

Секція 1. НОВІ ТЕХНОЛОГІЇ ПРОДУКТІВ ХАРЧУВАННЯ

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КАРОТИНОЇДНІ БУЛОЧКИ «SUNROLL» ДЛЯ ЗДОРОВОГО ХАРЧУВАННЯ, ВІТАМІНІЗОВАНІ НАТУРАЛЬНИМИ НАНОДОБАВКАМИ

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Розроблено каротиноїдні булочки «SunRoll» для оздоровчого харчування, вітамінізовані натуральними нанодобавками з рекордним вмістом β -каротину та інших БАР як для підприємств ресторанного господарства, так і для харчових підприємств. Показано, що розроблені булочки відрізняються високим вмістом натурального β -каротину (4,5–5,5 мг у 100 г), що забезпечує добову потребу організму людини.

Ключові слова: оздоровчі булочки, натуральні каротиноїдні нанодобавки, β -каротин, вітамінізація, булочка, морква, гарбуз.

КАРОТИНОИДНЫЕ БУЛОЧКИ «SUNROLL» ДЛЯ ЗДОРОВОГО ПИТАНИЯ, ВИТАМИНИЗИРОВАННЫЕ НАТУРАЛЬНЫМИ НАНОДОБАВКАМИ

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Разработаны каротиноидные булочки «SunRoll» для оздоровительного питания витаминизированные натуральными нанодобавками с рекордным содержанием β -каротина и других БАВ как для предприятий ресторанного хозяйства, так и для пищевых предприятий. Показано, что разработанные булочки отличаются высоким содержанием натурального β -каротина (4,5–5,5 мг в 100 г), что обеспечивает суточную потребность организма человека.

Ключевые слова: оздоровительные булочки, натуральные каротиноидные нанодобавки, β -каротин, витаминизация, булочка, морковь, тыква.

THE CAROTENOID «SUNROLL» BUNS VITAMINIZED BY NATURAL NANOADDITIVES FOR HEALTHFUL NUTRITION

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The carotenoid buns «SunRoll» vitaminized by natural nanoadditives with a record content of β -carotene and other BAS are developed for enterprises of restaurant industry and catering enterprises which can be used in health-giving nutrition. It is shown that the developed buns contain a high quantity of natural β -carotene (4,5 – 5,5 mg per 100 g), which covers the daily need of human organism.

It is shown that the natural nanoadditives, which are obtained by cryogenic treatment, steam-thermal processing in a modern apparatus (steam-convection oven) and fine-dispersed grinding of raw materials, differ in a record amount of β -carotene in a free state: in particular, the mass fraction of β -carotene in cryopuree from carotene-containing vegetables is 3,0–3,5 times more than in the raw materials, in the heat-treated nanopuree is 2,0–2,5 times more in comparison with raw materials. It is shown that the nanopuree contains also more low-molecular phenolic compounds and L-ascorbic acid comparing with their amount in the bound (hidden) form in the raw materials.

It is shown that the new carotenoid buns «SunRoll» for healthful nutrition with the use of natural nanoadditives as fortificants by BAS, have a record amount of natural β -carotene, L-ascorbic acid and low-molecular phenolic compounds (almost daily human need in 100 g of product). The carotenoid buns «SunRoll» exceed the world-known analogues by the content of BAS. So, they can be recommended for the population with the purpose of immunoprophylaxis.

Keywords: health-giving buns, natural carotene-containing herbal nanoadditives, β -carotene, vitaminizing, bun, carrot, pumpkin.

Statement of the problem. The actuality of the development of vitaminized products is connected with the fact that nowadays the global problem in most countries is a significant reduction of the protective forces in the human body. This problem is consequence of the deterioration of the ecological situation around the world. In addition, according to statistics, the population of Ukraine consumes the vitamins together with fruits, berries and vegetables (as the sources of natural vitamins) in an amount which is twice less than the recommended norm [1–3]. The insufficient consumption of vitamins affects on the health of people negatively. It results to the deterioration of general health, the reduction of working capacity, the lowering of resistance to colds and infectious diseases, as well as to the increasing of influence of harmful working conditions and the environment on the human organism. In this regard, an effective way to improve the providing of vitamins to the population is additional fortification of food products of mass consumption by vitamins [4; 5].

In international practice, the immunoprophylaxis of the population, including the children, is carried out by the vitaminization of food products. First of all, these products are vitaminized with β -carotene, ascorbic acid, B-vitamins, as well as various types of premixes – complexes of minerals and vitamins. The vitaminization of food products is carried out in two main ways: the introduction of synthetic vitamins or introduction of natural vitamin additives from vitamin-containing herbal raw materials into the recipes of products [4; 5].

The problem of immunization in most developed countries (particularly in the USA, Japan, France, Great Britain, Germany, Belgium, etc.) as well as in the many countries of Asia, Africa and Latin America is dissolved by the improving of providing to the population with the synthetic preparates-vitamins into the food products, including the baked and pasta goods, food concentrates, confectionery, non-alcohol drinks and fruit juices, fruit and vegetable canned food, dairy and meat products, margarine, sugar and others [1–6]. The amount of vitamins added to the products is clearly regulated and strictly controlled by the government. The information about vitaminization is always on the package of the product. In addition, for vitaminization of food products together with the synthetic additives it can be used the natural additives in the form of puree, pastes, powders, extracts from the natural herbal sources of vitamins. Over the last years, the additives from tropical and subtropical cultures with a high content of vitamins and minerals have been used abroad. Among them the additives from Barbados cherry, guava, oranges, lemons, persimmons, grapefruits, avocados and other tropical and subtropical crops. It is also can be used the juice of mango and pomegranate [7; 8]. In countries of Western Europe, Poland, Bulgaria, Latvia, Estonia, Lithuania and others it can be used the vitamin-containing raw materials (for example, berries of blackcurrant, rosehip, ashberry, strawberry, sea buckthorn, etc.) [9].

Review of the latest researches and publications. According to the recent research data obtained in the international practice in the field of molecular biology by the prominent vitaminologists (Klaus Oberbeil (Germany), Martin Prins and John Frizoli (USA), etc.), it is determined that the consumption of products with a high content of natural carotenoids is a reliable protection for a human organism from cancer and other diseases [10]. In recent times oncologists, immunologists and dieticians of all over the world pay considerable attention to herbal carotene-containing additives [10]. It is also known that carotenoids protect the cells of the human body from pathogenic microorganisms and reduce the effect of free oxidative radicals which cause pathological shifts in the human body and lead to the development of various diseases. Carotenoids together with vitamin A fight viruses, bacteria and other pathogens in our immune system, support youth and health, prevent old age, improve visual acuity and make the human skin smooth and elastic [10]. The high-carotene plant

products (such as carrots, pumpkins, apricots, sea buckthorn, etc.) due to its rejuvenating and detoxifying properties can be compared with the properties of the liver, which is a filtering organ in the human body.

According to vitaminologists people need to consume β -carotene-containing products regularly in their ration to be healthy.

The author [11] has shown that vitamins and other micronutrients play an important role in increasing the immune status of the human body, the need for which is not fully satisfied and constantly growing. These substances, especially β -carotene, L-ascorbic acid, mineral substances (such as K, Se, Ca, P, Fe, Mg, etc.), unsaturated phenolic compounds and ether oils with antioxidant activity are found mainly in herbal raw materials. In this regard, nowadays the development of functional healthful products with its use is actual [12]. It is known that stability of the human body to diseases, its working capacity and life expectancy depend on the quality of nutrition [13].

The analysis of own research results for the last 15 years within the framework of the scientific school of prof. R. Pavlyuk shows that the difficulties during the processing and consumption of carotene-containing vegetables in the human stomach with a help of the gastric juice are associated with the dense packing of a large part of the carotene molecules (for example, in carrots) to the plant fibers – nanocomplexes or nanoassociates of heteropolysaccharides and proteins, and their heavy extraction into a soluble form.

An overview of literary sources on the range of baking technology showed that today there are no industrial technologies and formulations of carotenoid additives and buns with their use for health nutrition, as in restaurants, as well as in bread factories and bakeries. The range of buns enriched with natural carotenoid herbal additives is limited abroad also. The description of the assortment and technologies applies only to buns enriched with synthetic β -carotene, or oil form of microbiological production. There is no information about technology and formulation of the industrial production of buns with the use of carotenoid herbal additives.

The expediency of development of bakery and confectionery products for health nutrition vitaminized by natural β -carotene and other BAS from herbal carotene-containing raw materials has developed thanks to the work of such domestic and foreign scientists as R. Pavlyuk, V. Pogarskaya, L. Shatniuk, V. Spirichev, L. Kaprilyantsa, G. Simakhina, L. Telezhenko, L. Iorgacheva and others.

The authors of the article for the first time in international practice have developed the technology of nanostructured herbal carotene-containing additives from carrots and pumpkin in the form of frozen and heat-treated puree, in which the content of β -carotene in a free state exceeds the initial raw materials 3,5–4 times. This discovery is confirmed by the authors during the implementation of fundamental scientific researches of the complex action of

steam-thermal and mechanical treatment of carotene-containing raw materials on the storage and transformation of carotenoids during the studying of enzymatic, biochemical, physico-chemical processes in modern apparatuses used in restaurant business. The semi-finished products obtained from carotene-containing raw materials are used by the authors during the manufacture of various culinary products for healthy nutrition: first and second courses, desserts, nanodrinks, nanosorbets, rolls, biscuits, cakes, etc. In particular, there are results of scientific and research work in this article, which are connected with development of new buns for sandwiches enriched by carotenoid nanoadditives for health nutrition.

The objective of the article. The purpose of research is scientific substantiation and development of formulations and technologies of carotenoid buns «SunRoll» vitaminized by natural nanoadditives from carrots, pumpkins and sea buckthorns for healthful nutrition, studying of their quality, production of experimental samples and introduction them into the industry (small and large enterprises of food business).

To achieve the goal, it is necessary to solve the following tasks:

- to study the content of biologically active substances in fresh, cryogenically frozen and thermally treated fine-dispersed nanoadditives from sea buckthorn, carrots and pumpkins (in particular, β -carotene, L-ascorbic acid, phenolic compounds, etc.);

- to develop the recipes and technologies of new generation of carotenoid buns, vitaminized by natural (frozen or heat-treated) nanoadditives from sea buckthorn, carrots and pumpkins in the form of puree without the use of synthetic components for the healthful nutrition of different sections of population for immune prophylaxis; to study their organoleptic and physico-chemical indicators;

- to study the content of biologically active substances (β -carotene, L-ascorbic acid, phenolic compounds, polyphenols) and prebiotics (pectin, cellulose) in the new healthful carotenoid buns «SunRoll» in comparison with analogues.

Presentation of the research. The research was conducted at Kharkov State University of Food Technology and Trade (Kharkov, Ukraine) at the Department of processing of fruits, vegetables and milk at the laboratory «Innovative cryo- and nano-technologies of herbal additives and healthful products» with the participation of specialists of Kharkov Trade and Economic College of Kyiv National Trade and Economic.

The research was conducted with the use of carotene-containing berries and vegetables (in particular, carrots, pumpkins, sea buckthorns), as well as frozen fine-dispersed nanoadditives on their base and new healthful carotenoid buns with them.

The modern cryogenic and steam-thermal equipment, which is on the above-mentioned department of Kharkov State University of Food Technology and Trade (such as steam-convection oven «Uno» (Italy), fast-freezing apparatus with computer software for cryogenic «shock» freezing of fruits and vegetables, and low-temperature fine-dispersed chopper – homogenizer – cutter (France)), is used in the work. The processing of the samples is carried out with the use of gaseous or liquid nitrogen in a fast-freezing apparatus. More details can be found in [4; 5; 9].

Methods of determining the parameters of the studied samples. For the solving of the tasks the authors of article used the generally accepted methods in research. For example, the mass fraction of β -carotene is determined by the colorimetric method of Moore [4; 8; 9]; the mass fraction of L-ascorbic acid – by the method of visual and potentiometric titration [4; 8; 9]; the total number of low-molecular compounds (by chlorogenic acid) – by the colorimetric method of Folin-Denis [4; 8; 9]; the amount of flavonol glycosides (by routine) – by the colorimetric method [4; 8; 9]. The content of polyphenolic substances (by tannin) is determined according to DSTU 4373: 2005 [4], protein – by the method of Kjeldal [4], pectin – by the calcium-pectat method [4], cellulose – by the standard method [4; 8; 9].

The results of research and their discussion. As an innovation in the development of carotenoid buns «SunRoll» the authors of the article used the natural nanoadditives from sea buckthorn, pumpkin, carrots and citrus fruits (lemons with peel) which can play the role of BAS-fortifiers, colourants and structural formers. The mentioned nanoadditives are obtained at the Department of processing of fruits, vegetables and milk in Kharkov State University of Food Technology and Trade due to the use of cryogenic freezing, steam-thermal treatment in a modern apparatus (steam-convection oven) and fine-dispersed grinding [5; 6].

It is shown that the new frozen or steam-treated nanoadditives from the carotene-containing berries and vegetables are in nanostructured form. The particle size of the nanoadditives is tens times less than the particle size of the traditional puree [3–6]. In addition, they have principally new characteristics in comparison with puree obtained by the traditional technologies. In particular, they are dissolved much better, dispersed in a water and differ by 1,7–3,5 times higher than in the raw materials content of natural carotenoids, L-ascorbic acid, low- and high-molecular phenolic compounds and other BAS (table 1).

It is known that the BAS mentioned in the article have immunomodulating, antioxidant and detoxicant properties. They can be used as natural fortificants of BAS, colorants and structure-forming agents during the adding of nanoadditives to the various types of products, in particular, buns. It is shown that carotenoid nanoadditives obtained by cryogenic treatment of raw materials, steam-thermal processing in a modern apparatus (steam-convection oven) and

fine-dispersed grinding differ by a record amount of β -carotene in free state (table 1). Thus, the mass fraction of β -carotene in cryopuree from carotene-containing vegetables is 3,0–3,5 times more than in the raw materials and in the heat-treated nanopuree is 2,0–2,5 times more comparing with the start raw materials. It is shown that the quantity of nanopuree is higher than the quantity of the start raw materials by the content of low-molecular phenols and L-ascorbic acid.

Table 1

The comparative characteristics of BAS-content in fresh, frozen, steam-treated carotene-containing vegetables, berries and nanostructured puree on their base

Product	Mass fraction, mg in 100 g			
	β -carotene	L-ascorbic acid	phenolic compounds (by chlorogenic acid)	flavonol glycol-sides (by routine)
Fresh sea buckthorn	11,3±1,2	50,0±2,5	210, ±11,1	80,4±3,8
Cryopuree from sea buckthorn	36,9±2,5	102,1±10,0	380,1±12,4	155,6±4,2
Fine-dispersed puree from steam-thermally-treated sea buckthorn	30,4±3,2	80,4±7,2	305±10,3	102,2±3,4
Fresh carrot	9,5±1,0	12,8±1,5	214,6±10,8	50,2±2,5
Frozen pieces of carrot	14,6±2,1	19,2±1,8	219,6±12,3	87,4±10,2
Cryopuree from carrot	30,8±2,5	32,9±3,2	324,2±15,4	110,5±8,2
Carrot, treated in the steam-convection oven	16,0±2,5	7,0±1,0	120,4±5,6	40,2±3,4
Fine-dispersed puree from carrot treated in the steam-convection oven	23,8±3,5	15,0±1,2	180,6±10,2	80,6±6,7
Fresh pumpkin	8,8±1,0	9,8±1,2	108,8±5,6	64,5±7,2
Frozen pieces of pumpkin	16,8±2,5	12,0±1,5	126,9±10,2	70,2±3,2
Cryopuree from frozen pieces of pumpkin	32,2±3,5	16,7±1,8	178,2±11,1	98,6±5,2
Pumpkin, treated in the steam-convection	20,0±1,8	12,5±1,3	75,0±5,6	35,8±3,5
Fine-dispersed puree from pumpkin treated in the steam-convection oven	30,5±2,5	19,5±1,2	136,2±6,7	76,2±7,2

The main thing in the development of recipes of carotenoid buns «SunRoll» was to get a porous texture, a yellow-orange color, a pleasant taste; to preserve β -carotene and other healing substances in a free form; to exclude the use of synthetic components due to the introduction of natural nanoadditives to the dough.

3 recipes of carotenoid buns were developed with the help of method of mathematical modeling and experimental research. The buns took the general name «SunRoll» from their yellow-and-orange color. The buns are distinguished from each other by amount of introduction of additives. In particular, the buns «SunRoll» (carrot) are dominated by an additive from carrots, the buns «SunRoll» (squash) are dominated by an additive from pumpkin, and the buns «SunRoll» (berry) are dominated by an additive from sea buckthorn.

It is shown that the new carotenoid buns «SunRoll» with natural nanoadditives have an attractive appearance, a rounded shape, a smooth, elastic and aromatic surface without the breaking of crumb. The color of crumb is yellow-and-orange without the use of synthetic colorants. The taste of the buns is pleasant, harmonious, with fresh citrus aroma. It is determined that the carotenoid buns, which are vitaminized by the fine-dispersed nanoadditives from carrots, pumpkins, sea buckthorn and lemon pill, have physical-and-chemical parameters at the level of analogues (table 2).

Table 2

Physical-and-chemical parameters of carotenoid buns «SunRoll» vitaminized by natural nanoadditives from carrots, pumpkins and sea buckthorn in comparison with analogue

Parameter	Carotenoid buns			Analogue
	«SunRoll» (carrot)	«SunRoll» (squash)	«SunRoll» (berry)	
Dry substances, %	69,2±1,5	68,0±1,5	68,5±2,0	70,0±2,0
Organic acids, %	0,40±0,01	0,40±0,01	0,40±0,01	0,30±0,01
Protein, %	8,5±0,2	9,0±0,2	8,8±0,1	7,6±0,2
Fat, %	5,1±0,1	5,0±0,1	5,0±0,1	5,0±0,1
Carbohydrates, %	50,3±1,8	50,4±1,8	50,2±1,3	56,4±1,2
Energy value, kcal	279,6±2,0	276,2±2,0	275,6±2,0	288,0±2,0

It is shown that the carotenoid buns have a high level of β -carotene, vitamin C, phenolic compounds and other BAS (table 3, fig. 1). For example, 100 g of «SunRoll» (carrot) contain 5,0 mg of β -carotene, which cover the daily human need in β -carotene. The bun «SunRoll» (squash) contains 4,5 mg per 100 g, which covers almost 90% of the daily human need in

β -carotene. And the bun «SunRoll» (berry) contains 5,5 mg of β -carotene, which covers the daily human need in this component. In the same time the analogue doesn't contain β -carotene.

Table 3

The content of β -carotene, L-ascorbic acid and other BAS in carotenoid buns «SunRoll» vitaminized by natural nanoadditives

Parameter	Carotenoid buns			Analogue
	«SunRoll» (carrot)	«SunRoll» (squash)	«SunRoll» (berry)	
β -carotene, mg in 100 g	5,0 \pm 0,1	4,5 \pm 0,1	5,5 \pm 0,1	–
L-ascorbic acid, mg in 100 g	50,3 \pm 3,5	48,2 \pm 2,2	51,2 \pm 3,8	–
Phenolic compounds (by chlorogenic acid), mg in 100 g	115,3 \pm 10,5	105,3 \pm 9,8	120,4 \pm 8,4	48,2 \pm 1,9
Flavonol glycosides (by routine), mg in 100 g	30,0 \pm 1,5	35,2 \pm 2,0	38,4 \pm 2,5	18,0 \pm 0,8
Polyphenols (by tannin), mg in 100 g	28,4 \pm 1,2	30,1 \pm 1,5	35,3 \pm 1,8	17,6 \pm 1,1
Cellulose, %	0,70 \pm 0,05	0,5 \pm 0,05	0,60 \pm 0,05	0,20 \pm 0,01
Protein, %	8,5 \pm 0,2	8,2 \pm 0,1	9,0 \pm 0,1	7,6 \pm 0,2
Pectin, mg in 100 g	500,0 \pm 10,5	650,0 \pm 12,1	800,0 \pm 15,6	0

It means that eating of the one bun (weighing 100 g) is enough to satisfy the daily need for β -carotene. In addition, the weakened persons can take a few buns a day for the therapeutic need. It is also shown that 100 grams of buns contain 50% of daily human need in vitamin C (table 3, fig. 1).

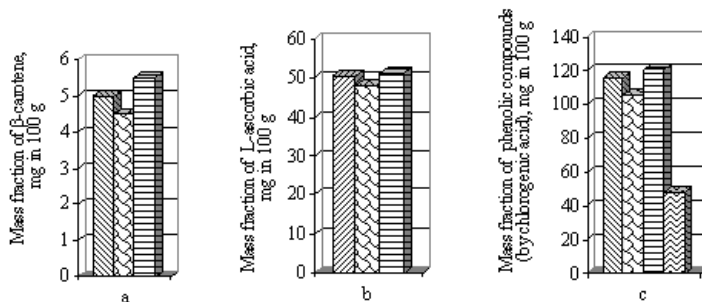


Fig. 1. The comparative characteristic of content of BAS in the buns «SunRoll» vitaminized by natural additives and in the analogue: 1, 2, 3 – the buns vitaminized by natural additives: 1 – «SunRoll» (carrot), 2 – «SunRoll» (squash), 3 – «SunRoll» (berry); 4 – analogue; A, B, C – mass fraction of: A – β -carotene, B – L-ascorbic acid, C – phenolic compounds

Thus, the developed buns have the status of vitaminized functional healthful products due to content of β -carotene, vitamin C and phenolic compounds. They can be attributed to products of special purpose.

According to the recommendations of FAO/WHO and the Ministry of Education and Science of Ukraine, which are reflected in the state programs, the carotenoid buns «SunRoll» can be attributed to the products of special purpose, in particular, for immune prophylaxis of Ukrainian population, including pupils, children of kindergartens, the elderly people, etc.

The results of research of development of a new generation of healthful buns «SunRoll» vitaminized by natural nanoadditives. The development and continuation of research in this direction is the expansion of the range of healthful buns with the use of frozen nanopuree and phytoextracts for health nutrition (children, elderly people, etc.). In addition, the microbiological, spectroscopic, chromatographic studies of new healthful buns vitaminized by natural nanoadditives are of interest in the further time. The regulatory documents for new buns are developed and approbation in the production conditions is conducted.

Conclusions. It is shown that the natural nanoadditives, which are obtained by cryogenic treatment, steam-thermal processing in a modern apparatus (steam-convection oven) and fine-dispersed grinding of raw materials, differ in a record amount of β -carotene in a free state: in particular, the mass fraction of β -carotene in cryopuree from carotene-containing vegetables is 3,0–3,5 times more than in the raw materials, in the heat-treated nanopuree is 2,0–2,5 times more in comparison with raw materials. It is shown that the nanopuree contains also more low-molecular phenolic compounds and L-ascorbic acid comparing with their amount in the bound (hidden) form in the raw materials.

1. 3 recipes of carotenoid buns «SunRoll» for healthful nutrition are developed. They distinguished from each other by amount of introduction of carotene-containing additives from carrots, pumpkins and sea buckthorn. It is shown that the new buns have an attractive appearance, yellow-and-orange color, stable fluffy texture, harmonious original taste and fresh citrus aroma.

2. It is shown that the new carotenoid buns «SunRoll» for healthful nutrition with the use of natural nanoadditives as fortificants by BAS, have a record amount of natural β -carotene, L-ascorbic acid and low-molecular phenolic compounds (almost daily human need in 100 g of product). The carotenoid buns «SunRoll» exceed the world-known analogues by the content of BAS. So, they can be recommended for the population with the purpose of immunoprophylaxis.

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