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Development Of Dietary Food With The Use Of Soy Protein.

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ABSTRACT

The article is devoted to the issue of development of dietary nutrition, namely pasty products based on soy protein. There were analytically justified and experimentally modeled recipes for therapeutic and prophylactic products - soy pastes. Factors influencing the amount of trypsinin inhibitory activity of soy proteins were determined, soy varieties with minimal inhibitors content were recommended, optimal technological parameters for the preparation of the main raw materials and individual components of the formulation composition were worked out. Operational models of technological flows of soy pastes production, schemes for hardware supply of technological subsystems and schemes of technological control of production. There also were established normalized organoleptic and physicochemical indicators of the quality of dietary products based on soy. The indicators providing food and energy value of these products and allowing their usage in dietary nutrition of preventive purpose were determined. The norms of consumption were established in accordance with the daily requirement in essential nutrients of an adult. Theoretical analysis of modern types of packaging was held and recommendations on the use of containers for sterilizable and non-sterilizable soy pastes were drawn. Based on the results of the organoleptic evaluation and microbiological studies, the optimal storage time for soy pastes with and without the use of preservatives were established. The regulatory parameters of production were developed, the production inspection of technological and regulatory parameters were carried out, the normative documentation (technical standards and technology regulations) for the production of pasty products based on soy protein were developed.

Keywords: soy pastes, recipes, technology, consumption norms, nutritional value, normative indicators, production inspection, regulatory documentation

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INTRODUCTION

Among various environmental factors that affect body, nutrition is one of the most important. Correctly organized and built on modern scientific principles, rational and dietary nutrition ensures the normal course of the processes of growth and development of the body, as well as the preservation of health. Changing the nature of nutrition, it is possible to regulate the metabolism and thereby actively influence the course of the disease or prevent the occurrence of certain diseases.

In recent years, due to the complicated environmental and economic situation in the country, there has been a sharp leap in the incidence rate of adults, adolescents, children covering such diseases of the century such as diabetes, stomach ulcer, cardiovascular diseases, congenital anemia in newborns, etc. In this regard in order to increase the resistance of the organism to the influence of unfavorable environmental factors and preserve the gene pool of mankind, great attention must be paid to the organization of preventive and therapeutic nutrition, creation of new generation foodstuffs, designed to delay the aging of the body, to bind, neutralize and remove harmful substances from the body, to prevent the development of diseases.

One of the directions in the organization of healthy nutrition is the use of vegetable proteins in the nutritional balance of the population to compensate for the deficiency of animal proteins.

Analysis of the structure of protein nutrition of population in our country over the past 10 years shows a dangerous trend of a steady decline in protein consumption from animal sources. Since the 1990s, there has been a serious deficit in protein consumption with a constant increase in protein and has now reached 25% of the norm. For certain categories of the population, it reaches an alarming level for human health.

The consumption of protein in Russia is on the average by 50% provided by the import of foodstuffs, which on the one hand puts the country in a significant dependence on other states and aggravates the problem of "protein security", and on the other hand shows a pronounced protein deficit in the production of domestic protein-containing products. This problem can be solved by intensifying traditional methods of producing protein-containing products and obtaining protein products from new sources.

Among the additional sources of food proteins over the past 15-20 years, the attention of researchers to products of soybean processing, in particular to soy proteins, has increased significantly the use of which for food purposes has become widespread in many economically developed countries, including the USA, Japan, Denmark, Russia, etc., not only in the traditional, but also in the treatment and preventive nutrition.

The results of biomedical research of various forms of processing of soy protein products obtained abroad and in Russia using the most promising technologies confirmed literature data, which testify to the high food qualities of these protein products, revealed a number of specific properties that had a therapeutic and preventive orientation, in particular, a clear effectiveness in the correction of metabolic disorders of lipid, carbohydrate, mineral metabolism, immune status, etc. [9].

Soybeans are the only plant product containing such a high percentage of protein (up to 50%), additionally the soy protein in the food ratio is quite balanced in amino acid composition, comparable in biological value to proteins of milk, fish and beef, but unlike them do not contain cholesterol, but also help reduce its content in the body. This allows us to recommend it to patients with impaired lipid metabolism (atherosclerosis, IHD, hypertension) and for the prevention of these diseases [13].

A set of essential amino acids in soy is enough to satisfy the need for them in different age groups of the population, including children and the elderly.

Soy contains a sufficient amount of bioavailable micronutrients: iron, magnesium, potassium, zinc, calcium. Low sodium content with a high potassium supply allows us to achieve a stable diuretic effect without the use of pharmacological agents during periods of diet therapy using soy proteins and soybean processing products. Lecithin, contained in soy, prevents the formation of stones in the gallbladder and helps to dissolve them [10].

Soy products are the only alternative today for allergies and congenital intolerance of humans, especially children, towards animal proteins, cereal proteins and lactose.

Soy and its processing products are an excellent source of dietary fiber, represented by both water-soluble and insoluble fractions, capable of forming structural and functional formations and having an independent therapeutic and physiological function for affecting intestinal motility.

In addition, oligosaccharides (raffinose, stachyose) contained in soy have a bifidus factor and play a certain role (though indirect) in the correction of the intestinal microflora. Soy products are an ideal food for Bifidobacteria and can replace various bacterial preparations (Bifidumbacterin, lactobacilli, etc.) recommended for these purposes. Correct selection of daily requirement of soy products can regulate the intestinal microflora [5,15].

Recent year studies have shown the protective effect on the human body of the unique anti-carcinogenic substances contained in soy proteins, isoflavones, one of them - ginestein – inhibits the development of cancerous tumors. Isoflavones are also responsible for the antioxidant properties of soy protein products. Due to the antioxidant properties of soy products, the life expectancy of people increases, the aging process is inhibited. Soy contains vitamins of group B and is especially rich in vitamin E. The presence of vitamin E in soybeans completely satisfies the need for it in the human body, and also plays a protective role in maintaining the quality of full-fat soybeans during storage, preventing its rancidity [11].

This article presents the results of research of the development of an assortment of pasty food products based on soy.

MATERIALS AND METHODS

Theoretical modeling of the assortment and structure of dietary products on soybean basis was carried out taking into account the results of preliminary analysis of research on the problem of dietary nutrition conducted in the Russian Federation and a number of advanced countries [3]. Experimental modeling of soybean pastes and processing of technological methods and parameters of preparation of the main raw materials and auxiliary components was carried out in laboratory conditions on laboratory equipment.

The composition of components, formulations and food additives were selected taking into account the consumer taste, increase in the biological value of the finished product and the compatibility of the components according to organoleptic indicators. Optimum variants of formulations were selected by the method of sensory evaluation.

Soybean was used as source of raw material for the production of paste in the form of beans, soy flour or soy concentrate, which is an insoluble fraction obtained in the production of soy milk after liquid phase separation.

To create a paste-like consistency of soybean pastes (such as "Nutella") such substancesw as gelatin and starchwas used as thickeners.

Technological methods and parameters of production of soybean pastes were established depending on the raw material.

The standardized quality indicators (organoleptic and physicochemical) of soybean pastes were established in accordance with standard requirements for similar products. Limits of standardized indicators were determined by standard methods in prototypes of products produced according to the optimal variants of the formulation composition.

Physico-chemical indicators and nutritional values were determined analytically by standard methods, certain nutritional values were justified theoretically, and the energy value was determined by the calculation method.

The norms of consumption of the dietary products on the basis of soybean developed by us were determined in accordance with the physiological need of a healthy person in food substances (according to the formula of a balanced diet of A.A. Pokrovsky).

Production verification of the technology of production of dietary soy pastes took place in the conditions of the “UNIK Technologist” Company.

The maximum permissible storage time for unsterilized soybean pastes was established according to the organoleptic characteristics and results of microbiological studies for normal storage conditions and at low temperatures with and without the use of preservatives.

Normative documentation for pasty soy products was developed in accordance with standard requirements. Microbiological studies were carried out according to generally accepted methods in accordance with All Union State Standard (GOST) 10444.15-94, All Union State Standard (GOST) 30425-97, All Union State Standard (GOST) 5048-93.

RESULTS

Based on the results of the research, the formulas of the therapeutic and prophylactic food products - soy pastes - were justified and experimentally modeled. The assortment of soybean pastes, including chocolate paste, paste with fruit fillings (apples, apricots, bananas, raspberries, currants, etc.) and vegetable (squash, pumpkin, carrot) in the form of puree, as well as with flavors were offered. As a raw material in the production of pasta soy can be used as whole grains, soy flour or food soybean concentrate (okara), obtained after squeezing soy milk and, depending on the raw materials, the appropriate production technologies were developed.

It is known that soy beans, despite their high nutritional value, contain various anti-nutrients, mainly substances that inhibit the action of proteolytic enzymes, in particular, trypsin and chymotrypsin, which gives fresh soybean a specific "soy" flavor and requires special processing for its processing for food products [6,7]. Therefore, when working out the technological parameters of soybean preparation for the production of soybean pastes, factors affecting the decrease of trypsinin inhibitory activity were investigated and, based on the results of the studies, technological parameters of hydrothermal soybean processing were established, which minimized the activity of inhibitors or completely inactivated them depending on the content in the raw material.

The conducted studies of perspective soybean varieties regionalized in Krasnodar Krai (selection by All-Russian Research Institute of Oil Crops) showed that trypsinin inhibitory activity is mainly a variety feature and varies from 15.8 to 36 mg / g, depending on the variety. Apparently, the feature of inhibitory activity is largely due to the genotype and in the selection directed to this feature a reduced content of inhibitors or its complete absence can be obtained.

The effect of hydrothermal treatment and pH of the medium on the activity of inhibitors was also noted. Thus, an increase in the pH of the medium from 5.4 to 6.8 ensures almost tenfold decrease in the trypsin inhibitory activity.

Thus, according to the results of the studies, it was found that when the inhibitors in the source raw material is 16-17 mg/g and below and the corresponding processing is provided, their complete inactivation in the finished product is ensured (Fig. 1, 2).

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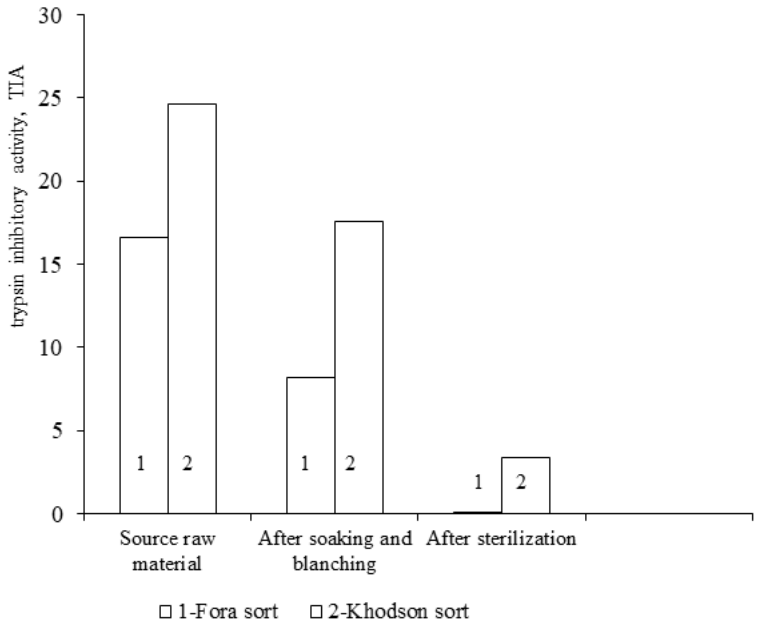

Figure 1. Effect of inhibitor content in ready product and technological processing on TIA

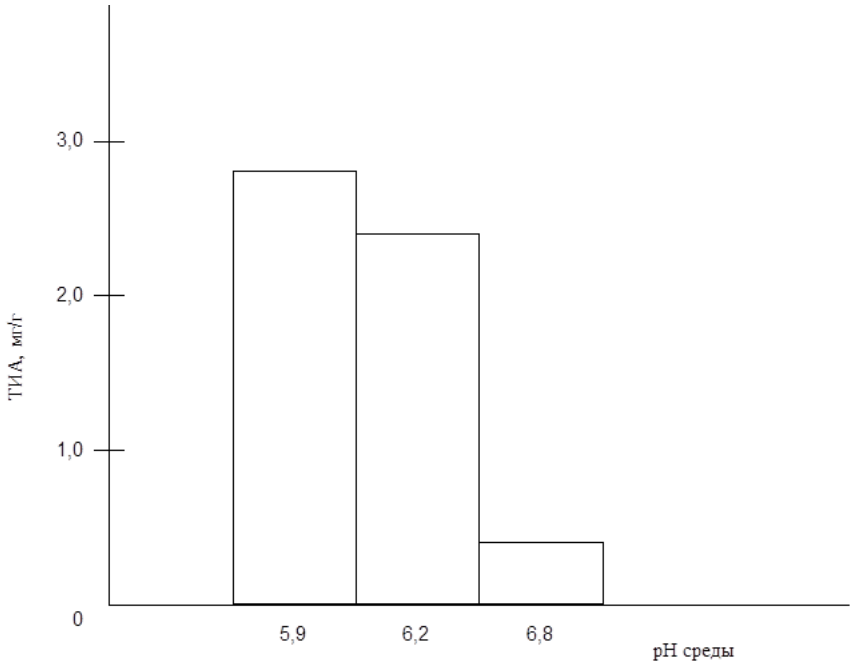

Figure 2. TIA and pH relationship in ready product

The technological scheme for preparing the main component of soybean pastes includes the following operations: separation, beans washing, soaking, blanching, cooling, grinding, mixing with other components of the formulation composition, homogenization, heating, and packaging.

When using pasty soy products for the production of soybean foodstuffs as source raw material of soy flour, the absence of inhibitors in the finished product is also ensured, since the very technology of soy flour, based on the process of purification, heat treatment, grinding without access to air, minimizes the level of trypsin inhibitory activity proteins. In addition, the technology provides a very fine grinding of flour, which provides a paste-like consistency without homogenization.

The technological process involves mixing soy flour with water for swelling, mixing with components, preheating and packaging.

As a source raw material food soybean concentrate (okara)can be used which is an insoluble fraction obtained after grinding the soybean seeds, heat treatment at a temperature above 100° C and then squeezing the liquid phase.

The data were obtained on the Fora variety with a duration of sterilization of 30 minutes. Okara in terms of nutrient content is inferior to soy flour and comparable to cow's milk (Table 1).

Table 1 – The content of nutrients in soy based products and cow's milk

Name	Caloric value, kcal/ 100 g	Moisture, at most %	Protein, %	Fat, %	Carbohydrates, %	Calcium, mg %	Iron, mg %	Vitamin B_1, mg %	Vitamin B_2, mg %
okara	96	80	4.5	4.0	10.5	49	0.8	0.01	0.01
soya flour	434	9.0	43.0	14.0	34.0	79	2.4	0.2	0.4
cow's milk	51	88.2	2.8	3.5	4.7	20	0.06	0.04	0.15

In addition, okara is a source of dietary fiber, bivalent iron, contained in the shell of soy.

Based on the results of technological research, an operator model of a technological system for the production of soy pasty products was developed. For the implementation of the developed technologies, the appropriate equipment was selected and a machine-hardware production scheme was compiled.

The most important factor ensuring the production of high quality products and compliance with its regulatory requirements is the organization of technological control and regulation of the technological process. The control scheme regulates the incoming quality control of raw materials, the acceptance control of the finished product and the operational control of the technological process at critical points. The main task in the development of the control scheme is the selection of controlled operations and process parameters that ensure the maintenance of a given level of quality of the finished product. Such indicators were also determined for the production process of soybean pastes and a monitoring route with the indication of controlled parameters was compiled. The main controllable indicator of soybean pastes in the production process is the viscosity before packing. The technique for determining the viscosity providing the required consistency of the finished product was developed. For this purpose comparative tests of various methods for determining the viscosity according to Gepler, Engler, and others were carried out. The most acceptable method was the determination of the viscosity by the spreading coefficient, which was adopted for control. Input control of raw materials, semi-finished products and materials is made in accordance with applicable standards.

Soybean pastes can be produced with sterilization and unsterilized with the addition of preservatives approved for use by the Ministry of Health of the Russian Federation (potassium sorbate, sodium benzoate) with a limited shelf life.

The theoretical analysis of modern types of packaging was given and recommendations for the packaging of sterilized soybean pastes into glass containers of any type with a capacity of 50 to 400 ml were given.

For the packaging of unsterilized soybean pastes, polymeric types of packaging containers are recommended, in particular plastic cups made of polystyrene (PS) and polypropylene (PP) with capacities from 50 to 500 ml, diameters from 68 to 100 mm, with welding aluminum cover, foil and walkilid covers with heat-sealing varnish and lid-snaps.

It should be noted that for this group of products there are no standards of medical and biological requirements for microbiological indicators, which is the criterion of sanitary and technological production parameters. The danger of contamination of food products by microorganisms and their enterotoxins is now very high.

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In this regard, a series of studies was carried out to establish the acceptable shelf life of unsterilized soybean pastes. The objects were pastes: soy chocolate, soy-apple, soy-vegetable marrow, soy flavored. The product samples were taken before packing and, in addition, the analysis of the packaged pastes was carried out at intervals of 1, 2, 3, 4 weeks and then after 30 days for another two months (with the aim of establishing storage times). The pastes were stored at a temperature of 7-12 ° C and a humidity of 60-75%.

When sowing, the presence of coliform bacteria (CB) was detected as the most common sanitary and demonstration microorganisms and the total quantity of mesophilic facultative and anaerobic microorganisms (MFAM) in 1 g was determined (Table 2).

Table 2 - Total viable count in soy-bean paste, CFU/G

Type of paste	Term of storage (days)					
	7	14	21	30	60	90
Soy-apple	390	700	1100	1400	1470	1440
Soy- marrow squash	480	650	1400	1725	1800	1720
Soy-chocolate	370	800	1500	1874	1948	2020
Soy-bean paste with flavorant	310	720	1120	1320	1400	1380

It should be noted that CB (in 0.1 g), pathogenic microorganisms, including salmonella (in 25 g), were not found in any of the samples studied. The number of mold fungi (in 1 g) in the test samples ranged from 2 to 10 cells and did not change during storage. Yeast was not detected in the test samples.

The amount of MFAM in the pastes when deposited for storage did not exceed 500 cfu / g. The relatively low storage temperature of 8-10°C caused the latent phase of the life activity of microorganisms. There is a large activity of microorganism development during the first three weeks of storage.

At the end of three months of storage, the amount of MFAM did not exceed $2 \cdot 10^3$ cells / g in all sample pastes, which indicates the satisfactory quality of the stored food products.

Based on the results of microbiological studies and organoleptic evaluation, the following storage times were established (Table 3).

Table 3 – Optimal storage time of non-sterilized soy-bean paste

Name	Dry solids weight ratio, %	Storage conditions	Term of storage, days	
			without conservant	with conservant
Chocolate soy-bean paste	57.0	Room temperature (+20÷25° C) In refrigerator (+ 4÷5° C)	7 30	12 90
Soy-bean paste with fruit filler (apple)	33.2	Room temperature (+20÷25° C) In refrigerator (+ 4÷5° C)	3 12	12 90
Soy-bean paste with vegetable filler (marrow squash)	36.6	Room temperature (+20÷25° C) In refrigerator (+ 4÷5° C)	3 12	12 90
Soy-bean paste with flavorant		In refrigerator (+ 4÷5° C)	12	90

Indicators were also determined that ensure the nutritional and energy value of these products and allow them to be used in dietary nutrition for prophylactic purposes.

One of the most important biological regularities is the correspondence rule: the enzyme sets of the organism must correspond to the chemical structures of food and the violation of this correspondence causes many diseases, leading to a disruption of the normal processes of the transformation of the food product. These relationships are fixed as formulas for a balanced diet [4].

Satisfaction of the body's needs for essential nutrients while consuming soybean pastes (for example, chocolate pasta) is given in Table 4.

Table 4 - Daily nutrient requirements ratio of 100 g of soy-bean paste for adults

Nutrients	Daily requirements for adult, g	Content in 100 g of soy-bean paste, g	Daily requirements ratio, in 100 g, %
Protein, g	80	7.0	8.75
including vegetable protein	35	7.0	20.0
Fat, g	80	18.5	23.1
including vegetable oil	25	18.5	74.0
Essential amino acids: valine	3-4	0.27	7.67
isoleucine	3-4	0.25	7.07
leucine	4-6	0.39	7.78
lysine	3-5	0.29	7.43
threonine	2-3	0.20	7.86
tryptophan	1	0.06	6.20
phenylalanine	2-4	0.22	7.40
methionine	2-4	0.08	2.66
Vitamins, mg E	9	10.35	115
B_1	1.1-2.0	0.11	7.3
B_2	1.3-2.4	0.08	4.5
B_6	1.8-2.0	0.09	4.1
Mineral elements, mg Sodium	5000	21	0.42
Potassium	3700	220	6.3
Calcium	900	73	8.1
Magnesium	420	26	6.2
Phosphorous	1300	100	7.7
Caloric value, kkal	2775	282.7	10.2

As can be seen from the table, when 100 g of soybean paste is consumed, from 5 to 10% of the daily requirement for basic nutrient materials is met. For vitamin E, the daily requirement is satisfied by 100%. Vitamin E is a strong biological antioxidant, as it prevents oxidation of PUFA, participates in the exchange of proteins, fats, carbohydrates, and plays a role in maintaining the stability of cell membranes [8].

For the proper functioning of the human body, it is important not only to supply a sufficient amount of each of the essential amino acids together with food, but also their ratio, which approximates the ratio in the proteins of the human body. If the balance of the amino acid composition of food is disturbed, the synthesis of body proteins is also impaired, which entails a growth retardation, development and a whole chain of functional disorders. The ratio of essential amino acids in the amino acid composition of soybean pastes in comparison with the physiologically necessary ratio is shown in Table 5.

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Table 5 – Amino acids ratio in soy-bean paste

Physiologically necessary ratio of amino acids	Tryptophan	Leucine	Isoleucine	Valine	Threonine	Lysine	Methionine	Phenylalanine
	1:	6:	4:	4:	3:	5:	4:	4
Amino acids ratio in soy-bean paste	1:	6.3:	3.9:	4.3:	3.2:	4.8:	1.4:	3.6

It can be seen from the table that the amino acid composition of the soybean paste is well balanced; their ratio is close to the physiologically necessary ratio, with the exception of methionine, which is the limiting amino acid in soy proteins.

The norms of consumption of raw materials and materials in the production of soybean pastes were developed. The norms of losses and waste for components of the formulation were adopted according to the approved standards.

For the packaging of unsterilized paste, it is possible to use a polymer container with a capacity of no more than 0.5 dm3, approved for use by the Ministry of Health of the Russian Federation, with hermetic sealing by heat sealing.

Normative documentation for products was developed and approved.

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