

## **НАТУРАЛЬНІ ОЗДОРОВЧІ ПЛОДОВОВОЧЕВІ НАНОНАПОЇ З РЕКОРДНИМ ВМІСТОМ БАР ДЛЯ ПІДПРИЄМСТВ РЕСТОРАННОГО БІЗНЕСУ, ТУРИЗМУ ТА ФІТНЕСУ**

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*Розроблено нові натуральні функціональні оздоровчі сокові нанонапої з рекордним вмістом БАР (L-аскорбінової кислоти, β-каротину, хлорофілу, антоціанів, фенольних сполук) і пребіотиків (целюлози, пектинових речовин) у розчинній іономолекулярній формі. Інноваційним у технології нанонапоїв було використання як збагачувачів БАР, барвників, структуроутворювачів рослинні каротиноїдні, хлорофіловмісні, антоціанові криопюре в наноформі із плодів і прянощів. Нанонапої призначені для імунпрофілактики та рекомендовані для використання в закладах ресторанного бізнесу, туризму та фітнесу.*

**Ключові слова:** оздоровчі нанонапої, натуральні нанопюре, каротиновмісні, хлорофіловмісні, антоціанові добавки, плоди, овочі.

## **НАТУРАЛЬНЫЕ ОЗДОРОВИТЕЛЬНЫЕ ПЛОДОВООЩНЫЕ НАНОПИТКИ С РЕКОРДНЫМ СОДЕРЖАНИЕМ БАВ ДЛЯ ПРЕДПРИЯТИЙ РЕСТОРАННОГО БИЗНЕСА, ТУРИЗМА И ФИТНЕСА**

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*Разработаны новые натуральные функциональные оздоровительные соковые нанопитки с рекордным содержанием БАВ (L-аскорбиновой кислоты, β-каротина, хлорофилла, антоцианов, фенольных соединений) и пребиотиков (целлюлозы, пектиновых веществ) в растворимой иономолекулярной форме. Инновационным в технологии нанопитков было использование в качестве обогатителей БАВ, красителей, структурообразователей растительные каротиноидные, хлорофиллсодержащие, антоциановые криопюре в наноформе из плодов и пряностей. Нанопитки предназначены для иммунопрофилактики и рекомендованы для использования в учреждениях ресторанного бизнеса, туризма и фитнес-центрах.*

**Ключевые слова:** оздоровительные нанопитки, натуральные нанопюре, каротинсодержащие, хлорофиллсодержащие, антоциановые добавки, плоды, овощи.

# NATURAL HEALTHFUL FRUIT AND VEGETABLE NANOBEVERAGES WITH A RECORD AMOUNT OF BAS FOR ENTERPRISES OF RESTAURANT BUSINESS, TOURISM AND FITNESS

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*The new natural functional healthful juicy nanobeverages with a record amount of BAS (L-ascorbic acid,  $\beta$ -carotene, chlorophyll, anthocyanins, phenolic compounds) and prebiotics (cellulose, pectins) in a soluble ion-molecular form are developed. As an innovation in technology of nanobeverages the authors used the herbal carotene-, chlorophyll- and anthocyanin-containing cryopuree from fruits and spices in the nanoform as fortificants of BAS, colorants and structure formers. The beverages are aimed for immunological prophylaxis and recommended for the use at the enterprises of restaurant business, tourism and fitness centers.*

*It is shown that the frozen cryoadditives from fruits and vegetables (apples, cherry, black currant, lemons with a peel, spinach, apricot, sea buckthorn, pumpkin) are found in the nanostructured form (on 70%) and have a particle size ten times smaller than in traditional puree. It is determined that the cryopuree has fundamentally new properties and chemical composition, in comparison with puree, which are made by the traditional technologies. In particular, they differ by a higher content (2,5–4 times) of vitamins, carotenoids, anthocyanins, chlorophylls, phenolic compounds and other BAS in the free state in a soluble and easily digestible form comparing with the fresh fruits.*

*It is shown that the new healthful juicy nanobeverages, obtained with the use of frozen nanoadditives from fruits and vegetables and phytoextracts from natural spices, differ in a record amount of vitamins (L-ascorbic acid),  $\beta$ -carotene, chlorophylls a and b, anthocyanins, low- and high-molecular phenolic compounds, aromatic substances and other BAS. They have a pronounced natural color (yellow, green, pink-and-cherry), original taste and aroma, do not contain synthetic components. The nanobeverages exceed the world-known analogues by the content of BAS, and they are recommended for use in immunoprophylaxis of the population.*

**Keywords:** *healthful nanobeverages, natural nanopowders, carotene-, chlorophyll-, anthocyanin-containing additives, fruits, vegetables.*

**Stalment of thw problem.** The research work is devoted to the development of the new natural functional healthful juicy nanobeverages with a record amount of BAS (L-ascorbic acid,  $\beta$ -carotene, chlorophyll, anthocyanins, phenolic compounds) and prebiotics (cellulose, pectins) in a soluble ion-molecular form are developed. As an innovation in technology of nanobeverages the authors used the herbal carotene-, chlorophyll- and anthocyanin-containing cryopuree from fruits and spices in the nanoform as fortificants of BAS, colorants and structure formers. The beverages are aimed for immunological prophylaxis and recommended for the use at the enterprises of business, tourism and fitness centers.

The actuality and timeliness of the scientific results and information provided in the article are connected with the necessity of solving on the planet such global problems as: hunger, 50% deficiency of biologically active substances (BAS) in the daily rations, in particular vitamins, carotene, minerals, protein and others that are aggravated by the deterioration of the environmental situation and the decline in immunity in the population of Ukraine and many other countries in the world [1; 2]. According to UNESCO in the international forecast "Nutrition of the XXI Century", one of the most important ways of solving this global problem is the development and creation of healthful functional products aimed at health promotion [3].

In this regard, today the functional healthful products (especially fruits, berries and vegetables), which are aimed at increasing the immunity of the population are widely used in many countries of the world. The main requirements for such products are their harmlessness, that is, the absence of harmful synthetic impurities in their composition and the high content, primarily of natural herbal BAS such as: vitamins (especially L-ascorbic acid,  $\beta$ -carotene,  $\alpha$ -tocopherol, phenolic compounds, chlorophyll, aromatic and mineral substances, etc.). Particularly among the population of many countries of the world the natural juices and juicy beverages are used by a high popularity [4; 5].

**Review of the latest researches and publications.** The analysis of periodical literature over the last 15 years has shown that the nutrients are stored during the obtaining of juicy beverages with pulp, but the vitamins and other BAS are lost in the production of transparent juicy beverages, but in less quantity [8; 9]. Loss of vitamins and other BAS occurs at different stages of technological processing of raw materials (during the heat treatment, in the process of wiping, pasteurization, etc.) and they range from 20 to 80% in comparison with their content in fresh raw materials [7; 10].

The difficulties in obtaining of juicy beverages from fruit and vegetable raw materials with pulp are associated not only with the loss of vitamins and other BAS of fresh raw materials during the wiping and obtaining fruit puree, as well as with reception of a homogeneous consistency with granulometric composition when the grinding of high-molecular protein-polysaccharide hardly-soluble nanocomposites of raw materials. It leads to the stratification of juicy beverages, the flocculation and loss of their saleable condition [8].

Thus, existing technologies in the world practice do not allow reception of juicy beverages of high quality. The technological methods which allow obtaining juicy beverages of high quality (by the content of natural vitamins and other biologically active substances) have not been found till today. In this

regard, it is important to develop natural high-quality juicy nanobeverages with a high content of vitamins and other BAS, which can be used by the population to strengthen immunity and for healthy nutrition.

The study of the range shown that the fruit and vegetable juices and beverages, which are produced and sold in Ukraine, are low in vitamins and other BAS, high in sugar content and synthetic components (colorants, flavors, thickeners, preservatives) that affect on the human body negatively [6; 7]. In this regard, it is important to develop a new generation of natural juicy nanobeverages with a high content of vitamins and other BAS, which have immunomodulatory and detoxifying properties for use in healthy nutrition.

As innovation in the research work the authors used the nanostructured additives from natural herbal raw materials: carotene-, chlorophyll- and anthocyanin-containing, as well as puree from apples and lemons with peel. They are used as stabilizers and structure-forming agents for fortification of juicy beverages with natural BAS. The composition of high-BAS enriching supplements, which are used in the research, includes also proteins, pectin and cellulose, which are in the soluble form predominantly, the ion-molecular and colloidal state. They form a colloidal homogeneous consistency with a water and make a texture of juicy nanobeverages. The juicy nanobeverages obtained with their use are not stratified during the storage, in other words, the enriching additives play the role of stabilizers of the texture.

**The objective of the article.** The purpose of research is the development of a new generation of natural juicy healthful nanobeverages fortified by carotene-, chlorophyll- and anthocyanin-containing fine-dispersed nanoadditives from fruits and vegetables (obtained by the cryogenic nanotechnology) and phytoextracts from natural spices.

To achieve the purpose, it was necessary to solve the following tasks:

– to characterize and determine the content of BAS in frozen nanoadditives (from apricot, sea buckthorn, pumpkin, apples, spinach, cherries, lemons with peel, bananas in comparison with raw materials) – as the main component for juicy nanobeverages;

– to study the impact of the fine-dispersed grinding of natural spices on the rate and degree of extraction of BAS during the obtaining of phytoextracts from marjoram, cardamom, coriander, estragon used in the manufacture of juicy nano-beverages;

– to develop three recipes of juicy nanobeverages based on the fruit and vegetable cryoadditives in the form of nanopuree from chlorophyll-, carotene- and anthocyanin-containing fruits and vegetables and phytoextracts from natural spices;

– to study the content of BAS in juicy nanobeverages (L-ascorbic acid,  $\beta$ -carotene, chlorophyll a and b, anthocyanins, low-molecular phenolic compounds, etc.), the patterns and mechanisms of stable dispersed texture of healthful nanobeverages.

**Presentation of the research.** The research was conducted at Kharkov State University of Food Technology and Trade at the Department of Technologies of the Processing of Fruits, Vegetables and Milk in the Laboratory "Innovative Cryo- and Nanotechnologies of Herbal Additives and Healthful Products" in collaboration with experts from Kharkov Trade and Economic College of Kyiv National Trade and Economic University.

The research was carried out using carotene-containing berries and vegetables (in particular, sea buckthorn, apricots, pumpkin), chlorophyll-containing vegetables (spinach), anthocyanin-containing berries (cherries), as well as apples, lemons with a peel, bananas, the frozen fine-dispersed nanopuree from them and new healthful nanobeverages based on them with the adding of phytoextracts from natural spices (cardamom, marjoram, coriander, estragon).

In the research the authors used the modern cryogenic equipment, which is present at the above-mentioned department of Kharkov State University of Food Technology and Trade, namely: the cryogenic program freezing apparatus with computer software for cryogenic "shock" freezing of fruits and vegetables and the low-temperature fine-dispersed cutting machine-homogenizer-cutter (France). The processing of the samples was carried out with the use of gaseous and liquid nitrogen in a freezer. More details can be found in the work [4].

The methods of determination the parameters of the research samples. To accomplish the tasks, the following research methods were used: the colorimetric method of Muri for determination of  $\beta$ -carotene; the method of visual and potentiometric titration for determination of L-ascorbic acid; the colorimetric method of Folin-Denis for determination of the total number of low-molecular compounds (by chlorogenic acid); the colorimetric method for determination of total amount of flavonol glycosides (by routine). The chlorophyll a and b were determined by the spectrophotometric method, the polyphenolic substances (by tannin) were determined according to DSTU 4373: 2005, the protein – by Kjeldahl method, the total sugar – by the permanganometric method (Bertran method), the cellulose – by the standard method based on the formation of furfural from pentosans when treating cellulose with a solution with a mass fraction of hydrochloric acid 13% when heated and the deflected furfural – by spectrophotometric method. The methods for determination of the samples parameters in details can be found in [4].

The results of the research of development of a new generation of healthful juicy nanobeverages fortified by carotene-, chlorophyll- and anthocyanin-containing nanoadditives and phytoextracts and their discussion

The frozen nanoadditives from apricots, pumpkin, sea buckthorn, apples, spinach, cherries, topinambour and lemons with a peel, which are high in vitamins, carotenoids, chlorophyll, anthocyanin and antioxidants, were used in the development of juicy nanobeverages as an innovation. These additives were obtained by the cryogenic technology at the Department of Technologies of Processing of Fruits, Vegetables and Milk in Kharkov State University of Food Technology and Trade. Additionally the phytoadditives in the form of extracts from medicinal aromatic herbal raw materials (cardamom, coriander, marjoram, estragon) were introduced to the nanobeverages [3; 4; 6].

It is shown that the new frozen fruit and vegetable additives are in nanostructured form. The size of them is ten times smaller than in the traditional puree. In addition, they have fundamentally new properties, in comparison with traditional puree, in particular, several times better dissolved and dispersed in a water. The new additives also have (2,5–4) times higher (than in fresh fruits) the content of natural vitamins, carotenoids, chlorophylls, anthocyanins and other low-molecular BAS in a free state (table 1).

The above-mentioned substances have the potential immunomodulating, antioxidant, detoxifying properties, as well as they play the role of natural fortificants by BAS, thickeners, structure-forming agents and colorants during the introduction them into a various types of products, including juicy nanobeverages.

An analysis of the size of biological components, substances or nanocomplexes, nanoassociatives in the fine-dispersed frozen nanopuree obtained by the new technology from fruits and vegetables suggests that they are in nanosize [3]. Thus, the size of carotenoids, L-ascorbic acid, vitamins B<sub>1</sub>, B<sub>2</sub>, which are in the free state, range 1,0–1,6 nm and so on. The size of the  $\alpha$ -amino acids, contained in the herbal heterogeneous fine-dispersed biosystems in the free state, is in the range from 0,42 nm (for glycine) to 1,5 nm (for tryptophan). The dimensions of other amino acids take intermediate values. The monocyclic molecules (glucose, fructose) also have a size about 1 nm. The sizes of protein molecules in soluble state in the frozen puree are in the range 100–500 nm, the size of the associatives or nanocomponents of biopolymers is 200–800 nm, and so on [3].

Table 1

**The comparative characteristics of L-ascorbic acid,  
β-carotene, phenolic compounds, prebiotics (pectin, cellulose) and nutrients  
in fresh fruits and vegetables and frozen nanopuree from them**

Product	Mass fraction, mg in 100 g			Mass fraction, g in 100 g			
	L-ascorbic acid	β-carotene	Phenolic compounds (by chlorogenic acid)	flavonol glycosides	Polyphenols (by tannin)	pectins	cellulose
1	2	3	4	5	6	7	8
Fresh apples	32,2±1,2	0,1±0,05	410,6±26,1	120,2±5,4	320,3±7,4	1,5±0,1	1,6±0,2
Frozen nanopuree from apples	75,4±2,8	0,3±0,06	670,2±10,5	204,1±12,5	560,2±10,5	7,2±0,3	1,3±0,1
Fresh black currant	265,0±20,4	4,5±0,5	680,3±17,4	145,5±12,4	542,0±20,4	1,6±0,1	2,5±0,3
Frozen nanopuree from black currant	610,4±25,3	13,5±0,8	990, ±25,4	250,8±13,3	984,2±24,3	7,4±0,5	2,3±0,2
Fresh cherry	40,8±3,2	0,3±0,05	318,2±4,5	75,6±3,8	310,2±5,4	1,3±0,1	1,0±0,1
Frozen nanopuree from cherry	89,6±5,1	0,7±0,05	610,6±10,2	131,2±2,4	600,1±12,5	6,8±0,3	0,9±0,1
Fresh lemons	60,2±3,2	0,2±0,05	305,2±10,2	65,1±5,2	280,1±5,6	1,8±0,1	2,5±0,1
Frozen nanopuree from lemons with a peel	125,6±4,2	0,4±0,07	550,3±12,5	110,6±4,5	420,0±10,3	7,5±0,4	2,1±0,2
Fresh bananas	31,0±1,0	0,1±0,05	210,0±10,2	385,2±11,2	180,2±5,2	2,0±0,1	0,8±0,1

Continuation of table 1

1	2	3	4	5	6	7	8
Frozen nanopuree from bananas	65,2±2,5	0,2±0,05	315,2±10,2	450,8±25,2	280,3±6,8	8,0±0,4	0,5±0,1
Fresh spinach	48,2±4,0	4,2±0,5	240,6±5,8	80,4±5,6	320,4±10,2	1,3±0,1	1,5±0,1
Frozen nanopuree from spinach	99,8±10,1	9,8±1,0	420,5±6,5	150,2±6,8	510,5±25,0	7,1±0,5	1,3±0,1
Fresh pumpkin	10,2±1,2	8,5±0,5	130,4±1,2	48,4±3,2	150,2±4,2	1,6±0,1	1,1±0,1
Nano-structured puree from pumpkin	25,6±3,1	35,2±2,6	245,2±5,2	96,8±7,3	290,0±6,8	7,3±0,2	0,8±0,1
Fresh sea buckthorn	70,2±5,4	12,8±0,6	160,2±12,1	70,2±5,4	150,6±3,8	1,3±0,1	1,2±0,1
Frozen nanopuree from sea buckthorn	215,3±11,2	36,8±2,8	240,2±25,2	125,2±1,6	280,4±5,8	7,5±0,2	0,9±0,1
Fresh apricots	40,5±1,6	8,5±1,6	120,3±10,1	45,4±1,2	180,0±5,6	1,4±0,1	1,0±0,1
Frozen nanopuree from apricots	120,3±10,4	28,6±2,2	180,5±12,1	80,3±3,9	281,4±6,2	7,0±0,2	0,9±0,1
Fresh topinambour	10,3±0,1	0,5±0,05	350±5,7	240,0±4,8	300,0±6,4	1,9±0,1	1,8±0,1
Frozen nanopuree from topinambour	19,8±0,5	0,8±0,06	700,0±10,4	460,0±7,8	540,0±6,8	6,5±0,2	2,6±0,2

It is found that the fine-dispersed frozen nanopuree, which were used in the work, are in nanosized form on 70% [3]. The phytoadditives in the form of water-alcohol extracts from natural spices were also used as additives in the manufacture of nanobeverages. The water-alcohol infusions or nanoextracts from spicy aromatic raw materials were used in the research work: cardamom (*Elettaria cardamorum* Maton, Ginger family – *Lingiberaceae*), garden majoran (*Majoran nortensis* Moench, *Lamiacue* family), coriander fruits (*Coriandri* fruits, *Apiaceal Umbellferae* family) and



estragon, which were obtained by the classic technology with the help of infusion and extraction. The mechanical and cryogenic processing of the raw materials were used during the extraction as an innovation for the intensification of this process and for the more complete extraction of BAS from the raw materials. These methods of treatment were developed at the department and introduced into production at various enterprises of Ukraine, Russia, Latvia.

It is determined that the use of fine-dispersed grinding of spicy aromatic herbal raw materials during the obtaining of hydroalcoholic extracts significantly increases the yield of extractive BAS from the raw materials (1,4–1,5 times) and significantly accelerates the extraction in comparison with traditional methods (4–5 times faster) (table 2).

It is shown that the content of dry substances in the hydroalcoholic extracts is 1,8–4,8% in 100 ml (table 2). The amount of extractives in phytonanoextracts depends on the chemical composition, the architectonic of plant tissues, the cells of the raw materials and the amount of BAS, which are in a bound state in associatives or nanocomplexes with biopolymers of polysaccharides, proteins, tannins, etc.

It is determined that the phytoextracts from spicy aromatic raw materials are in nanosized form and similarly to the initial (dried) raw materials are characterized by a high content of BAS (table 2). So, the aromatic substances are contained in an amount 82,3–168 ml of  $\text{Na}_2\text{S}_2\text{O}_3$  per 100 ml of experimental phytoextracts, the low-molecular phenolic compounds (by chlorogenic acid) – 320,6–1210,6 mg per 100 ml, the flavonol glycosides (by routine) – 115,4–199,4 mg per 100 ml, the free catechins – 41,2–310,2 mg per 100 g, the tannins – 302,6–890,8 mg per 100 ml (table 2). The phytoextracts from cardamom and marjoram are differ with the highest content of aromatic substances and the phytoextract from estragon has the smallest one.

Table 2

**The content os BAS in phytonanoextracts from spicy aromatic plant material (n=3, P≥0,95)**

Parameter	Water-alcohol phytonanoextracts			
	from coriander seeds	from cardamom	from estragon	from marjoran
1	2	3	4	5
Aromatic substances (by the number of flavors), ml $\text{Na}_2\text{S}_2\text{O}_3$ in 100 ml	140,2	168,8	82,3	152,4
Phenolic compounds (by chlorogenic acid), mg in 100 ml	320,6	540,6	860,4	1210,6

Continuation of table 2

1	2	3	4	5
lavonol glycosides (by routine), ml in 100 ml	199,4	115,4	145,5	189,2
Free catechins (by d-catechin), mg in 100 ml	41,2	156,4	320,6	310,2
Tannic substances (fortannin), mg in 100 ml	302,6	890,8	405,6	505,6
L-ascorbic acid, mg in 100 ml	5,1	10,4	6,5	8,9
Dry matter, %	2,0	3,5	4,3	4,8

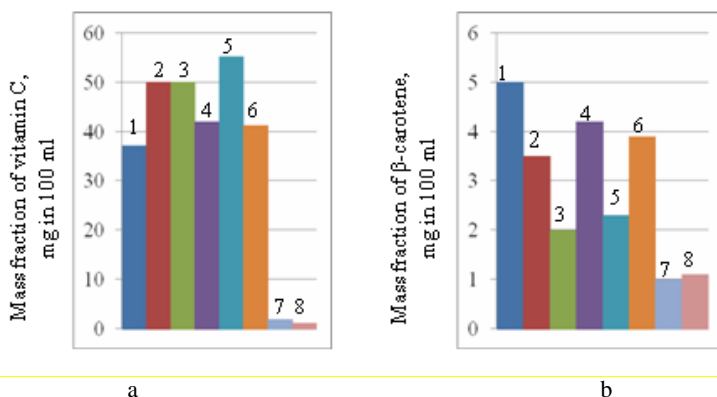
The main thing during the developing of recipes of juicy natural nanobeverages with a pulp using the fine-dispersed nanoadditives from fruits and vegetables was to obtain a homogeneous, stable consistency of the beverages, which wouldn't decompose while the storage and would not lose a natural yellow-and-orange (or green or pink) color, would not contain the synthetic components (in particular, thickeners, stabilizers, colorants, flavors). In this regard, the frozen nanoadditives from apples and lemons with a peel (as the sources of soluble pectins in the active form and soluble proteins in the form of free amino acids, dipeptides, triterpenoids) are added to the beverages as stabilizers and formers. In addition, the mentioned substances are in the ionomolecular and colloid state, so they form stable, colloidal nanocomplexes with a water and between each other, providing a homogeneous consistency and a stable texture of nanobeverages with pulp, which do not decompose during storage. Yellow-and-orange color of juicy nanobeverages is provided by the carotenoids of apricot, sea buckthorn and pumpkin. The green color is provided by spinach, and pink color – by cherry and black currant. The nanoextracts from spicy aromatic herbal raw materials (except for preserving the carotenoids) enrich also the beverages with natural antioxidants, detoxification agents and other substances, and extend the shelf life of beverages during the storage.

The formulations of 6 kinds of nanobeverages were developed by the method of mathematical modeling and experimental research: 3 carotenoid juicy nanobeverages – "Orange-Tonic", "Carotela" and "Caroton", 1 nanobeverage of green color from chlorophyll-containing vegetables – "Green-Tonic" and 2 nanobeverage of pink-and-cherry color – "Purple-Tonic" and "Blackberry-Tonic", based on the cryopuree from cherry, black currant, apples and lemons with a peel.

It is determined that, according to organoleptic parameters, the new types of carotene-, chlorophyll- and anthocyanin-containing nanobeverages have a homogeneous, uniformly colored suspension of yellow-orange, green and pink-

cherry color. They also have the sour-sweet original natural taste and aroma of the fantasy direction (in particular, the fres aroma of guava, papaya and citrus, etc.). The new nanobeverages for the healthful nutrition have a homogeneous stable consistency and a structure that does not stratify during the storage.

It is shown that the new nanobeverages obtained with the use of frozen fine-dispersed nanoadditives from fruits and vegetables and phytoextracts from spices differ in the record levels of vitamin C, carotenoids, phenolic compounds and other BAS (table 3, figure 1).



**Fig. 1. The content of  $\beta$ -carotene and vitamin C in 100 ml of fruit and vegetable nanobeverages in comparison with analogues: a –  $\beta$ -carotene, b –  $\beta$ -vitamin C; 1–6 – fruit and vegetable nanobeverages Orange-Tonic (1), Green-Tonic (2), Purple-Tonic (3), Carotella (4), Blackberry-Tonic (5), Caroton (6); 7–8 beverages – analogues of carrot beverage (7) and pumpkin beverage (8)**

For example, 100 ml of nanobeverage contains 2,0–5,0 mg of  $\beta$ -carotene, which is in the easily-digestible hydrophilic nanoform (that is 2–5,0 times higher than in analogues). It is known that the daily requirement of the human body in  $\beta$ -carotene is 5–6 mg. Thus, 100 ml of nanobeverage contain 50–100% of daily need for  $\beta$ -carotene. That is, it is enough to drink 0,5 cups of nanobeverage to satisfy the daily need in  $\beta$ -carotene, and in the case of a therapeutic dose, for a weakened person, you can take a glass of beverage per a day. It is also shown that 100 ml of the beverage contain 50% of the daily requirement in vitamin C and a glass (200 ml) of the mentioned product – the day requirement.

The new juicy carotene-, chlorophyll- and anthocyanin-containing nanobeverages with a record characteristics (by the content of natural carotenoids, chlorophylls, anthocyanins and other BAS) for healthful nutrition were obtained for the first time in the international practice.

It is also shown that the content of phenolic compounds (by chlorogenic acid) in fruit and vegetable nanobeverages is 10 times higher than in analogues. The content of flavonol glycosides (by routine) and polyphenols is also 10 times more than in analogues (table 3). It is also shown that a number of pectin substances in analogues is 3–5 times higher than in analogues. The nanobeverages also have a high content of minerals and so on (table 3). It is shown that the content of dry substances in nanobeverages is 11,5–12,0%, organic acids – 2,1–2,3%. These parameters are standard for beverages and correspond to analogues.

Table 3

**The content of biologically active, prebiotic and nutritional substances in juicy nanobeverages in comparison with analogues (n = 3, P≥0,95)**

Parameter	Fruit juicy nanobeverages						Analogues	
	«Orange-Tonic»	«Green-Tonic»	«Purple-Tonic»	«Carotella»	«Blackberry-Tonic»	«Carotone»	«Carrot beverage»	«Pumpkin beverage»
1	2	3	4	5	6	7	8	9
Phenolic compounds (by chlorogenic acid), mg in 100 ml	91,2	105,3	120,7	80,6	132,4	85,7	9,2	8,8
Flavonol glycosides (by routine), ml in 100 ml	45,6	48,9	46,3	50,2	47,1	49,2	4,3	5,0
L-ascorbic acid, mg in 100 ml	37,2	50,0	50,0	42,0	55,2	41,2	2,0	1,2
β-carotene, mg in 100 ml	5,0	3,5	2,0	4,2	2,3	3,9	1,0	1,1
Polyphenolic tannins (for tannin), mg in 100 ml	75,2	82,8	79,8	70,6	79,1	73,6	12,1	10,4
Pectin substances, %	1,3	1,2	1,3	1,4	1,2	1,4	0,3	0,4
Mineral substances, mg in 100 ml: K	80,9	85,4	82,3	90,5	85,3	86,2	110,0	124,0
Ca	25,8	29,4	28,6	30,2	27,2	28,6	20,	16,0
Mg	22,5	19,3	20,6	21,0	20,9	21,4	10,6	13,2
P	24,3	29,3	25,2	30,2	27,6	26,3	24,2	19,6
Fe	1,1	0,9	1,1	1,0	1,1	1,0	0,3	0,6

Continuation of table 3

1	2	3	4	5	6	7	8	9
Total sugar, %	8,1	8,0	8,0	8,0	8,0	8,0	8,0	8,5
Organic acids, %	2,1	2,2	2,2	2,0	2,1	2,0	2,0	2,0
Cellulose, %	1,2	0,9	1,2	1,1	1,1	1,2	0,2	0,3
Dry matter, %	11,5	12,0	12,0	12,0	12,0	12,0	10,0	11,2

Thus the carotene-, chlorophyll- and anthocyanin-containing nanobeverages exceed the known analogues by the content of  $\beta$ -carotene, L-ascorbic acid and other BAS. The high quality of juicy nanobeverages is achieved due to the use of cryogenic nanoadditives, obtained by nanotechnologies, which include freezing and fine-dispersed low-temperature grinding. The mentioned processes allow more complete disclosure and destruction of both: the plant cells and the complexes of nano-asociacities or nanocomplexes of carotenoids and other BAS with biopolymers (cellulose, pectin, protein, etc.), releasing their hidden (bound) forms and transforming them into the water-soluble free forms, which are easily digested by the human body. The beverages are aimed for immunological prophylaxis and recommended for the use at the enterprises of business, tourism and fitness centers.

**Conclusions.** It is shown that the frozen cryoadditives from fruits and vegetables (apples, cherry, black currant, lemons with a peel, spinach, apricot, sea buckthorn, pumpkin) are found in the nanostructured form (on 70%) and have a particle size ten times smaller than in traditional puree. It is determined that the cryopuree has fundamentally new properties and chemical composition, in comparison with puree, which are made by the traditional technologies. In particular, they differ by a higher content (2,5–4 times) of vitamins, carotenoids, anthocyanins, chlorophylls, phenolic compounds and other BAS in the free state in a soluble and easily digestible form comparing with the fresh fruits.

It is determined that the use of fine-dispersed grinding of natural spices (coriander, estragon, cardamom, marjoram) during the obtaining of water-alcohol extracts significantly increases the extraction of extractive BAS from them (1,4–1,5 times more) and accelerates the extraction process significantly in comparison with the use of traditional methods (4–5 times faster). It is shown that the obtained phytoextracts are high in BAS, in particular, low-molecular phenolic compounds (0,3–1,2 g in 100 ml), aromatic substances and tannins (0,3–0,9 g in 100 ml), etc.

Three groups of juicy nanobeverages are developed on the base of cryopuree from carotene-, chlorophyll- and anthocyanin-containing fruits and vegetables and phytoextracts for health nutrition. The nanobeverages have a homogeneous stable consistency, are not disintegrated during the storage, do not lose natural color (yellow, green and pink-cherry) and do not contain synthetic components.

It is shown that the new healthful juicy nanobeverages, obtained with the use of frozen nanoadditives from fruits and vegetables and phytoextracts from natural spices, differ in the record level of vitamins (L-ascorbic acid),  $\beta$ -carotene, chlorophylls a and b, anthocyanins, low- and high-molecular phenolic compounds, aromatic substances and other BAS. They have a pronounced natural color (yellow, green, pink-and-cherry), original taste and aroma, do not contain synthetic components. The nanobeverages exceed the world-known analogues by the content of BAS, and they are recommended for use in immunoprophylaxis of the population. The beverages are aimed for immunological prophylaxis and recommended for the use at the enterprises of business, tourism and fitness centers.

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