

Innovative technology of natural raw materials processing and biologically active complexes with systemic effect development

Boisjoni Tokhiriyon
 Department of Commodity
 Research
 and Examination
 Ural State University
 of Economics
 Ekaterinburg, Russia
tohiriyoni@mail.ru

Valery Poznyakovsky
 Department of Nutrition
 Technologies”
 Ural State University
 of Economics
 Ekaterinburg, Russia
pvm1947@bk.ru

Elena Vyalyh
 Department of Commodity
 Research
 and Examination”
 Ural State University
 of Economics
 Ekaterinburg, Russia
tohiriyoni@mail.ru

Svetlana Andrievskikh
 Department of Foreign
 Languages
 Ural State University
 of Economics
 Ekaterinburg, Russia
tohiriyoni@mail.ru

Abstract – The article deals with the issues of digitization in the production of specialized products based on natural raw materials of plant and animal origin, including biologically active supplements. Taking into account agriculture and food industry digitization, an innovative technology has been developed for processing a new specialized dietary supplement for the body metabolism multifactorial support. Innovative production technology ensures high safety of biologically active components due to liposomalization. Liposomalization allows simultaneous delivery of active substances, which have different ways of body penetration and absorption, but at the same time affect one body organ. Other biologically active substances of the supplement formula boost the body’s natural defenses and prevent alimentary chronic diseases. Selenium, which is part of an innovative product, combined with tocopherol and other antioxidants, has anti-inflammatory activity, blocks free radicals and thus prevents their toxic effects. The presence of natural dihydroquercetin in the dietary supplement ensures better capillary permeability, has a positive effect on the body metabolism and various pathological conditions, and reduces the risk factors of different types of diabetes by increasing the body’s resistance to excess sugar effects. The innovative product quality indicators have been studied during its production and storage process. The article demonstrates the product hygiene standards, storage terms and modes, and informs about its production testing.

Keywords – innovative technology, production, biologically active complexes, supplement formula, quality, safety, efficiency, functional property.

I. INTRODUCTION

In the era of digital economy, in particular, digital agriculture and food industry, specialized products, including biologically active complexes produced from natural raw materials, are increasingly used to improve people’s diet and health, and in general, to maintain the quality of life. It can be explained both by their availability and positive influence on the body metabolism [1, 3,11,16,17].

Special attention is paid to these food supplements intake for alimentary diseases prevention and complex treatment aimed at keeping health and ability to work [5,10,12,13]. In this context Russia’s government set the task to develop new products manufactured from natural raw materials, study their quality characteristics, safety

and functional properties. This task is set in the country’s program of food and processing industry development and healthy nutrition provision to the population of the Russian Federation [2,6,9].

II. RESEARCH OBJECTIVES

The research objective is to develop an innovative production technology and determine quality standards of a new specialized dietary supplement made from natural raw materials of plant and animal origin, including biologically active substances.

III. MATERIALS AND METHODS

The materials used are plant raw materials and biologically active substances. The methods used included generally available and specific techniques to examine the quality, safety, efficacy and functional properties of the product.

IV. RESEARCH RESULTS

The innovative specialized nutrition supplement formula has been developed after analyzing biochemical properties of the natural raw materials being used. Its composition is scientifically proven. All the formula ingredients and their active substances, which determine its functional properties, are characterized.

Linseed oil is a traditional and indispensable product of healthy nutrition, participating in numerous metabolic processes. The functional properties of linseed oil play a very important role in the prevention and complex therapy of cardiovascular, hormonal, oncological, and other diseases. If we compare omega 3 with other mass consumption products, it can be characterized by a significant content of unsaturated fatty acids. Linseed oil obtained by the traditional cold-pressing method (first spin) has the highest nutritional value.

Selenium (selexene) is a new highly effective, low toxic organic selenium compound (9-phenyl-symmetric octahydroselenoxanthene). It is recommended as a selenium-containing fat-soluble food ingredient-antioxidant to increase the shelf life of fat-containing products. Selenium deficiency leads to coronary and myocardial disease development. People with normal selenium level develop this disease much less frequently.

Low selenium level can be a triggering factor for other cardiovascular diseases. The results of population studies confirm the protective effect of micronutrient against metabolic disorders in arteries and heart muscle. Low blood level of this mineral is recorded in patients with rheumatoid arthritis. Selenium, in combination with tocopherol and other antioxidants, has anti-inflammatory activity so it helps prevent arthritis development. Selenium deficiency is detected in people suffering from asthma. This can be proved by the medical examination of people who live in New Zealand. They tend to have a low level of selenium-dependent enzyme – glutathione-peroxidase and, as a result, a number of people with asthma is 6 times as big as in other countries. Selenium is necessary for the normal maintenance of metabolic processes in the thyroid gland, as it provides the activity of the enzyme that affects the thyroid hormones function. The thyroid hormone replacement therapy is ineffective in the absence of selenium, and its deficiency may lead to impaired metabolism, overweight and obesity.

Dihydroquercetin (DHQ) belongs to the vitamin P group. It reduces capillaries permeability and fragility, shows anti-inflammatory and gastroprotective properties, relieves the intestine smooth muscle spasms, increases the liver rebound tenderness, and has a protective anti-radiation effect. There is a definite relation between vitamin P and histamine. DHQ is able to prevent anaphylactic shock, which is attributed to its antihistamine effect. It has the ability to inhibit histidine decarboxylase activity, and this in turn prevents histamine formation. Histamine synthesis blocking reduces pain, swelling, and allergic reactions.

Dihydroquercetin is a free radical scavenger and is used as an antioxidant, which is considered the most active one. Even a small amount of dihydroquercetin has the ability to prevent various diseases, showing a rejuvenating effect. Inhibition of toxic radicals, which are caused by radiation and toxins exposure, is the reason why this micronutrient is recommended to be included in the diet of the population living in unfavorable environmental conditions. DHQ as well as vitamin P improves capillary permeability, has a positive effect on metabolism and various pathological conditions. It also reduces bad cholesterol accumulation by regulating high-density lipoprotein metabolism. Thus, we find it possible to include DHQ in the dietary supplement formula as a means for the atherosclerosis prevention and complex treatment. DHQ reduces the likelihood of diabetes and its various types by increasing the body's resistance to excess sugar effects. The micronutrient positively affects the immune system and inflammatory processes and this property explains its use as an anti-allergic and anti-inflammatory agent. DHQ, possessing antioxidant properties, is able to prevent cardiovascular diseases and support metabolism.

DHQ is incorporated in the dietary supplement formula by using a new technology that allows increasing its bioavailability and efficiency.

Vitamin N (lipoic,thioctic acid) is a vitamin-like compound with unique biochemical and pharmacological properties. It possesses high hydrophobicity and easily

penetrates cell membranes. It has key positions in carbohydrate and energy exchanges, forming the tissue and organs energy pool. Thanks to its antioxidant properties vitamin N blocks free radicals and thus prevents toxic effects on the body. It shows protective activity under lipid peroxidation conditions. Interacting with other antioxidants, vitamin N supports metabolic processes at a given physiological level. Lipoic acid has a hepatotropic effect due to its ability to maintain thiol-disulfide interactions, in particular the reduced state of biologically active SH-groups in the structure of enzymes and proteins.

Marked antioxidant properties and active participation in metabolism predetermine the possibility of using lipoic acid in nervous diseases and disorders prevention and complex treatment. Free radicals can damage nerve cells, while thiols play the leading role in antioxidant protection, performing the function of neuroprotectors in neurological disorders therapy. The most essential thiol antioxidant is glutathione, which is absorbed at the cellular level and does not fully manifest its functions due to its properties. Lipoic acid, on the contrary, is actively involved in the metabolic processes of brain tissue [5,8-14,15].

All the above-mentioned micronutrients characteristics and properties were taken into consideration while developing qualitative and quantitative composition of the specialized product with systemic effect (Table 1).

TABLE I. DIETARY SUPPLEMENT COMPOSITION

№	Ingredients	Content, mg/1 capsule
1	Fish oil	500
	EPA (eicosapentaenoic acid)	90
	DHA (docosahexaenoic acid)	60
2	Linseed oil	455
	Alpha linolenic acid	200
3	Liposomes, substance with DHQ 5%	150
	Dehydroquercetin	7.5
	Phospholipids	48
4	Lipoic acid	9
5	Vitamin E	3.06
	Tocopherol acetate	3.00
6	Selexene (23% of selenium)	0.043
	Selenium	0.01

Fish oil, one of the formula ingredients, is obtained by processing Greenland salmon using the cold processing method. Linseed oil stabilized with tocopherol from oxidation is obtained in the same way. The dietary supplement includes polyunsaturated fatty acids (PUFAs), which help normalize triglycerides and cholesterol level, as well as lipoproteins alpha-beta ratio and blood rheological parameters.

Indispensable PUFAs cannot be synthesized by the human body and must be fed regularly in sufficient quantities with food. PUFAs are the most important components of the human diet; their presence determines the nutritional value and functional properties of fatty products.

PUFAs deficiency can provoke cholesterol metabolism disorders and atherosclerosis development. Enriching the diet with PUFAs, we can provide prostaglandin E1 tissue synthesis, necessary to reduce inflammatory reactions. PUFAs help improve the skin and hair structure, reduce cholesterol level, blood pressure, reduce the risk of blood clots, have a positive effect on people with other diseases (inflammatory and allergic disorders, eczema, psoriasis).

PUFA manifests a systemic effect in improving the physiological reserve in people with different diseases: diseases of joints, skin, pancreas, liver, atherosclerosis, hypertensive heart disease, angioneurosis, arrhythmia, diabetes [4].

In view of the above-mentioned information, the biologically active complex is positioned in the pharmaceutical market as a specialized product, the functional properties of which are aimed at the prevention and complex treatment of common diseases, protecting the body from the effects of harmful environmental factors.

In the era of digital economy, in particular, the digitization of agriculture, new innovative technologies of production liposomalization, natural raw materials and biologically active substances processing have been developed. The obtained mixture is put into soft gelatin capsules (Fig. 1).

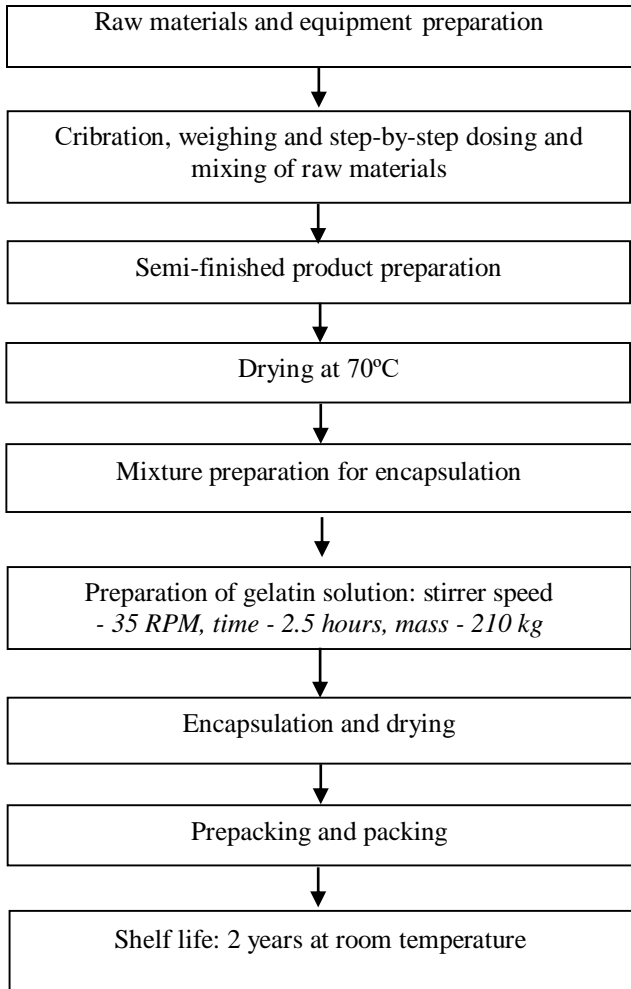


Fig. 1. Product manufacturing technology

Liposomalization technology allows for the simultaneous delivery of active substances into the body. They have different ways of the body penetration and absorption, but affect the same organ. Omega-3 and vitamin E are fat-soluble ingredients, and dihydroquercetin is a water-soluble one, but the innovative form of their delivery into the body allows for their simultaneous activity and provides triple protection of the heart and blood vessels against atherosclerosis.

The product was studied during 27 months' period. It was stored in a dark dry place at 25 ° C. Safety characteristics after the specified expiration date are presented in Table 2 and indicate the sanitary and hygienic characteristics of the developed dietary supplement [7].

The supplement shelf life is 2 years if all the requirements are met. It can also be safely used within 3 months after the expiry date.

The regulated quality characteristics are shown (Table 3), including nutritional value (Table 4).

TABLE II. SANITARY AND TOXICOLOGICAL CHARACTERISTICS OF THE SUPPLEMENT SAFETY

Characteristic		Permissible level mg/kg, max	Sample content
Toxic elements	Lead	1.0	0.46-0.48 (0.47)
	Arsenic	1.0	0.10 -0.12 (0.11)
	Cadmium	0.2	0.05- 0.07 (0.06)
	Mercury	0.3	0.01-0.03 (0.02)
	Iron	5.0	2.0-2.2 (2.1)
	Copper	0.4	0.099-0.12 (0.1)
Pesticides	HCCH (sum of isomers)	0.1	Less than 0.003
	DDT and its metabolites	0.2	Less than 0.007
Mycotoxins	Aflatoxin B1	0.005	Less than 0.002
Radionuclides	Cesium-137	40	1.22 -1.24 (1.23)
	Strontium-90	80	Less than 25.0
Peroxide value, mmol of active O ₂ / kg		10	3.9 – 4.1 (4.0)
Acid number, mg KOH / g		4.0*	2.4 -2.6 (2.5)

* – calculated by raw materials – fish oil and linseed oil.

TABLE III. TOXICANT AND PHYSICO-CHEMICAL CHARACTERISTICS OF THE DIETARY SUPPLEMENT

Criteria	Characteristic
Appearance	Gelatin capsules
Capsule content color	From light brown to yellow, with possible residue
Capsule content taste and smell	Specific, no rancidity
Capsule average weight, g	1620 (1458 – 1782)

TABLE IV. NUTRITIONAL VALUE

Ingredients, mg/capsule	Content
PUFA Omega 3	349 -351 (350)
Dehydroquercetin	7.4 -7.6 (7.5)
Phospholipids	47-49 (48)
Selenium, mcg	9-11 (10)
Lipoic acid	8.9- 9.1 (9.0)
Vitamin E	2.9 -3.1 (3.0)

Common technical document has been developed and approved. The supplement formula and technology performance have been tested at the enterprises of Artlife Company (Tomsk) in accordance with the requirements of the international standards of the ISO 9001: 2000 series and GMP rules, which ensures competitiveness, stability of quality and safety of the products under development.

V. CONCLUSIONS

Our new innovative specialized product has the following competitive advantages: innovative liposomalization technology provides the ability to simultaneously deliver biologically active substances possessing different properties directly to targeted cells. The product produces a synergistic effect and improves metabolism disorders.

Physiological dosage of functional natural ingredients does not cause any addiction or other side effects, and the effective concentration of bioactive substances contained in the formula contribute to increasing the body's resistance to the negative effects of various unfavorable environmental factors. The results of the studies are aimed at digitizing the production and processing of agricultural and food products.

REFERENCES

- [1] A.N. Avstrieviskikh, A.A.Vekovtsev, V.M. Poznyakovsky "Healthy nutrition products: new technologies, quality assurance, efficacy," Novosibirsk: Siberian University Publishing House, 2005, 416 p.
- [2] N.F. Gerasimenko, V.M. Poznyakovsky, N.G. Chelnakova "Methodological aspects of adequate safe nutrition: its role in health and working capacity preservation," People. Sport. Medicine, No. 1, Vol. 17, pp. 79-86, 2017.
- [3] Yu.Yu. Gichev, Yu.P. Gichev, "New guide to micronutrientology (biologically active food supplements and people's health)," Moscow: "Triada-X", 2009, 304 p.
- [4] The art of being healthy: Handbook for general practitioners and advisors, Compiled by candidate of medical science N.G. Zhevachevsky, 15 edition, Novosibirsk: Publishing house «Reclamoizdatelskaya firma Novosibirsk», 2016, 508 p.
- [5] V.M. Poznyakovsky "Diet evolution and home sapiencie nutriome development," Food industry, No. 3, pp. 5-12, 2017.
- [6] V.B. Spirichev, L.N. Shatnyuk, V.M. Poznyakovsky, "Foods enrichment with vitamins and minerals," Science and technology, Novosibirsk: Siberian University Press, 2004, 548 p.
- [7] Technological regulations TS 027/2012 "On the safety of certain types of specialized food products, including dietary, therapeutic and dietary preventive nutrition": app. by Eurasian economic commission of 05.06.2012, No. 34, 26p.
- [8] G.A. Podzorova, A.N. Avstrieviskikh, V.M. Poznyakovsky, "Formula, production technology and expertise characteristic of biologically active supplement "Neirostabil"," Vestnik USUE. Series « Food biotechnologies», No. 1, Vol. 6, pp. 77-83, 2018.
- [9] G.A.Podzorova, A.N. Avstrieviskikh, V.M. Poznyakovsky, "New biologically active complex with specific functional properties: efficacy assesement," Technology and commodity expertise of foods, No. 3 (38), pp. 69-72, 2016.
- [10] N.G. Chelnakova, V.M. Poznyakovsky, "Diet and health of a contemporary person," Publishing house «Starye russkiye», 2015, 224 p.
- [11] B. Tokhiriyon, V.M. Poznyakovsky, S.S. Andrieviskikh, "Industrialization issues in the production of specialized products for complex body metabolism support," Advances in Social Science, Education and Humanities Research, Vol. 240, 2nd International Scientific Conference on New Industrialization: Global, National, Regional Dimension (SICNI), 2018, pp. 109-112.
- [12] J.P. Swann, "The history of efforts to regulate dietary supplements in the USA," Drug Test. Anal., 2016, No. 8, pp. 271–282.
- [13] G.F. Deng, S. Li, F. Li, S. Wu, H.B. Li, X.R. Xu, "Natural antioxidants in food," Phytochemicals: occurrence in nature, health effects and antioxidant properties, pp. 147–174, 2013.
- [14] H.N. Duy Bao, T. Ohshima, "Strategies to minimize oxidative deterioration in aquatic food products: application of natural antioxidants from edible mushrooms," Lipid oxidation: challenges in food systems, pp. 345-380, 2013.
- [15] P.F. Surai, V.I. Fisinin, "Natural antioxidants and stresses in poultry production: from vitamins to vitagenes," The proceedings of XXV world's poultry congress, pp. 116–121, 2016.
- [16] V.L. Fulgoni, D.R. Keast, R.L. Bailey, J. Dwyer, "Foods, fortificants, and supplements: Where do Americans get their nutrients?," J. Nutr, No. 141, pp. 1847-1854, 2011.
- [17] M. Fenech, A. El-Sohemy, L. Cahill, L.R. Ferguson, T.A.C. French, E.S. Tai, J. Milner, W.P. Koh, L. Xie, M. Zucker, et al., "Nutrigenetics and nutrigenomics: Viewpoints on the current status and applications in nutrition research and practic," J. Nutr, No. 4, pp. 69-89, 2011.