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SOYBEAN PROCESSING TECHNOLOGY IN THE PRODUCTION OF HEALTH PRODUCTS

ТЕХНОЛОГІЯ ПЕРЕРОБКИ СОЇ У ВИРОБНИЦТВІ ОЗДОРОВЧИХ ПРОДУКТІВ

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Abstract. *The most important determinant of public health is a balanced, nutritious diet that ensures normal human growth and development, life expectancy, increases the body's resistance to adverse environmental conditions, and leads to progress and improvement of the quality of life.*

The article provides reasonable reasons for the expediency of using soybean raw materials, which has led to the emergence of mass consumption products available to all groups of the population that can be regularly used in everyday, dietary, therapeutic or preventive nutrition with a high degree of digestibility and assimilation of food, in accordance with the recommendations, while maintaining an adequate level of energy expenditure per day. Trends in the development of modern food technologies are aimed at expanding the range of health products. Against the backdrop of popularization and awareness of healthy eating, the population needs new products that would meet the nutritional needs of the body, be inexpensive and enrich the daily diet. One of the ways to produce such products is to use the main representative of vegetable legumes - soybeans. The aim of the study is to develop a technology for protein and vitamin concentrate and formulations of health products based on soy. The following methods were used in the study: cause-and-effect analysis, experimental, economic and statistical, calculation, and constructive and logical generalization. As a result of the study, practical recommendations on the technology of protein-vitamin concentrate and reconstituted.

Key words: *soybeans, functional foods, tofu, okara, soy flour, Supra 760, Supra 2640, soy drinks, soy semi-finished products.*

Introduction. Ukraine is currently experiencing the most critical period in its independent existence. Modern food processing companies in Ukraine are operating in extremely difficult conditions of war in the country. These include limited raw materials, financial, technical and labor resources; unresolved social and labor problems (high level of manual labor, unattractive, difficult and harmful working conditions); low quality of management and organization; lack of sea connections; shortage of shipping containers in the Baltic region; fuel shortages; lack of foreign carriers' vehicles in cities that are periodically shelled; and an increase in the cost of export delivery by land by more than 40%-60%; traders' refusal to work on a prepayment basis, lack of working capital to fulfill export orders; large stocks of goods in warehouses; complicated crossing and/or low throughput with Romania and Poland; uncoordinated scheme of reissuing veterinary and customs documents in the EU and Turkey when reloading from a truck to a container, and many others.

The food problem of providing the population of both Ukraine and the world as a whole with adequate dietary protein remains relevant in the 21st century. Humanity is faced with limited natural resources (fresh water, arable land, pastures, opportunities for further yield growth...) against the backdrop of local military conflicts, continued rapid population growth in economically underdeveloped

countries, and other factors.

Today's challenge is to provide high-quality, inexpensive raw materials that will facilitate the production of food with essential nutrients. The strategies of many countries also include improving the quality and developing new types of specialized and health foods.

The development of recipes and technologies for such foods is based primarily on enriching consumer products with physiologically functional ingredients by introducing additional components or additives.

The requirements for additives are particularly demanding. In addition to being safe, they must enrich the chemical composition, increase the benefits of consuming such products, help prevent nutritionally dependent diseases, and at the same time have a positive impact on the organoleptic characteristics without reducing the overall quality of the product.

Soybean processed products can be successfully used as one of the components of such additives. They are mass-consumption products, available to all population groups, can be used regularly in everyday, dietary, therapeutic or preventive nutrition, and have a high degree of digestibility and absorption. After all, one of the most important factors that ensure public health, normal growth, human development, life expectancy, promote the body's resistance to adverse environmental conditions, and improve the quality of life is a high-quality, balanced, nutritious diet.

In addition, the lack of protein in the diet can be eliminated by using sources of vegetable protein, namely soybeans, which have high nutritional and biological value. Numerous studies and practical experience convincingly prove that proteins extracted from soybeans are well absorbed by the body, practically balanced in amino acid composition, have a number of functional and technological properties, and can therefore be used in the production of functional foods.

Research results. The perfection of the body's regulatory systems is not absolute, so any formula for a balanced diet cannot be equally adequate for all processes of human life. In addition, individual genetic characteristics of metabolism and functions of organs and systems play an important role. Healthy, balanced, functional nutrition involves providing the body with the necessary nutrients: proteins, fats and carbohydrates in a ratio of 1:1:4. Violation of the established balance of these substances leads to various diseases of the living organism. Proteins play an important role in nutrition, as they are a plastic material for the body.

The most complete proteins are those of animal origin, the level of consumption of which has significantly decreased due to a number of reasons. Due to the lack of consumption of animal products, there is a deficit of protein both in quantity and quality.

The food problem and, in particular, the task of providing the world's population with adequate dietary protein remains relevant in the 21st century. Humanity is faced with limited natural resources (fresh water, arable land, pastures, opportunities for further yield growth...) against the backdrop of continued rapid population growth in economically underdeveloped countries. At the same time, it should be noted that reforms in our country are taking place in a difficult economic, social, medical and demographic situation.

Obviously, the world cannot be supplied with nutrients using only traditional, expensive technologies. Food containing cereals, legumes, nuts, vegetables and fruits also provides people with the necessary amount of protein. Since the second half of the twentieth century, the soy food industry has been growing rapidly. These changes are driven by the public's awareness of the requirements of a healthy diet.

The lack of protein in the diet can be eliminated by using sources of vegetable protein, in particular, soybean seeds, which have high nutritional and biological value.

Among modern world scientific works, most of the research on soybean products belongs to China and European countries, where the maximum amount of soy products is consumed [1-13]. Among the scientific achievements and innovations in the field of soybean and soybean products processing described in the papers are the following: characterization of the nutritional value, processing and biological activity of beverages derived from soybeans; influence of the particle size of hulls on the physical properties and consumer value of tofu; study of chemical, microbiological and functional characteristics of kefir obtained from cow and soy milk; high-pressure pasteurization of soy hulls; physicochemical changes in soy protein during tofu processing; fermentation of hulls in the solid state, which with Aspergillus spp. which improves lipid metabolism and prevents obesity caused by high-fat diet and other recent works, etc. [1-13].

Soybeans and its products are considered a protein component in food products, a source of polyunsaturated fatty acids, isoflavonoids, phospholipids, enzymes, carbohydrates, including dietary fiber, minerals, as well as vitamins E, B, PP and other physiologically valuable nutrients. However, in order to maximize the extraction of these nutrients, it is important to use special methods and gentle processing regimes for raw materials.

Soybean dishes not only provide a diverse diet, but are also used for certain indications. Sometimes soy is used as a therapeutic and preventive product: its beneficial effects on the human body help to improve health in certain diseases. This list includes: osteoarthritis and arthritis; myocardial infarction; cholecystitis; chronic constipation; hypertension; ischemia; allergy to animal protein; atherosclerosis; gout.

Soy in food products. Soybeans are widely used in the modern production of various products. All of them are characterized by a high concentration of protein and lecithin. When consumed in moderation, they benefit the body and improve overall health. Types of soy products that are common today: dairy; flour; meat; pasta; vegetable oil; soy sauce; tempeh; yuba; chocolate.

One of the first soy-based products was milk. It is a pleasant white drink with a delicate flavor. To make milk, soybeans are crushed, soaked and squeezed, and the resulting liquid is boiled. The finished product is ideal for baby food in case of allergies to cow's milk products. Soy is lactose-free and low in fiber, so it does not cause diathesis.

Adults can also add soy milk to coffee, tea, various cereals and other dishes. In addition, common fermented milk products are made from soy: yogurt and kefir. They are practically indistinguishable from conventional ones, contain a minimum of animal fats, and are therefore used for vegan food [14].

Tofu cheese. It is quite popular in China and other Asian countries. It is well digested, does not contain cholesterol, helps restore bone and muscle tissue, strengthens them, and prevents the formation of cancer cells. It can be frozen, but has a slight specific ammonia odor. Perhaps because of this feature, it is not so popular in Ukraine.

Flour made from cake or dry beans. The basis for the flour is soybean seed or post-press cake or post-extraction meal, which are obtained in the process of soybean oil production. Its advantage is the high content of minerals and proteins. In addition, such flour does not contain starch, so it is useful for overweight and diabetes. It can be used instead of eggs at the rate of two tablespoons of flour per egg. Flour is used in the manufacture of sausages and frankfurters, which makes them a product for health and dietary purposes. Soy flour products are difficult to make because of their low gluten content. To make them, you need to add about 70-80% wheat flour.

Another interesting product is soy meat as an alternative and substitute for animal meat. Technologically, it is made by extrusion cooking on the basis of defatted soybean flour. The whole manufacturing process can be described as follows: it starts with pushing a certain size of doughy textured protein through a "sieve" and at the end of the process it is dried. Meat can have different granule sizes, it all depends on the size of the sieve holes: from very small ones (used for making minced meat) to small pieces. The product is delivered to the market freeze-dried. After soaking, it increases 4 times. This "meat" can be consumed by everyone, because it is absolutely natural. In addition, it is low in cholesterol, and its calorie content is very low, so the product is perfect for dietary nutrition.

Fermented miso paste. It is a product of fermentation of soybean paste with molds. It is considered indispensable in Japanese cuisine and is compared in importance to rice. It is believed that the paste reduces the negative effects of cholesterol and external environmental factors on the body. The latter even include radionuclides and heavy metals. The paste is used to make miso soup. It is ideal for breakfast because it gives you energy for the whole day. To prevent liver disease, it is recommended to eat a spoonful of paste every day. This soybean product is also used to prepare the following dishes: light soups - misoshiru; appetizers - miso dengaku; thick hodgepodge soups – ishiaki nabe; main dishes with rice, green onions and cucumber.

Vegetable oil from soybean seeds. This type of oil is quite common in America. It is characterized by a high degree of digestibility and a light nutty flavor. It is produced using the soybean extraction method. The oil is useful because it contains unsaturated fatty acids. An example is linoleic acid, which prevents the development of cancer cells. It is recommended to use soybean oil in case of kidney and nervous system diseases. This oil is added to salads, cold and hot dishes. Industrial production uses this oil in the manufacture of margarine; vegetable cream; mayonnaise; bread [14].

Soy sauce is a product of soybean processing that has become the most popular among soy products in Ukraine. Soy sauce is made by fermenting beans, just like the Japanese dish natto. The process takes at least six months. When fermentation is complete, the sauce is diluted with water and a little sea salt. It is widely used as a

dressing for salads and an addition to side dishes. Fried meat marinated in soy sauce is delicious. It is also used when eating sushi or rolls. The product is useful for its antioxidant properties. This means that the sauce is able to remove free radicals and other toxins from the body.

Tempeh. It is also a fermented product, like miso, made from whole soybeans. They are softened, hulled, and then cooked, but not completely. Then a starter with a fungal culture or an acidifier is added to the boiled beans. Finally, they are spread in a thin layer and then fermented at 30°C for a day. The finished product is very rich in protein. Tempeh is used by vegetarians. It is cut into pieces, then fried in oil with other ingredients. Tempeh is served in soups, with a side dish or as an independent dish [14].

Yuba. Also called fuli, fuchsia or doupe. Yuba is a foam of soy milk used in dry or raw form. This ingredient belongs to East Asian cuisine. In Ukraine, yuba is more commonly known as “soy asparagus,” although it has nothing to do with asparagus. Soy milk is boiled, resulting in a solid layer on the surface - yuba. It contains a lot of fat. Using special equipment, the film is removed and hung to dry. Fuju is eaten fresh, as an appetizer or with sauce.

Soy chocolate is a dietary analog of regular chocolate. In its production, cocoa beans are replaced with soy beans. The benefit of such chocolate is that its calorie content is much lower compared to conventional sweets. For this reason, it is widely used in dietary nutrition. Soy chocolate is especially recommended for people who are overweight [14].

Soy lecithin. This is an ingredient in most store-bought baked goods. Lecithin is necessary to give creams the desired consistency. The substance is made by processing vegetable oil from soybeans and fatty glycerin. Lecithin is a viscous, oily liquid with a dark yellow hue. The substance is used as a thickener for zucchini caviar, mayonnaise, margarine, chocolate, pates, and instant soups. With regular use, lecithin can cause an increase in internal organs.

Recently, combined structural minced products have been widely used. A significant advantage of producing such products is the ability to combine almost any raw material of plant and animal origin with various technological parameters and nutritional properties. This makes it possible to expand the range of food products for various commodity purposes (dietary, children's and general consumption) and for different population groups.

In addition to improving and enriching the chemical composition, the production of functional and specialized foods requires improving their consumer properties. To this end, when developing functional foods, it is important to ensure that the ingredients in the products are compatible in terms of organoleptic characteristics, structural and mechanical characteristics, and biomedical properties.

The production of combined food products from soybeans facilitates the rational use of raw materials, increases the production of protein products, and ensures economic efficiency of production by reducing costs and making them more affordable for the population.

The main raw materials used to produce nutritious foods with soy-based additives containing dietary fiber, minerals, and vitamins, along with proteins and

vegetable fats, are meat and vegetable and fish and vegetable compositions.

Our task is to develop modern technologies for complete protein foods that can be used as standalone foods and as food ingredients in health products.

Our research has shown that, using methods of physical and chemical transformation of soy and vegetable (carrot, pumpkin), as well as mushroom (mushrooms) raw materials, it is possible to obtain a protein-vitamin dispersed system containing sufficient amounts of proteins, vegetable fats, carbohydrates (including dietary fiber), vitamins and minerals.

The main stage in the process of producing a protein-vitamin product is the preparation of a protein-carbohydrate dispersion system formed as a result of grinding and extraction of soybeans and additional vegetable and mushroom raw materials.

The purpose of this stage is to mix, mutually saturate and enrich each component with valuable essential nutrients, and, equally importantly, to achieve harmonious organoleptic flavor and aroma characteristics and good consumer properties.

The combined dispersed raw materials form a protein suspension and an okara containing a large amount of insoluble nutrients, including dietary fiber from soy, vegetable and mushroom raw materials, and have eubiotic properties. The okara from the combined products can be further used as an enrichment in the production of meat, fish and bakery products, in fresh or dried structured form (granules, powder or flour).

To form the protein component from soybeans, we used the classical method of thermal coagulation with the use of coagulants.

When selecting a coagulant, we took into account the purpose of the product and its sale to a particular consumer group. For example, for the dietary and children's groups, we propose to use lemon juice and exclude or limit the mushroom composition in the recipe. As for general purpose products, we propose to use a biologically active additive made from a mixture of acids: ascorbic, citric and lactic.

We are deliberately moving away from using traditional coagulants of calcium or magnesium salts, as it has been proven that products obtained using this technology are undesirable for consumers with cardiovascular diseases, atherosclerosis or impaired hematopoietic function (prone to blood clots). After all, our products are focused on the group of functional health products.

In the food industry, ascorbic acid is used as an acidity regulator or acidifier, color stabilizer, antioxidant and antioxidant booster, as well as vitamin C for food fortification.

Vitamin C is one of the main vitamins necessary for the normal functioning of the human body, with a daily recommended dose of 70 to 100 mg. The inclusion of ascorbic acid in food products helps to prevent almost all diseases, especially diseases of the nervous and skeletal systems, and improves iron absorption. List of main properties of vitamin C:

- Antioxidant properties: Vitamin C is a powerful antioxidant that protects cells from damage caused by free radicals. Free radicals can damage DNA, proteins, and lipids in cells, leading to the development of various diseases, including cancer and

cardiovascular disease;

- immune system support: vitamin C supports the health of the immune system, helping the body fight infections and protect itself from disease;

- Collagen synthesis: Vitamin C is essential for the synthesis of collagen, a protein responsible for the health of the skin, joints, cartilage, and bones. It promotes wound healing and tissue repair;

- maintaining healthy teeth and gums: vitamin C promotes healthy gums and supports tooth stability;

- heart health: Some studies show that vitamin C may help reduce the risk of cardiovascular disease, such as heart attacks and strokes, by lowering bad cholesterol and increasing good cholesterol levels;

- Eye health: Vitamin C can be beneficial for eye health as it helps protect the eyes from free radical damage, which can reduce the risk of developing diseases such as cataracts and retinal degeneration;

- balanced brain function: Vitamin C plays an important role in supporting brain function, including memory, attention, and mood. It helps to protect brain cells from damage and may reduce the risk of developing neurodegenerative diseases such as Alzheimer's disease.

Citric acid. It is used in the food industry as a natural preservative, acidity regulator, flavor enhancer, and antioxidant. It is also known as the food additive E-330. Citric acid is considered to be: a preservative, since a large number of known pathogenic microorganisms die in an acidic environment; an antioxidant, since it counteracts oxidation by binding free radicals; a color stabilizer; an acidity regulator.

Citric acid is also used as a leavening agent in combination with alkali (baking soda). The additive is used for carbonated beverages, sweets and bread, alcohol, canned and frozen fruits and vegetables (fresh fruits and vegetables can also be surface treated to protect them from putrefactive bacteria); bread (the additive is a part of a leavening agent, used as a flour quality improver, and as an acidity regulator); juices, carbonated beverages, nectars (citric acid is a pH regulator and preservative); confectionery, chocolate (citric acid can be an acidifier, preservative, stabilizer in sweets); fish and meat products (E 330 is used as a color fixer, preservative); alcoholic beverages; bouillon cubes, vegetable oils, cheeses.

Lactic acid is widely used in the food industry due to the absence of contraindications. As a food additive in baking, lactic acid is most often used as a prophylactic measure to combat potato disease caused by high-temperature resistant Bacillus mesentericus potato sticks and to improve the taste of wheat flour products. Acidification of the environment with lactic acid accelerates the maturation of bread, which eliminates the possibility of the development of foreign microorganisms in it. Bread produced by the accelerated method contains a large amount of sugars, water-soluble carbohydrates and bisulfite binding compounds, which is reflected in an increase in bread porosity, improved crumb properties, aroma, taste and increased resistance to staling.

In the confectionery industry, lactic acid and its sodium salt (sodium lactate) are used to make marmalade, pastilles, marshmallows, caramel with filling, sunflower halva, gingerbread and other products.

Lactic acid is used in the production of meat and meat products due to its high diffusion properties, antimicrobial effect, ability to plasticize proteins, accelerate meat maturation, loosen collagen bundles, and regulate pH and flavor. Treatment of meat and meat products with aqueous solutions of lactic acid, which keeps the pH at 4.0-5.4, contributes to the formation of a 5 to 20 mm “protective layer” on the surface impregnated with acid, which prevents the development of putrefactive microbes.

In the brewing industry, lactic acid is used in the preparation of malt or mash to reduce water hardness, create an optimal pH level, improve the physiological state of yeast, increase the yield of malt extractives, and regulate taste and aroma.

Currently, the production of canned fruits and vegetables, snacks, juices and other canned products is carried out in accordance with technical documentation containing state standards, technological instructions and industry standards. When preparing marinades, it is recommended to use mixtures of acetic and lactic acids. It has been found that a stronger antimicrobial effect with lower acidity is achieved when these additives are combined. Marinades acquire a more delicate flavor and mild sour taste. Keeping vegetables in an acidic environment with a pH of 3.0-4.0, created by lactic acid, for 30-60 minutes allows you to remove nitrates from them, which is important from a hygienic point of view.

So, as we can see, ascorbic, citric and lactic acids are successfully used in the food industry as a technological additive to regulate the activity of enzymes and pH of products, improve the properties and stability of colloids, increase the swelling of proteins, etc.

The use of selected acids and their mixtures as a structure-forming agent (coagulant) for the production of protein-vitamin foods will allow: first, to ensure waste-free production, and second, to obtain health foods with high antioxidant activity due to the synergy of vitamin C and vitamin E.

Characteristics of vegetable and mushroom supplements. Vegetables are edible parts of plants that are usually eaten raw or cooked. They are an important part of the human diet and have a significant nutritional, vitamin and mineral composition. Vegetables contain a variety of nutrients, such as vitamins (e.g., vitamin C, vitamin K, vitamin A), minerals (e.g., potassium, calcium, iron), antioxidants, and other biologically active compounds.

The importance of vegetables lies not only in their nutritional value, but also in their positive impact on health. They help to maintain the normal functioning of the body, reduce the risk of cardiovascular disease, diabetes, obesity and other diseases. Some types of vegetables also have anti-inflammatory and anticarcinogenic properties.

In our research, we used carrots and pumpkins from the local geographical and climatic zone.

Carrots and pumpkins are vegetable crops that have significant benefits for human health. Here are some of their main health benefits:

- Vitamins and minerals: carrots are an excellent source of beta-carotene (a precursor to vitamin A), vitamin C, vitamin K, potassium and other minerals. Vitamin A is important for healthy eyes, immune system, and skin. Pumpkin is a supplier of beta-carotene, vitamin C, vitamin E, potassium, copper and other

minerals;

- antioxidant properties: beta-carotene, found in carrots and pumpkin, is a powerful antioxidant that protects cells from free radical damage. This can help reduce the risk of heart disease and cancer;

- support for skin health: vitamins A and C contained in carrots promote skin health, make it more elastic and protect it from harmful environmental influences;

- support for eye health: beta-carotene in carrots and pumpkin is converted into vitamin A in the body, which is important for vision health. It helps reduce the risk of eye diseases such as cataracts and retinal degeneration;

- support for heart health: some studies have shown that consuming carrots can help lower blood cholesterol and maintain heart health; pumpkin helps control blood pressure and reduce the risk of cardiovascular disease;

- support during pregnancy: carrots and pumpkin contain folic acid, which is important for maternal health and fetal development during pregnancy;

- digestive support: carrots and pumpkin contain soluble and insoluble fibers that promote healthy digestion and maintain normal intestinal function.

Mushrooms, which are proposed to be used as a component of the protein-vitamin dispersed system, are mushrooms.

The main components of mushrooms include: proteins: gluten, albumin and globulins; carbohydrates: the main carbohydrate in mushrooms is cellulose, chitin and inulin; vitamins and minerals: mushrooms contain B vitamins (in particular, B2 - riboflavin, B3 - niacin, B5 - pantothenic acid, B6 - pyridoxine, B9 - folic acid), vitamin D, vitamin K, potassium, phosphorus, selenium, copper and other useful minerals; phytonutrients - lignans, phenols, terpenes and flavonoids, which have antioxidant properties and promote health. Mushrooms also contain phenolic acids, amino acids, lipids, etc. The exact chemical composition varies depending on the mushroom variety, age, cultivation methods, and storage conditions.

The coagulation stage is based on the joint processing of soybeans and vegetable and mushroom raw materials with appropriate formulation ratios, which will contribute to the uniform color of the protein-carbohydrate suspension.

The technological process of producing protein and vitamin products includes the following operations.

1. Preparation of a protein-vitamin dispersion system from prepared soybean seeds and prepared chopped vegetables (carrots, pumpkin), mushrooms (mushrooms) at a ratio of 1:1 by their joint grinding, heating and extraction in water at a hydraulic module of 1:6.

2. Separation of the resulting system into a liquid, soluble fraction - protein-vitamin suspension and a solid, insoluble fraction - okara.

3. Precipitation of the protein-vitamin clot is carried out with a mixture of organic acids: ascorbic, lactic, and citric, taken in an amount of 0.2-0.6% in terms of 100% concentration of organic acids that make up the mixture. The ratio of acids is (1-1.24): (1-1.22): (1-1.1) for ascorbic, lactic, and citric acids. Acids are administered in the form of a 10-20% solution. The dietary supplement makes it possible to obtain a high-quality product with a long shelf life.

4. Heating the protein-vitamin suspension to a temperature of 50-60°C and

adding a coagulant (dietary supplement) to coagulate the protein substances of the suspension.

5. Separation of the formed clot-coagulant from the serum.

6. Granulation and drying of the clot-coagulant to obtain a protein-vitamin concentrate.

For the process of obtaining soy-vegetable-mushroom protein-vitamin concentrate, the initial moisture content of the granules, drying temperature, drying time, and strength of the granules depending on these factors were determined: 36.7%, 71.7°C, 60 min, 93.8%, respectively.

The obtained protein-vitamin coagulants and protein-vitamin concentrates have positive organoleptic characteristics - expressive color, inherent in carrots and pumpkins, smell and taste, corresponding to the raw materials used.

The technological scheme of the protein and vitamin concentrate production process is shown in Fig. 1.

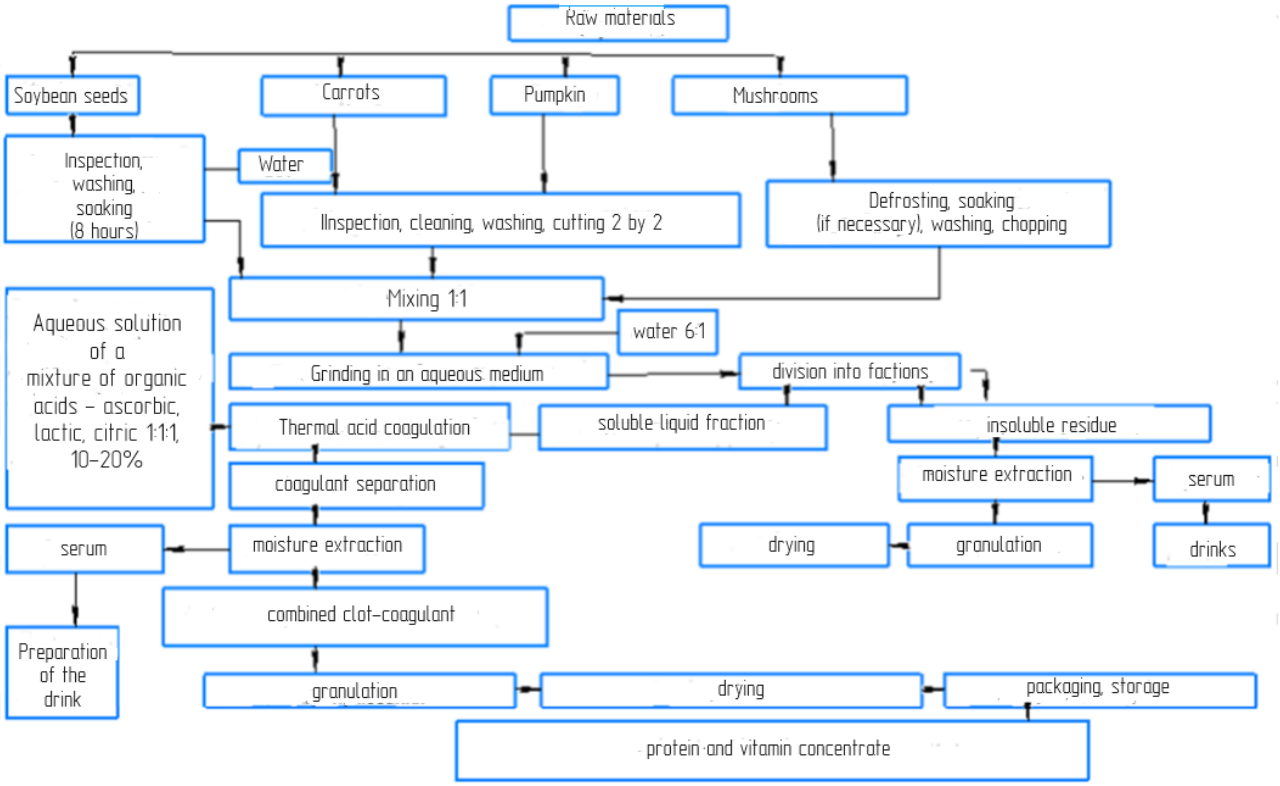

Fig. 1- Flow chart of the process of protein and vitamin concentrate production

Technology of a protein and vitamin food product. The technological process of producing a protein and vitamin clot-coagulant involves preliminary preparation of the raw materials used: sorting, washing, cleaning of inedible parts, cutting, washing, defrosting (if necessary) and soaking of soybeans. An important condition for obtaining a high-quality product is cutting the raw materials; it is necessary to chop the vegetables into pieces that correspond to the size of the swollen soybean. Then the prepared components are mixed and chopped, while the mixture is heated in water to extract soluble substances. To do this, we used a soy milk machine (Fig. 2).

Fig. 2 - Vilitek CSM-100 soy milk and tofu production machine.

Next, the mixture was separated into liquid and solid phases. A coagulant (a solution of dietary supplements taken in an amount of 0.2-0.6% in terms of 100% concentration of organic acids that make up the mixture) was added to the liquid phase - a protein-carbohydrate suspension. The ratio of acids is (1-1.24): (1-1.22): (1-1.1) for ascorbic, lactic, and citric acids).

The separated solid fraction contains soybean hulls, insoluble fibers of vegetables and mushrooms and can be successfully used in the food industry as a source of dietary fiber.

The resulting clot-coagulant was separated from the whey and further pressed. The resulting whey is colored in the color of the raw material, has a pleasant sour taste and aroma, contains vitamin C and dietary supplements from selected acids, soluble proteins, fats and minerals. It can be used as a basis for preparing beverages for health food.

The separated coagulated clot is edible and can be consumed without further processing. You can also add additional flavoring ingredients to it. It can be used to prepare a variety of pastes, sauces, confectionery and many other culinary products and dishes.

After obtaining coagulated clots, we use a drying process to prepare protein and vitamin concentrates. This process will increase the shelf life and expand the use of protein-vitamin coagulants. To do this, the clots are granulated and dried. The drying parameters (temperature and duration) are selected based on the highest possible humidity.

Concentrates that have been dried to a moisture content of 10-12% can be used in crushed (cereal or flour) or granulated form. These can be a variety of dishes enriched with protein, vitamins and minerals of natural origin. They are also used in the bakery, pasta, and confectionery industries.

The chemical composition of the products is shown in Table 1.

After analyzing the data in Table 1, we see a rather high content of the protein-hydrocarbon component, which doubles in the process of concentration during drying. And the vitamin C component decreases by half due to heat sensitivity. Vitamin E remains almost unchanged during drying due to its thermal stability.

Composition and functional and technological properties of protein-vitamin concentrate as a food additive.

Table 1. - Chemical composition of the products (coagulant and concentrate)

Product name	Humidity, %	Protein, %.	Fats, %.	Carbohydrates, %.	Dietary fiber, %.	Mineral substances, %.	Vitamin C, mg/100 g	Vitamin E, mg/100 g
Soybean-vegetable-mushroom coagulant	56,3	34,2	11,5	28,4	3,6	5,7	350	3,8
Soy and vegetable mushroom concentrate (flour)	10,0	59,7	23,2	56,2	7,1	10,1	150	7,8
Soy and vegetable mushroom concentrate (granules)	14,0	61,6	25,8	58,9	8,4	11,7	150	8,1

After drying and bringing to a moisture content of 10-12%, protein and vitamin concentrates are porous, brittle structures with a rough surface and a deep yellow color that fades during drying. They have a moderately pronounced, pleasant taste and aroma of vegetable and mushroom hue, which is due to all the components that make up the composition.

Characteristics of chemical composition and energy value are presented in Tables 1 and 2.

Table 2 - Chemical composition of minerals in protein and vitamin concentrate

Product name	Content, mg per 100 g			
	potassium	calcium	magnesium	phosphorus
Soy, vegetable and mushroom concentrate	3478	645	624	1568

The presented content shows that the experimental concentrate is quite rich in micro- and macronutrients. It can be considered a valuable food additive that can be used to enrich food and be used in the production of health products.

Protein and vitamin coagulants have a viscous and plastic consistency, with the appropriate color and taste of the vegetables used, with a slight acidity, without foreign flavors and odors.

A protein-vitamin coagulant clot with carrots and pumpkin can be used to make a dessert in the form of a molded jelly, but we don't usually add mushrooms to this recipe.

The jelly has a whipped and chilled structure; to make it, you need to soak gelatin in water to swell. Put the ingredients of the recipe mixture into a blender and whip for 3-5 minutes. Add the soaked gelatin 1 minute before the end of blending to obtain a homogeneous consistency. Pour the finished mixture into molds and chill for 2-3 hours until a stable structure is obtained. Remove the finished jelly from the molds and send it to the market.

Protein and vitamin jelly makes it possible to obtain a high-protein dietary product.

When developing recipes, it is necessary to take into account that the process of preparing fortified foods largely depends on the functional and technological properties of the raw materials and components of the recipe.

Therefore, when developing food formulations using new types of additives in granular and dispersed form, it is necessary to study their functional and technological properties, as well as the possibility of these properties affecting the formation of the structure of products and methods of technological processing.

After all, when protein and vegetable additives are introduced into various food products to enrich the chemical composition, it is necessary to design and ensure the compatibility of these additives with the product components.

To achieve this goal, it is necessary to conduct research to study the functional and technological properties of the protein and vegetable component: solubility, swelling, water absorption capacity, water binding capacity, and fat absorption capacity.

In this case, solubility, swelling, water absorption and water binding capacity characterize the ability of the raw material component to bind and retain water, thicken systems during processing, and fat absorption capacity - to bind and retain fat.

The solubility of food additives in water at a temperature of +18 - +20°C was determined on samples of protein and vitamin concentrate in the form of granules and in a fine fractional form (flour).

It was found that additives in the form of flour have the highest solubility (up to 80%), while additives in the form of protein-vitamin concentrate granules have lower solubility (up to 65%), which is explained by the chemical composition of the additives and the degree of particle dispersion. The high content of partially denatured protein substances and the content of insoluble dietary fiber significantly reduce the solubility of the protein and vitamin concentrate. Proteins and dietary fibers that make up the protein and vitamin concentrate are highly hydrophilic and retain moisture well due to the formation of associative bonds with water.

The process of swelling depends on the type of raw material, the degree of its dispersion, the type and concentration of the solvent, temperature, and other factors. It is known that swelling, as the first stage of the dissolution process, is characteristic of many high molecular weight compounds, but it is not always accompanied by dissolution [14].

The swelling of protein and vitamin concentrate is associated with a change in the physical state of hydrophilic components, in particular proteins and polysaccharides, due to their interaction with the solvent.

When using soy-based ingredients in food technology, it is necessary to take into account the duration of their swelling. To this end, we studied the dynamics of swelling of protein and vitamin concentrate in the form of granules and flour in terms of time. Swelling was evaluated as the maximum amount of water that an object can absorb and retain before the onset of dynamic equilibrium, relative to the weight of the sample. The swellability was determined by the volumetric method. The research results show that the swelling rates of the additive in the form of flour and in the form of granules differ from each other. Thus, the swelling time of flour is 20 minutes,

while the same indicator for protein and vitamin concentrate granules is 35 minutes, which can be explained by the different particle sizes of the components. The high degree of swelling of the additives causes an increase in the viscosity of their aqueous suspensions.

In the future, it is planned to conduct studies of water-absorbing, water-binding, and fat-absorbing capacity.

Conclusions. The results of the research were the development of the technology of protein and vitamin concentrate and formulations of health products based on soy. Practical recommendations on the technology of protein and vitamin concentrate and formulations of health products based on soy have also been developed, which will expand the range of products for this purpose. The product formulations were included in the technical specifications "Soybean food products" TU U10.8-24824144966-002:2021, which are included in the database "Technical Specifications of Ukraine". The results of the study show the possibility of expanding the use of soy-based health foods in the production of soy-based foods, which allows to increase the range of soy products with improved chemical composition. In general, it has been proven that technological approaches to the production of protein and vitamin foods are based on the principles of food combinatorics, which takes into account the technological processes of raw material processing. In turn, they shape the structural, mechanical and rheological characteristics of the product, as well as the physical and chemical processes that occur during technological transformation. The chemical composition of the product changes due to the introduction of physiologically active ingredients, as well as the compatibility of the nutritional composition of the product components.

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Анотація. *Найважливішою детермінантою здоров'я населення є збалансоване, повноцінне харчування, яке забезпечує нормальний ріст і розвиток людини, тривалість життя, підвищує опірність організму до несприятливих умов навколишнього середовища, веде до прогресу і поліпшення якості життя.*

У статті наведено обґрунтовані причини доцільності використання соєвої сировини, що призвело до появи продуктів масового споживання, доступних для всіх груп населення, які можуть регулярно використовуватися в повсякденному, дієтичному, лікувальному або профілактичному харчуванні з високим ступенем перетравлюваності та засвоюваності їжі, відповідно до рекомендацій, при збереженні адекватного рівня енерговитрат за добу. Тенденції розвитку сучасних харчових технологій спрямовані на розширення асортименту оздоровчих продуктів. На тлі популяризації та усвідомлення здорового харчування населення потребує нових продуктів, які б відповідали харчовим потребам організму, були недорогими та збагачували щоденний раціон. Одним з напрямків виробництва таких продуктів є використання основного представника овочевих бобових культур – сої. Мета роботи розробити технологію білково-вітамінного концентрату та рецептури оздоровчих продуктів на основі сої. У дослідженні використано такі методи: причинно-наслідковий аналіз, експериментальний, економіко-статистичний, розрахунковий та конструктивно-логічного узагальнення. У результаті дослідження розроблено практичні рекомендації з технології білково-вітамінного концентрату та рецептури продуктів оздоровчого призначення на основі сої, які дозволяють розширити асортимент продукції зазначеного призначення. Також розроблено технічні умови «Продукти харчові з сої» ТУ У 10.8-

24824144966-002:2021 та внесено до бази даних «Технічні умови України». Наукова новизна одержаних результатів полягає в розробці технології білково-вітамінного концентрату та рецептур оздоровчих продуктів на основі сої, затверджених технічними умовами. Галузь застосування результатів дослідження. Результати досліджень свідчать про можливість розширення використання соєвої сировини у виробництві оздоровчих продуктів харчування.

Ключові слова: *соя, функціональні харчові продукти, тофу, окара, соєве борошно, Supra 760, Supra 2640, соєві напої, соєві напівфабрикати.*

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