, the shear stress increases to 17.1 and 66.3 PA, respectively.

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Based on the experimentally obtained data, the dependences of the shear stress of the broth-based system on the shear rates of the composite mixture of dietary supplements at different concentrations (3-18%). 3% is 3.1 and 6.1 Pa. When the concentration of the composite mixture increases to 18%, the shear stress increases to 4.5 and 4.6 times, respectively.

The dependence of the effective viscosity of the food system for sweet sauces at different values of shear rates and concentrations (3–18%) of the composite mixture is obtained. viscosity 0.22 Pa·s. In model systems with a concentration of the mixture of 6, 9, 12, 15, 18%, the effective viscosity increases by 9.2, 40.8, 80.3%, 2.45 and 2.8 times. Accordingly, at a concentration of 3% CS at low values of the shear rate of 10 s^{-1}, the effective viscosity is 0.9 Pa·s and increases by 11.6, 20.4, 32.4, 54.9, 61.8%, respectively.

The dependences of the shear stress of the apple juice-based system on the shear rates for the composite mixture of dietary supplements at different concentrations (3-18%) were constructed on the basis of experimentally obtained data. The shear stress at shear rates of 10 and 69 s^{-1} for the system based on broth with a concentration of COP 3% is 10.1 and 17.2 Pa. When the concentration of CS increases to 18%, the shear stress increases by 1.6 and 2.5 times, respectively.

The effective viscosity and shear stress of traditional sauces at a shear rate of 69s^{-1} is for dairy 0.6 Pa·s and 45 Pa, white – 0.5 Pa·s and 40 Pa, plum – 0.4 Pa·s and 25 Pa, apple – 0.3 Pa·s and 35 Pa. The values of effective viscosity and shear stress of the experimental model systems of sauces are close to the control samples at a concentration of the composite mixture of 15%.

Since the composition of the CS includes calcium lactate, to confirm the reactivity of pectin substances with calcium salts is the molecular weight distribution of pectin substances in solution at different pH values. It is established (table that the composition of pectin is dominated by fractions with low molecular weight of 20-70 kDa, accounting for 63% of the total amount of pectin. The average molecular weight of pectin is 367 kDa. It is established that the presence of calcium lactate at pH 7.1 -7.5 does not affect the increase in the average molecular weight of pectins, which indicates the absence of complexation and low stabilizing ability under these conditions. with a molecular weight of 2000 kDa (from 9.8% to 6.8%) and 1000 kDa (from 9.5% to 8.9%) with the accumulation of pectins with a molecular weight of 500 kDa (up to 19.2%) and 20 kDa (up to 25.3%) It was found that non-reactive calcium (at alkaline pH values) can be dissolved with decreasing pH, which leads to the formation of pectins in the presence of soluble pectins and stabilization of the heterogeneous system. Toron to values of 5.0–5.2, an increase in the average molecular weight (from 351 kDa to 522 kDa) was recorded, which is the result of the dissolution of calcium with decreasing pH. It is seen that the share of high molecular weight fractions of pectins increases with a simultaneous decrease in the share of low molecular weight fractions with a molecular weight of 20–40 kDa. Thus, the content of fractions with a molecular weight of 2000 kDa (from 6.8% to 13.2%), 1000 kDa (from 8.9% to 12.8%), 110 kDa increases (from 7.7% to 12.0%). The increase in weight average molecular weight is the result of complexation of low molecular weight pectins through calcium bridges with the formation of complexes with a certain degree of polymerization in the form of calcium pectates, which is a necessary prerequisite for stability of heterogeneous structures. It is obvious that at a certain concentration of pectins in solution, this course of the reaction can lead to chemical changes with the formation of a gel-like system.

Table 4

Molecular weight distribution of pectin substances at different pH values

Molecular weight of markers, kDa	**The content of fractions,% of the total**		
	pectin solution	**pectin solution with calcium lactate, pH = 7.1–7.5**	**pectin solution with calcium lactate, pH = 5.0– 5.1**
20	10,6	25,3	11,0
40	21,2	19,2	14,4
70	31,2	12,9	17,2
110	9,5	7,7	12
500	8,2	19,2	19,4
1000	9,5	8,9	12,8
2000	9,8	6,8	13,2
Всього	100,0	100,0	100,0
$\bar{M}_m$	367	351	522

In order to establish the possible complexation between gum arabic and calcium in the solution, gel chromatography of gum arabic and gum arabic was performed in the presence of 2% calcium lactate. As a result of the molecular distribution of gum arabic and the gum arabic-calcium lactate system, eight fractions were identified. Dominant is the fraction with a molecular weight of 4.3 kDa (32%), fractions with molecular masses of 1.9 kDa and 1 kDa were found in amounts of 6.7% and 10.6%, respectively, high molecular weight fraction obtained with free volume. – more than 2000 kDa – is 0.8% of the total. The remaining fractions (49.9%) are classified by us as polysaccharides with a molecular weight of less than 1 kDa.

After the addition of calcium lactate, there is a decrease in the number of fractions to six. A decrease in the total area under the peaks was found. There is a decrease in the fraction with a molecular weight of more than 2000 kDa by 2.7 times, which is 0.3%, new fractions with a molecular weight of 3.2 kDa (50.3%) and 1 kDa (15.8%) were found. 2, curve 2), the content of the fraction with a molecular weight less than 1 kDa is 33.6%, which confirms the precipitating effect of calcium ions on high molecular weight fractions of gum arabic. The appearance of a fraction with a molecular weight of 4.3 kDa may be associated with the complexation of low molecular weight fractions with calcium ions. Thus, it was confirmed that calcium precipitation, which is achieved at pH 7.1–7.5, leads to an increase in the solubility of polysaccharides and a decrease in their molecular weight (Fig. 1).

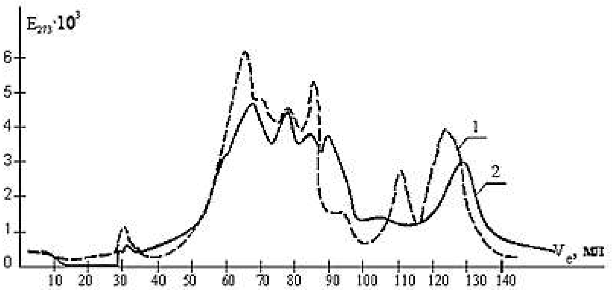

Fig. 1. Gel chromatography curves:
1 – gum arabic; 2 – gum arabic in the presence of calcium lactate

Confirmation of the formation of gum arabic complexes with low-esterified pectin is gel chromatography. A study of the molecular weight distribution of gum arabic in the presence of pectins at pH 7.1–7.5. The distribution of polysaccharides of gum arabic and pectin using a buffer (Na2HPO4 / NaH2PO4), which maintains a pH of 7.4, obtained two peaks with molecular weights of 537 kDa and 10.5 kDa, the average molecular weight is 96 kDa. Their shares in the total composition of polysaccharides were 16.3% and 83.6%, respectively. The presence of a certain intermediate optical activity of the elution curve from the abscissa in the zone of high molecular weights indicates that there are fractions with molecular weights of about 500 kDa, which are difficult to separate. Comparing the distribution of gum arabic fractions in the presence of pectin with the distribution of gum arabic fractions, it is seen that the introduction of pectin leads to a significant increase in molecular weights of the fractions recorded, which may be associated with intramolecular complexes between gum arabic and pectin. In order to determine the reactivity of gum arabic and pectin against calcium ions and possible complexation, 2% calcium lactate was introduced into the system containing gum arabic and pectin. Seven peaks were obtained under the same elution parameters: with molecular weights of 2000 and more kDa, 4.7 kDa, 2.4 kDa, 1.1 kDa and three fractions with molecular weights less than 1 kDa. Their share in the total composition was 3.0%, 32.3%, 12.7%, 12.5% and 39.5%, respectively (Fig. 2). This distribution of molecular weights is close to the distribution of gum arabic, which indicates the absence of the precipitating effect of calcium ions on gum arabic, which also confirms the preservation of the potential of pectins to complex formation.

Thus, it can be argued that calcium ions in the presence of gum arabic will react with pectins, forming calcium pectates, thus stabilizing the colloidal system. In order to establish the complexation between gum arabic, pectins and calcium lactate by lowering the pH value, which is a necessary condition for calcium dissolution, a study of the molecular weight distribution of gum arabic when the pH drops to 5.0-5.2. As a result of the distribution, two peaks with molecular masses of 762 kDa (99%) with high optical activity (Fig. 2, curve 3) and 1.1 kDa (1%) were obtained, which indicates the formation of intermolecular gum-pectin complexes. The molecular weight increases from 89 kDa to 761 kDa, which is evidence of the formation of complexes (gum arabic – pectin – calcium lactate).

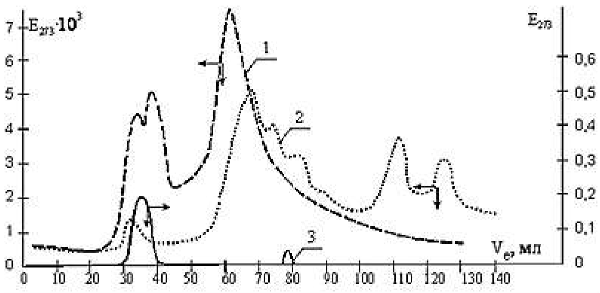

Fig. 2. Gel chromatography curves: 1 – solution containing gum arabic (6%) and pectin (2%) (pH = 7.1-7.5); 2 – solution containing gum arabic (6%), pectin (2%) and calcium lactate (2%) (pH = 7.1-7.5); 3 – solution containing gum arabic (6%) and pectin (2%) (pH = 5.0–5.2)

A study of the interaction of gum arabic with calcium lactate at a concentration of 1-3%. Analyzing the IR spectra in the range 3300 – 3380 cm^{-1}, it was found that the addition of calcium lactate in these quantities does not reduce the absorption band -OH groups, which could only be the case when the hydroxyl groups could bind to dynamic bonds. ligaments with calcium ions. This is indirect evidence that at these concentrations, calcium lactate is not a dehydrating agent relative to gum arabic and does not significantly affect the conformation of molecules in the solvent.

The simultaneous presence of these absorption bands is a confirmation of the presence of impurities of nitrogen-containing substances. Under these conditions, the addition of calcium lactate may lead to "oxygen-metal" bonds, which can significantly affect the structure. At the same time, it is possible to replace divalent metals with monovalent metals, resulting in interchain depolymerization and, as a consequence, increased mobility of polysaccharide monochains, which may be the cause of greater compaction of the structure of complexes.

2. Development of technology of sauces of functional purpose with dietary supplements

On the basis of the conducted researches the rational concentration of the composite mixture of dietary supplements (KSDD) and the ratio of other prescription components in sauces were determined. After testing the technology, formulations of milk sauce "Sunny" and white "Balance", technological schemes of their production were developed.

The technology of "Solar" sauce consists of the following stages:

And the stage. Hydration of the composite mixture. Hot milk or a mixture of milk and water is gradually poured into the composite mixture. The mass is brought to a boil, stirring constantly to prevent the formation of lumps, and boil for 4-5 minutes.

Stage II. The technology of making puree. Pre-prepared pumpkin, carrots, celery roots are boiled to readiness, crushed and ground to obtain a puree.

Stage III. Combining prescription components. The brewed composite mixture is combined with vegetable puree in a ratio of 2:1 and mixed to form a homogeneous mass and boiled for 2-3 minutes.

The technological process of production of Balance sauce is carried out in the following sequence: a quarter of hot broth or vegetable broth from onion, parsley root or celery is gradually poured into the composition mixture and butter is added. Mix thoroughly. Then gradually pour the remaining liquid and boil for 4.2·102 –6.0·10^2s. At the end of cooking add salt, black pepper peas, bay leaf. The sauce is filtered, grind boiled vegetables, and bring to a boil. The finished sauce is used to prepare derived sauces. If the sauce is used alone, it is seasoned with citric acid and butter.

The technology of sweet fruit sauces "Highlander", "Rainbow" has been developed. The technological process of production of Highlander sauce is carried out in the following sequence: fresh plums are cut in half and boiled, adding water until the plums boil. Then remove the skin and bone, then grind the mass to a puree-like consistency and boil for 30 minutes. on low heat. In technology, fresh plums can be replaced with plum puree. Chopped garlic, dill, coriander, mint, pepper, salt and the composition mixture are added to the mashed mass and heated, stirring, for $4.2 \cdot 10^2$ – $6.0 \cdot 10^2$s. The sauce is filtered and served.

The technology of production of "Rainbow" sauce consists of the following operations: peeled, sliced apples with peel are filled with hot water and left for 6-8 minutes. in a closed container until ready. Then grind to a puree-like consistency. You can use apple puree in technology. Add sugar, citric acid and a composite mixture based on BJD "Super" ESO, gum arabic "Fibregum", pectin "GRINDSTED YF 738", calcium lactate E327. Add sugar, cinnamon and bring to a boil. Strain and serve.

The use of a composite mixture of dietary supplements in the production of milk, white, fruit and sweet sauces allows to expand the range of sauce products for functional purposes of high nutritional value.

3. Quality and safety of functional sauces with dietary supplements

To conduct organoleptic evaluation of sauce products, a method of evaluation on a 10-point scale was developed. The organoleptic properties of sauces were studied using a composite mixture of dietary supplements, compared with traditional sauces.

Based on the generalization of expert assessments, it was found that the organoleptic characteristics of the developed sauces are at the level of control. Both control and test samples were characterized by fragrant odor and pronounced color, characteristic of the main raw material. Experts gave the developed sauces a slightly lower rating in terms of appearance compared to the control (0.8-1.0 points). However, the sauces were characterized by fairly high organoleptic characteristics. Based on the generalization of the results of tastings, it was found that the average organoleptic evaluation of the developed sauces is lower than the control by 0.15-0.30 points. On a ten-point scale, the quality of control and experimental samples can be characterized by a high organoleptic evaluation. [13]

An important characteristic of the quality of sauce products using a composite mixture are physico-chemical parameters (Table 4).

Table 4

Physico-chemical characteristics of sauce products

Indexes	**Control**	**Experiment**	**Deviation,%**
Sauce	*"Lactic"*	*"Solar"*	
Dry matter content,%	14,2±0,53	16,6±0,62	16,90
Acidity, pH	7,1±0,36	7,0±0,35	-1,41
Free moisture,%	16,3±0,75	13,6±0,62	-16,56
Bound moisture,%	83,7±1,62	86,4±1,42	3,23
Effective viscosity at γ = 69s^{-1}, Pa·s	0,6±0,03	0,59±0,03	1,5
Sauce	*"White"*	*"Balance"*	
Dry matter content,%	15,6±0,51	18,1±0,47	16,03
Acidity, pH	4,5±0,17	4,5±0,19	0
Free moisture,%	13,4±0,42	11,3±0,39	-15,67
Bound moisture,%	84,6±3,12	88,7±3,03	4,85
Effective viscosity at γ = 69 s^{-1}, Pa·s	0,5±0,03	0,52±0,03	4,0
Sauce	*"Tkemali"*	*"Highlander"*	
Dry matter content,%	13,5±0,41	14,4±0,34	6,67
Acidity, pH	7,3±0,31	7,3±0,28	0,00
Free moisture,%	17,1±0,56	12,9±0,42	-24,56
Bound moisture,%	82,9±2,12	87,1±2,38	5,07
Effective viscosity at γ = 69 s^{-1}, Pa·s	0,4±0,02	0,42±0,02	5,0
Sauce	*"Apple"*	*"Rainbow"*	
Dry matter content,%	16,1±0,61	17,0±0,63	5,59
Acidity, pH	4,5±0,17	4,5±1,6	0,00
Free moisture,%	14,8±0,44	10,8±0,41	-27,03
Bound moisture,%	85,2±3,48	89,2±3,51	4,69
Effective viscosity at γ = 69 s^{-1}, Pa·s	0,3±0,02	0,31±0,02	3,0

The increase in dry matter content is due to the increase in the mass fraction of structurant (CS), which is positive because the main share is dietary fiber. Moisture in sauces remains mainly in a bound state not only due to the dry matter retention of constituent components, but also due to the ability of polymers and reactants (pectin, gum arabic, calcium lactate) to swell and retain free moisture in the spatial framework. polymer complexes. The state of water in experimental and control sauces was experimentally determined.

Analysis of wood charts shows a change in the specific content of free and bound moisture in the developed sauces: the share of free moisture in the total mass decreases, bound – increases. It is established that the ratio of free and bound moisture in the control and experimental samples differs, because instead of flour and starch, a composite mixture of dietary supplements is used.

Analysis of changes in the fractional composition of water shows that simultaneously with the increase in dry matter content in the developed sauces there is an increase in the specific content of bound water – the ratio of bound water to the dry matter mass of sauces (Table 5).

Table 5

Specific content of bound water in sauce products

Samples of sauces	**The ratio of components, % by weight**		**Specific content of bound water, g (water) / g (dry matter)**
	dry matter	**water**	
"Dairy" (control)	14,2±0,53	85,8±3,61	6,04±0,27
"Solar" (experiment)	16,6±0,62	83,4±3,24	5,02±0,21
"White" (control)	15,6±0,51	84,4±3,55	5,41±0,24
"Balance" (experiment)	18,1±0,47	81,9±3,18	4,52±0,23
Tkemali (control)	13,5±0,41	86,5±3,11	6,41±0,29
"Highlander" (experiment)	14,4±0,34	85,6±3,17	5,94±0,23
"Apple" (control)	16,1±0,61	83,9±3,09	5,21±0,20
"Rainbow" (experiment)	17,0±0,63	83,0±3,32	4,88±0,19

It has been experimentally established that the specific content of bound moisture in sauces increases: "Solar" by 16.8, "Balance" – 16.3, "Highlander" – 7.2, "Rainbow" – 6.3% compared to the corresponding values of control samples. The increased specific content of bound water in the test samples compared to the control samples can be explained by the complex action of hydrocolloids present in the composition of the composition compared to wheat flour and starch, which are used in the control samples.

The humidity of the developed sauces decreases in the range of 1.0 – 3.1%. It is possible to keep moisture in new sauces due to the use of a composite mixture of dietary supplements (BJD, gum arabic, pectin, calcium lactate), which in complex use are able to form a polymer framework. The presence of milk and butter also contributes to better moisture retention. This is due to the formation of new active centers for the binding of water, which are formed by the combination of proteins of butter and milk with substances of polysaccharide nature.

Given the higher ability of polysaccharides to hydrate than BJD, we can assume that the formation of moisture-retaining ability of sauces belongs more to polysaccharides than proteins. Thus, the increase in moisture retention in the developed sauces is due to changes in the quantity and quality of hydrogen bonds, increasing the number of hydrophilically active centers, retention of free moisture in the three-dimensional framework of polymer hydrocolloids. This, in turn, reduces the mobility of water molecules in the developed sauces. The acidity of the experimental sauces, which is at the level of control samples, was studied. [14]

Studies of the rheological parameters of sauces have confirmed the improvement or compliance of the control of the following rheological indicators: aggregative and kinetic stability, thixotropy and thermal stability of new sauce products.

It was found that the effective viscosity of the developed sauces at t = 20±2°C is higher compared to the control samples, which is a consequence of the increase in dry matter content (Table 6). Thus, the sauce "Solar", made on the basis of the composite mixture, contains dry matter 16.6 ± 0.62 ($P \leq 0.05$) and has an effective viscosity (at $\gamma = 69 s^{-1}$) – 0.59 ± 0 03 March, which is 16.9% and 1.5% lower than the control. Balance sauce contains dry substances 18.1 ± 0.47 ($P \leq 0.05$), and the effective viscosity (at $\gamma = 69 s^{-1}$) is 0.52 ± 0.03, which is 16% and 4 % above control. A similar trend is observed for Highlander and Rainbow sauces: they contain 14.4 ± 0.34 and 17 ± 0.63 dry matter, and the effective viscosity (at $\gamma = 69 c^{-1}$) is 0.42 ± 0,02 and 0.31 ± 0.02 Pa·s ($P < 0.05$), which is 6.6–7.0% by dry matter content and 5% and 3% by effective viscosity higher than control samples in accordance.

Table 6

Rheological characteristics of sauce products

Indexes	**Control**	**Experiment**	**Deviation,%**
Sauce	*"Lactic"*	*"Solar"*	
Aggregative stability,%	96,1±1,4	99,3±0,7	3,3
Kinetic stability,%	98,0±1,6	99,2±0,8	1,2
Thixotropy,%	76,1±1,2	81,1±1.6	6,6
Thermal stability,%	72,5±1,3	79,4±1,9	9,5
Sauce	*"White"*	*"Balance"*	
Aggregative stability,%	96,3±1,8	98,4±1,9	2,2
Kinetic stability,%	98,1±1,4	99,2±2,1	1,1
Thixotropy,%	74,1±2,5	79,6±2,1	7,4
Thermal stability,%	71,1±2,1	76,2±2,1	7,2
Sauce	*"Tkemali"*	*"Highlander"*	
Aggregative stability,%	99,9±0,1	99,9±0,1	0,0
Kinetic stability,%	93,1±2,4	97,2±2,9	4,4
Thixotropy,%	78,3±2,1	82,6±2,0	5,5
Thermal stability,%	73,1±1,6	76,2±1,7	4,2
Sauce	*"Apple"*	*"Rainbow"*	
Aggregative stability,%	99,9±0,1	99,9±0,1	0,0
Kinetic stability,%	91,1±2,2	96,2±2,7	5,6
Thixotropy,%	76,2±2,8	83,1±2,9	9,1
Thermal stability,%	74,8±2,1	79,6±2,2	6,4

The effective viscosity of the developed sauces before and after heat treatment at a shear rate of 10 s^{-1} for Molochny sauce was 1.95 and 1.52, White – 1.38 and 1.13, Tkemali – 1.81 and 1.43, Apple – 2.83 and 2.31 Pa·s. The same figure was at the same shear rate in the experimental sauce systems: "Solar" – 2.05 and 1.73, "Balance" – 1.38 and 1.21, "Highlander" – 1.82 and 1.55, "Rainbow" – 2.84 and 2.56 Pa. in accordance.

Thus, the results of research show that the developed sauces in terms of organoleptic, physicochemical, effective viscosity, thixotropy, sedimentation and aggregation resistance meet the requirements for sauce products.

Experimental data show that the use of traditional vegetable raw materials in the technology of sauces and the introduction of non-traditional raw materials – dietary supplements (protein-fat supplements, gum arabic, pectin and calcium lactate), which contain biologically active substances, cause positive changes in the chemical composition of the finished food [15].

The study of the nutritional value of sauce products using a composite mixture of dietary supplements showed that the amount of protein, fat and carbohydrates of polysaccharide structure increases compared to the control (Table 7).

It is experimentally established that the total protein content increased in sauces: "Sunny" – 2.3 times, "Balance" – 2.5 times, "Highlander" – 3 times, "Rainbow" – 3.8 times compared to the control (the difference with the control is significant) (Table 15). There was an increase in fat content by 9.7%, 14.2%, by 1.84 g, and 1.81 g in the developed sauces, according to the control (the difference with the control is significant).

The increase in protein, fat and carbohydrates in the new sauces is due to the use in the technology of a composite mixture of dietary supplements. The content of the carbohydrate component also increased: in sauces "Sunny" – by 63.7%, "Balance" – 86.0%, "Highlander" – 23.9%, "Rainbow" – 15.3%.

Table 7

Nutritional and energy value of sauces using a composite mixture

Sauce	Indexes				
	Water	Proteins	Jury	Carbohydrates	Energy value, kCal
"Lactic"	85,80±1,32	2,00±0,08	6,00±0,11	7,04±0,31	92,86±2,52
"Solar"	83,40±1,21	4,74±0,11*	6,58±0,12*	11,53±0,35*	127,90±4,45
"White"	84,40±1,54	1,27±0,05	2,89±0,05	5,43±0,21	54,35±1,56
"Balance"	81,80±1,34	3,20±0,13*	3,30±0,04*	10,10±0,23*	85,22±2,45
Tkemali	86,50±1,52	0,8±0,01	0,10±0,003	14,2±0,34	62,43±1,45
"Highlander"	85,60±1,65	2,36±0,05*	1,85±0,03*	17,60±0,38*	99,04±3,1
"Apple"	83,90±1,82	0,60±0,01	0,10±0,003	22,10±0,42	94,00±2,57
"Rainbow"	83,00±1,67	2,15±0,05*	1,82±0,03*	25,50±0,45*	130,29±4,32

There was an increase in the energy value of new sauces: "Sunny" – by 37.7%, "Balance" – 56.8%, "Highlander" – 58.6%, "Rainbow" – 38.6% compared to control due to the use of a composite mixture of dietary supplements, which will adjust energy the value of meals and diets.

Experimentally, 18 amino acids were identified in the protein, with the total number of essential amino acids for sauces: "Sunny" – 41.0%, "Balance" – 37.3%, "Highlander" – 32.0%, "Rainbow" – 35, 9% of their total number, which characterizes the sauce products as a product of high biological value (Table 8).

The biological value of a protein at the amino acid rate was assessed by comparing it with the amino acid rate of the "ideal protein". Analysis of the data shows that the level of amino acids relative to the ideal protein decreases the amino acid rate of methionine + cystine (Soy sauce – up to 94.3, "Balance" – 91.4, "Highlander" – 79.1, "Rainbow" – 79.1 and "Rainbow" – 87.7 and threonine "Highlander" – 87.0).

Table 8

Characteristics of the amino acid composition of sauces based on a composite mixture of dietary supplements

Name of amino acids	FAO / WHO scale	Sunny Sauce		Balance Sauce		Highlander Sauce		Rainbow Sauce	
	mg / 1 g of protein	*mg / g protein*	*Amino acid speed*	*mg / g protein*	*Amino acid speed*	*mg / g protein*	*Amino acid speed*	*mg / g protein*	*Amino acid speed*
Leucine + isoleucine	110,0	142,0	129,1	132,0	120,0	110,9	100,8	127,7	116,1
Lysine + histidine	55,0	102,0	185,5	91,0	165,5	78,0	141,8	88,9	161,6
Valine	50,0	60,0	120,0	60,0	120,0	52,7	105,4	58,3	116,6
Tryptophan	10,0	16,0	160,0	16,0	160,0	13,6	136,0	12,7	127,0
Threonine	40,0	46,0	115,0	42,0	105,0	34,8	87,0	40,1	100,3
Phenylalanine + tyrosine	60,0	99,0	165,0	79,0	131,7	68,0	113,3	74,3	123,8
Methionine + cystine	35,0	33,0	94,3	32,0	91,4	27,7	79,1	30,7	87,7

For biologically complete proteins, not only the presence of all essential acids is essential, but also their balance. To determine the balance of essential amino acids, calculations were performed according to existing methods using "tryptophan" and "threonine" indices (Tables 9, 10).

Table 9

Balance of essential amino acids of sauces based on a composite mixture of dietary supplements according to the "tryptophan" index

Name of amino acids	FAO / WHO standard scale	Sunny Sauce	Balance Sauce	Highlander Sauce	Rainbow Sauce
Threonine	2–3	2,88	2,63	2,56	3,16
Lysine + histidine	3–5	6,38	5,69	5,81	7,00
Valine	4	3,75	3,75	3,88	4,59
Leucine + isoleucine	7–10	8,88	8,25	8,15	10,06
Phenylalanine	2–4	3,25	2,94	3,04	3,53
Methionine	2–4	1,38	1,00	1,08	1,14
Tryptophan	1	1,00	1,00	1,00	1,00

The results of the calculation of amino acid balance in sauces by determining the "tryptophan" index show that the ratio is not enough valine and methionine (in the rainbow sauce valine is more than normal), but the protein is overloaded with lysine and histidine. According to the "tryptophan" index, the protein is balanced.

Table 10

Balance of essential amino acids of sauces based on a composite mixture of dietary supplements on the "threonine" index

Name of amino acids	FAO / WHO standard scale	Sunny Sauce	Balance Sauce	Highlander Sauce	Rainbow Sauce
Threonine	1	1,00	1,00	1,00	1,00
Lysine + histidine	1,1	2,22	2,17	2,27	2,22
Valine	1,5	1,30	1,43	1,51	1,45
Leucine + isoleucine	3,1	3,09	3,14	3,19	3,18
Phenylalanine	1,1	1,13	1,12	1,19	1,12
Methionine	0,7	0,48	0,38	0,42	0,36
Tryptophan	0,25	0,35	0,38	0,39	0,32

The results of the calculation of amino acid balance in sauces by the definition of the "threonine" index show that the ratio is not enough valine (exception – Highlander sauce) and methionine, but the protein is overloaded with lysine + histidine and tryptophan. According to the "threonine" index, the protein is balanced.

In the production of traditional and developed sauces, we used butter, a composite mixture of dietary supplements, wheat flour of the highest grade, which contain a significant proportion of fat. In this regard, the fatty acid composition of lipid fractions of sauce products was determined. Of particular interest in the study of fatty acid composition is the presence of monounsaturated and polyunsaturated fatty acids.

The analysis of the obtained data showed that saturated fatty acids are dominant for the sauce "Sunny" and "Balance": 66.4% and 59.9% of the total fat, the predominant of which are palmitic – 26.4 and 25.2%, stearic – 11.6 and 11.3% and myristic – 8.6 and 7.8%. This content of saturated fatty acids is mainly due to the fact that sauces contain butter. Among monounsaturated and polyunsaturated, oleic acid dominates – 26.6 and 25.9% and lenoleic – 10.7 and 13.5% of the total fatty acids. Polyunsaturated and monounsaturated fatty acids dominate in Gorets and Veselka sauces: linoleic – 48.7 and 53.3%, oleic – 30.3 and 22.6%, respectively. Saturated fatty acids are represented mainly by palmitic – 10.8 and 12.3% and stearic – 3.5 and 3.8% of the total fatty acids. At the same time, the quantitative and qualitative composition of carbohydrates in the developed sauces changes structurally: the amount of dietary fiber increases (Table 11).

The content of polysaccharides in the developed sauces increases: "Sunny" – 2.2 times, "Balance" – 2.2 times, "Highlander" – 3 times, "Rainbow" – 2.8 times. Polysaccharides are a significant amount of carbohydrates in sauce products, the bulk of which, in control samples, is starch. The composite mixture of dietary supplements contains significantly less starchy substances than wheat flour and starch. Therefore, with the complete replacement of high-grade flour and starch by the composite mixture, the experimental samples show a decrease in starch by 83%, 71%, 91%, 91% compared to the control and the amount of dietary fiber increases by an order of magnitude.

Of particular note is the increase in the amount of dietary fiber in the experimental samples compared to control: by 7.4 g – in sauces "Sunny" and "Balance", 7.3 and 7.2 g – "Highlander" and "Rainbow", respectively. This is mainly due to the increase in the content of pectin and gum arabic, which are contained in the composite mixture.

Table 11

The composition of polysaccharides of sauce products based on the composite mixture

Sauce	The total number	Mono– and disaccharides	Starch and dextrins	Dietary fiber
"Lactic"	7,04±0,21	3,37±0,11	3,57±0,11	0,1±0,004
"Solar"	11,53±0,32	3,42±0,13	0,61±0,02	7,5±0,23
"White"	5,43±0,11	1,49±0,05	3,84±0,10	0,1±0,004
"Balance"	10,1±0,22	1,48±0,05	1,12±0,03	7,5±0,22
Tkemali	14,2±0,23	11,5±0,43	2,1±0,04	0,6±0,01
"Highlander"	17,6±0,33	9,5±0,33	0,2±0,01	7,9±0,21
"Apple"	22,1±0,85	19,2±0,62	2,1±0,06	0,8±0,01
"Rainbow"	25,5±0,97	17,3±0,58	0,2±0,005	8,0±0,31

Minerals play an important role in the metabolic processes of the human body. They are included as a plastic material in the supporting tissues bones, cartilage, teeth, are involved in hematopoiesis (iron, cobalt, copper, manganese, nickel); affect water metabolism, affect the osmotic pressure of blood plasma, are part of a number of hormones, vitamins and enzymes. Enrichment of sauce products with minerals through the use of natural raw materials, which contain a significant amount of them, is of great social importance.

It should be noted that a necessary condition for the developed sauces is the ability to enhance the protective functions of the human body, due to the increased amount of certain minerals. In this regard, the use of a composite mixture of dietary supplements in the technology of sauces affects the improvement of their nutritional value (increase in the content of minerals in their composition) (Table 12).

Table 12

The content of minerals in functional sauces

Sauce	**Potassium, mg/100 g**	**Calcium, mg/100 g**	**Magnesium, mg /100 g**	**Phosphorus, mg/100 g**	**Iron, mg/100 g**
Milk Sauce	151,4±4,3	112,9±3,4	18,9±0,4	103,0±3,1	392,1±7,4
Sunny sauce	284,0±5,7	376,0±7,6	31,9±0,1	103,2±3,1	3491,4±8,8
The difference,%	87,6	233,0	68,6	0,2	794,9
White sauce	20,0±0,5	4,0±0,1	6,3±0,1	21,1±0,6	300,2±9,5
Balance Sauce	85,9 0±2,1	269,0±8,1	12,0±0,1	32,9±0,7	810,3±10,3
The difference,%	329,5	6640,6	91,7	56,3	170,0
Tkemali Sauce	214,0±6,5	20,0±0,5	9,0±0,1	20,0±0,6	500,2±13,6
Highlander sauce	268,0±6,8	295,4±6,9	19,7±0,2	49,0±1,8	1225,6±18,5
The difference,%	24,8	1376,8	118,3	144,8	145,0
Apple Sauce	124,0±3,8	12,0±0,3	7,0±0,1	17,0±0,3	1301,3±15,9
Rainbow Sauce	190,6±4,3	290,4±9,1	19,0±0,8	49,0±1,8	2104,8±24,6
The difference,%	53,7	2319,6	171,4	187,9	61,5

Analyzing the quantitative composition of micro– and macronutrients, it should be noted an increase in potassium (in the sauce "Sunny" – 1.9 times, "Balance" – 4.3 times, "Highlander" – 1.25 times, "Rainbow" – 1.54 times), calcium ("Sunny" – 3.3 times, "Balance" – 265 mg, "Highlander" – 14.7 times, "Rainbow" – 24 times), magnesium "Sunny" – 1.7 times, "Balance" – 1 , 9 times, "Highlander" – 2.2 times, "Rainbow" – 2.7 times), phosphorus "Solar" – at the level of control, "Balance" – 1.6 times, "Highlander" – 2.5 times, "Highlander" – 2.5 times, "Rainbow" "– 2.9 times), iron (" Sunny "– 9 times," Balance "– 2.7 times," Highlander "– 2.2 times," Rainbow "– 1.6 times) on control, which is important because it helps to increase immunity and resistance organism to adverse environmental factors.

With increasing mineral content in sauces, the satisfaction of the daily needs of the human body in certain nutrients increases (Table 13).

Table 13

Satisfaction of daily demand for mineral elements when consuming 100 g of sauce products

Sauce	Satisfaction of daily needs,%				
	Potassium, mg / 100 g	Calcium, mg / 100 g	Magnesium, mg / 100 g	Phosphorus, mg/100 g	Iron, mg/100 g
Age requirement	2000,0	1200,0	300-350,0	800-1200,0	15,0
Milk sauce (control)	7,6	9,4	5,4	10,6	2,6
Solar sauce (experiment)	14,2	31,3	10,1	10,6	23,3
White sauce (control)	1,0	0,3	1,8	1,8	2,0
Balance sauce (experiment)	4,3	22,4	3,4	2,7	5,4
Tkemali Sauce (Control)	10,7	1,7	2,6	1,7	3,3
Highlander sauce (experiment)	13,4	24,6	5,6	4,1	10,2
Apple Sauce (Control)	6,2	1,0	2,0	1,4	8,7
Rainbow Sauce (experiment)	10,5	24,2	5,4	4,1	14,0

The study of mineral composition determined that the developed sauces have a higher content of macro– and microelements compared to traditional analogues and the quantitative content of minerals can be attributed to functional products. They can be recommended for use in health and preventive nutrition for all segments of the population as functional foods.

Analysis of the vitamin composition of the developed sauces revealed an increase in vitamins in sauces: "Solar" (niacin – 33%, thiamine – 45.5%, riboflavin – 18%, ascorbic acid – 154%, carotenoids – 4.2 times compared to control), " Balance "(niacin – by 40.0%, thiamine – 104.0%, riboflavin – 36.0%, ascorbic acid – 55.0%, carotenoids – by 23%)," Highlander "(niacin – by 85.0%, thiamine – 83.3%, riboflavin – 2.1 times, ascorbic acid – 7%, carotenoids – 2.3 times), "Rainbow" – niacin – 2.4 times, thiamine – 6.3 times, riboflavin – 60.0%, ascorbic acid – by 7%, carotenoids – 2.3 times, respectively) (Table 14).

The increased content of vitamins and vitamin-like compounds (carotenoids, thiamine, niacin, riboflafin, ascorbic acid) in the test samples is due to the presence in their composition of a composite mixture of dietary supplements.

Table 14

Content of vitamins and vitamin-like substances in sauce products

Sauce	Indexes				
	Carotenoids, mg / 100g	Thiamine (B1), mg / 100g	Riboflavin (B2), mcg / 100g	Niacin (PP), mg / 100g	Ascorbic acid (C), mg / 100g
Milk Sauce	0,140±0,001	0,055±0,001	0,143±0,002	0,200±0,002	1,300±0,03
Sunny sauce	0,605±0,002	0,080±0,001	0,169±0,002	0,266±0,002	3,30±0,09
The difference,%	1400,0	45,5	18,2	33,0	153,8
White sauce	0,130±0,001	0,025±0,001	0,013±0,001	0,100±0,001	0,200±0,007
Balance Sauce	0,160±0,001	0,051±0,00	0,017±0,001	0,140±0,001	0,310±0,01
The difference,%	23,1	104,0	36,0	40,0	55,0
Tkemali Sauce	0,100±0,001	0,060±0,0011	0,010±0,001	0,600±0,02	1,600±0,027
Highlander sauce	0,230±0,002	0,110±0,001	0,021±0,002	1,110±0,03	1,710±0,03
The difference,%	130,0	83,3	110,0	85,0	6,9
Apple Sauce	0,100±0,001	0,010±0,001	0,020±0,002	0,380±0,009	1,800±0,039
Rainbow Sauce	0,230±0,002	0,063±0,002	0,032±0,002	0,920±0,02	1,920±0,04
The difference,%	130,0	530,0	60,0	142,1	6,7

It should be emphasized that the daily requirement of vitamins due to new sauces is possible: carotenoids – up to 20%, thiamine, niacin, riboflavin, ascorbic acid – up to 10%. According to the generalized results of experimental research, it was found that the developed sauces "Sunny", "Balance", "Highlander" and "Rainbow" have a higher content of vitamins and vitamin-like substances than traditional sauces. Thus, increasing the content of the above vitamins in sauces using a composite mixture of dietary supplements allows us to predict that the new sauce products will increase immunity and resistance to adverse environmental factors.

Due to the high moisture content, sauces are a favorable environment for the development of microflora. Given the rapid deterioration of raw materials and favorable natural conditions for the development of microflora in sauces, high moisture content (80-90%), control of total microbiological contamination and detection of pathogenic bacteria is a mandatory step in the study of sauces.

It has been found that the moisture in the sauces is mainly in a bound state as a result of the use of complexing substances – a composite mixture of dietary supplements that helps reduce water activity and the speed of physico-chemical reactions. Due to the variety of processes that occur during storage of sauces, the degree of freshness was determined by organoleptic and microbiological indicators, given that changes in the quality of sauces in laboratory research are better than in sensory analysis.

To determine the microbiological safety of new sauces based on the composite mixture, the total number of mesophilic aerobic and facultative anaerobic microorganisms (MAFANM) in 1 g of finished product, the presence of Escherichia coli bacteria and other microorganisms was determined experimentally. The control was served by sauces made by traditional technology (according to microbiological indicators must meet the requirements of IBC № 5061, GSTU 18.06. When studying the shelf life of the developed sauces, it was found that the number of mesophilic aerobic and facultative anaerobic microorganisms after storage (t = 4 °C, 24 h) is 1.86–2.07$\cdot$ 10^2, which is 6–9% less compared to the control . Sauces after storage for 48 hours. also meet the requirements for microbiological standards of food safety.

In our opinion, increasing the proportion of dry matter and bound moisture helps to increase the osmotic pressure and slow down the growth of microorganisms. Bound moisture, in contrast to free, is inaccessible to microorganisms, so with a decrease in the proportion of free moisture or its transfer to the bound development of the microflora in food is suppressed. As a result of research of control and research samples of sauces of organophosphorus pesticides it is not revealed. According to the content of heavy metals, functional sauces correspond to IBC № 5061 (Table 15).

Table 15

Content of heavy metals and arsenic in sauce products

Name sauce	Heavy metal content, mg / kg					
	Lead (Pb)	**Cadmium (Cd)**	**Arsenic (As)**	**Copper (Cu)**	**Mercury (Hg)**	**Zinc (Zn)**
"Lactic"	0.02	Not found	Not found	0.10	Not found	0.40
"Solar"	0.02	Not found	Not found	0.05	Not found	0.42
"White"	0.03	Not found	Not found	0.11	Not found	0.51
"Balance"	0.03	Not found	Not found	0.12	Not found	0.53
Tkemali	0.03	Not found	Not found	0.12	Not found	0.60
"Highlander"	0.03	Not found	Not found	0.12	Not found	0.50
"Apple"	0.02	Not found	Not found	0.12	Not found	0.40
"Rainbow"	0.02	Not found	Not found	0.11	Not found	0.36

The results of the study showed that the microbiological parameters of both control samples and developed sauces of functional purpose during the established shelf life met the "Medico-biological requirements and sanitary standards of quality of food raw materials and food products" № 5061 from 01.08.89, which indicates safety of new sauces within the shelf life. Storage conditions of the developed sauces (t = 4°C, φ = 75%, T≤24 h) were established. A positive conclusion of the state sanitary-epidemiological examination was obtained for functional sauces № 05.03.02-06 / 43755 dated 17.07.2009

One of the main indicators of product quality during storage are organoleptic. The organoleptic parameters of freshly prepared and after 6, 12 and 24 h storage in control and developed sauces using a composite mixture were studied. [16]

The first 6 hours of storage of sauces had almost no effect on the organoleptic characteristics of control and experimental samples. Organoleptic evaluation for freshly made control samples of sauces was: "Dairy" – 8.77±0.15, "White" – 8.78±0.15, "Tkemali" – 8.79±0.15, "Apple" – 8.80±0.15 points; for experimental: "Solar" – 8.54±0.18, "Balance" – 8.61±0.18, "Highlander" – 8.51±0.18, "Rainbow" – 8.56±0.18 points. After 12 hours of storage, the organoleptic evaluation of traditional sauces was respectively: 8.75±0.15, 8.76±0.15, 8.74±0.15, 8.55±0.18 points, and experimental 8.54±0.18, 8.61±0.18, 8.50±0.18, 8.55±0.18. The decrease in organoleptic evaluation of all indicators during storage of sauces for 12 hours was mainly by 0.61-0.72 points in both control and experimental samples. After 24 h of storage, the organoleptic characteristics of the control and experimental sauces decreased by 0.65-0.73 points compared to the samples stored for 12 hours.

It is noted that the values of organoleptic evaluation of the developed sauces after 24 hours of storage of sauces are: "Sunny" – 7.22±0.11, "Balance" – 7.29±0.14, "Highlander" – 7.18±0.12, "Rainbow" – 7.23±0.14 points, and control. samples – 7.43±0.12, 7.44±0.14, 7.42±0.11, 7.42±0.12 points, respectively.

Indicators of thixotropy, aggregative and kinetic stability in control and experimental samples remained virtually unchanged throughout the shelf life.

Conclusions

According to the results of the research, it was determined that according to organoleptic evaluation, physicochemical, rheological and safety indicators, the new sauces were at a sufficiently high level during the established shelf life and correspond to high quality food products.

Based on organoleptic, physicochemical and chemical composition indicators, taking into account the weighting factors, complex quality indicators of functional sauces have been determined. As a standard for sauces, a conditional product has been identified that meets the set scientific objectives: to create a functional food product with a high content of nutrients, which provides 25% of the daily need for them. The safety of developed products (microbiological indicators, content of salts of heavy metals, pesticides and other pollutants) is taken into account when calculating the complex quality indicator. The "veto" rule was used: if the product does not meet the established sanitary and hygienic requirements, its complex quality indicator is multiplied by 0, if it meets – by 1. Complex quality indicators of developed sauces exceed the corresponding control values (100 units) and are: for sauces: "Sunny" – 162.4, "Balance" – 171.4, "Highlander" – 164.2, "Tkemali" – 171.6 units, exceeding the control by 62.4 – 71.6%, respectively.

Based on the obtained unit indicators, the quality profiles of sauces were constructed in comparison with the standard (for which a conditional product was adopted, which provides 25% of the daily requirement for certain nutrients). The quality profiles of the developed sauces have a larger surface area: "Sunny" – 9.2; "Balance" – 5.4; "Highlander" – 8.2; "Rainbow" – 8.1 times compared to the control and close to the reference. The increased content of physiologically necessary substances allows us to recommend new sauce products in the health of all segments of the population, especially those living in contaminated areas.

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