

ХІМІЧНІ, ФІЗИЧНІ, МАТЕМАТИЧНІ МЕТОДИ ДОСЛІДЖЕННЯ ЯКОСТІ ПРОДУКТІВ ХАРЧУВАННЯ

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*Slashcheva A. V., PhD in Engineering sciences,
Associate Professor*

Bodnaruk O.A., assistant

Pereverzev O. P., a graduate of a master's degree

Donetsk National University of Economics and Trade named after Mykhailo Tugan-Baranovsky
(Kryvyi Rih, Ukraine), e-mail: slashcheva@donnuet.edu.ua

QUALITY AND SAFETY OF SEMI-FINISHED VEGETABLE AND BERRY PURE

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Слащева А. В., канд. техн. наук, доцент

Боднарук О. А., асистент

Переверзєв О. П., здобувач СВО магістра

Донецький національний університет економіки і торгівлі імені Михайла Туган-
Барановського (м. Кривий Ріг, Україна), e-mail: slashcheva@donnuet.edu.ua

ЯКІСТЬ ТА БЕЗПЕКА ПОРЕПОДІБНИХ ОВОЧЕВО-ЯГІДНИХ НАПІВФАБРИКАТІВ

Objective is to determine the main indicators of quality and safety of a semi-finished product based on mashed pumpkin and sea buckthorn fruits.

Methods. Sampling was conducted according to requirements of DSTU ISO 874-2002, the preparation of samples for laboratory tests according to DSTU 7040:2009. Physico-chemical parameters were determined: content of dry substances in raw material – according to DSTU ISO 751-2004; mass fraction of soluble solids – refractometric method according to DSTU ISO 2173:2007; the content of polyphenolic substances – method Volna-Ciocalteu; mineral composition was determined by atomic absorption method using a chromatograph Z-8000 (Hitachi, Japan). Sampling for microbiological analysis was carried out according to GOST 26668-85, sample preparation was carried out in accordance with GOST 26669-85, cultivation of microorganisms GOST 26670-91. Determination of yeasts and molds according to GOST 10444.12-88, of bacteria of group of intestinal sticks according to GOST 30518-97, lactic acid microorganisms according to GOST 10444.11-94. Determination of toxic elements was carried out: cadmium – according to DSTU ISO 6561:2004, lead – according to DSTU ISO 6633:2001, arsenic – DSTU ISO 6634:2004, zinc – according to DSTU ISO 6636-2:2004, mercury – DSTU ISO 6637:2001.

Results. It was established that according to microbiological and toxicological indicators, the developed mashed potatoes do not exceed the established limit-permissible concentrations and meet the requirements of the standards. The developed purees have a number of advantages compared to the control (pumpkin puree) in terms of physical and chemical parameters: the ash content is 4.3-4.4 times higher (due to the increased content of potassium, calcium, magnesium and phosphorus), the carotenoid content is 1.9-4.6 times, pectins - 1.4 times (dessert puree) and 1.3 times (spicy puree). After 90 days of storage in the dessert puree, there was a slight decrease in the expressiveness of the smell, as well as the intensity and naturalness of the taste of sea buckthorn, and in the spicy puree, the smoothness of the surface, gloss and expressiveness of the smell of spices decreased.

Key words: semi-finished puree, pumpkin, sea buckthorn, safety indicators, quality indicators.

Formulation of the problem. Possibility to reduce storage and transportation costs, smoothing out the seasonality of canning production and the growing demand for reconstituted juices with pulp, nectars, sauces and food additives are contributing to the spread of concentrated semi-finished products throughout the world [1, 2].

The use of vegetable purees allows you to enrich the finished product with soluble and insoluble dietary fiber, and, as a result, recommend the resulting products as a healthy food product, as well as for people suffering from excess weight and carbohydrate metabolism disorders [3].

The vegetable puree market segmentation, based on category, includes organic and conventional. The organic category generated the most income. Homemade baby food often uses organic vegetable puree. It offers a wholesome and palatable way to introduce vegetables to young children. You can make organic vegetable purees from various vegetables, including carrots, sweet potatoes, peas, spinach, and butternut squash, and they'll give your baby the essential vitamins, minerals, and fiber they need to grow and develop normally. Organic vegetable purees can serve as the foundation for scrumptious sauces and dips. They can be used in dressings, marinades, marinara, and pasta sauces. These recipes gain a nutritional boost and improve flavor and texture when adding organic vegetable puree [4].

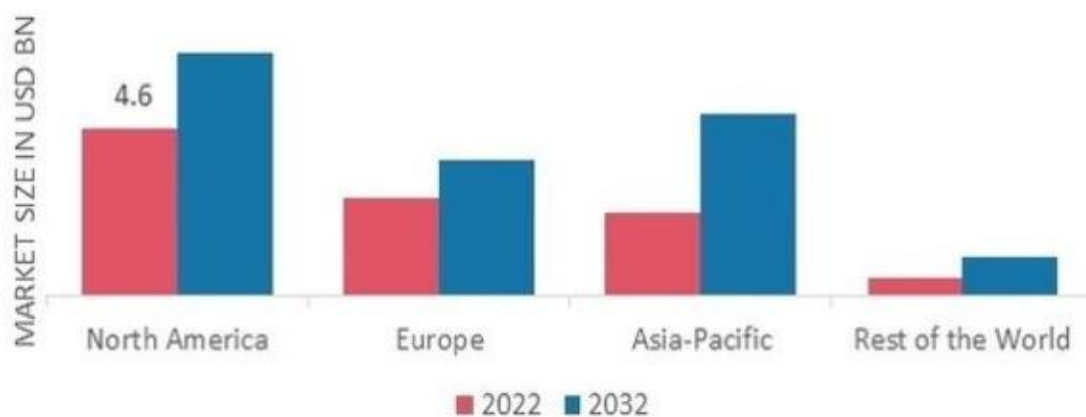


Figure 1 – Segmentation analysis of the vegetable puree market (source [5])

Market of a compound annual growth rate for the vegetable puree market is being driven by the rising popularity of healthy eating has created several business opportunities for those who sell and produce vegetable mash. Consumers now perceive it as a food component that satisfies nutritional needs and cuts down on cooking time. Additionally, the popularity of clean-label assurance products and the healthy eating fad has pushed producers to use organic vegetables when making vegetable mash. In the upcoming years, the aforementioned factors are anticipated to propel the vegetable puree industry.

A significant trend is the digitalization of the supply and value chains. The traditional supply chain model is a system that relies primarily on human interaction and interventions and uses less digitalized platforms. The importance of digitalization in the supply chain for processed vegetables is rising. Several outlines call for hassle-free operations beginning with the raw material purchase to cut down on waste and losses. The manufacturers are putting much effort into implementing digital control, design, synchronization, and other techniques to monitor the process's flow. To establish quality standards and gather market information, many customers, particularly millennials who might lack the knowledge, tools, or time to prepare meals, open up new opportunities to develop more upscale convenience and ready-to-eat foods. With so many rural children suffering from malnutrition, there is a high demand for baby foods containing vegetable puree. To meet this demand, key domestic players in the region focus on introducing new products by collaborating with pertinent stakeholders. This will help them advance their R&D initiatives, provide toddlers and young children with nutrient-rich food, and strengthen their distribution network [4, 5].

Additionally, the market now offers healthy yet palatable vegetable mash without compromising its nutrient content and several beverages and condiments thanks to the increased capitalization on technological advancements and research & development centers. Data is gathered at the sector association levels. This information aids in increasing supply chain visibility and control. Accessibility, analysis, and product innovation will all benefit from digitizing these data. Consumer awareness of the benefits of natural, plant-based products for health has significantly increased over the last few years. Veganism is a rapidly growing trend that has swept the world. In addition, fewer fruits and vegetables are associated with a higher risk of developing several chronic diseases. Vegetable mash is thus a practical way to include the health benefits of vegetables in a daily diet. Vegetable puree market growth is aided by consumers' widespread substitution of plant-based foods for meat in their protein diets.

Customers worldwide seek simple, healthier lifestyles to fit their hectic work and daily schedules. However, several factors, such as affordability, availability, convenience, lifestyles, and cultural preferences, influence their food choices, which has boosted the popularity of vegetable mash. Thus, driving the vegetable puree market revenue.

It is also worth noting that vegetable purees have high antioxidant activity, and eating foods with a high content of antioxidants prevents the occurrence of diabetes, kidney diseases, cardiovascular diseases (atherosclerosis, myocardial infarction), tumor and respiratory diseases. Antioxidants slow down or prevent the oxidation of human cells by molecular oxygen. Products containing antioxidants can be recommended for inclusion in the diet of groups of people who are constantly exposed to adverse environmental factors – exposure to exhaust gases, ultraviolet rays, tobacco smoke, radiation activity, and so on [6].

Various raw materials are used in our country and abroad to obtain mashed potatoes with a high content of biologically active substances, but plants with a high content of pectin substances are of particular value in this regard [7]. Despite all the positive aspects of the use of pectin substances, their lack in diets is an urgent problem, which is associated with a decrease in the consumption of vegetables, fruits and berries in their natural form and their processing products [6, 8]. One of the ways to solve this problem is the addition of pectin preparations during the technological process in food products (for example, in the production of bakery and confectionery products, dairy products, etc.) [9] or the development of ready-to-use products with an increased content of pectins [10].

One of the promising products of fruit processing, which can act as components of mashed potatoes, are pasty semi-finished products with an increased content of low-esterified pectins [6, 9]. The most modern way to increase the yield of pectins is the processing of pectin-containing raw materials with enzyme preparations [9, 10].

In connection with the above, the development of puree technology with an increased content of low-esterified pectins and high organoleptic characteristics is relevant. This will significantly enrich a person's diet with biologically active substances, dietary fibers, improve the organoleptic indicators of dishes and the overall quality of food.

Analysis of recent research and publications. Analysis of the technology and composition of traditional purees showed that the products meet the requirements of regulatory documentation in terms of quality indicators, while attention is not focused on biological value. It is significantly reduced by heat treatment, during which the labile biologically active substances of the raw material are destroyed. It should be noted that the range of such purees is limited, so scientists propose new types of fruit purees and technologies for their implementation, while solving the tasks of creating fundamentally new products for preventive purposes, with predicted properties, as well as expanding their range [11].

Among the priority tasks set by scientists, the development of new technologies should be singled out, which involve the use of moderate modes of raw material processing to preserve its native properties as much as possible; blending of various raw materials, which have specific properties in order to complement each other and obtain products with new quality indicators that are fundamentally different from the existing ones; the introduction of ingredients into the composition of the puree, which determine the given properties of the finished product; replacement of components with more valuable in terms of food [12].

However, the fact that the Ukrainian market mostly offers products of foreign production with a long shelf life, which is ensured by introduced artificial preservatives and thermal sterilization, has a negative effect on the preservation of biologically active substances. At the same time, domestically produced purees are almost non-existent, which makes it necessary to continue the search for technologies and to develop recipes for new types of purees that would meet modern quality and safety requirements.

Pumpkin fruits are the most valuable food and dietary product, the source of a rich set of biologically active substances. They contain proteins, pectin, carbohydrates, starch, organic acids, fats, vitamins, mineral salts and other substances useful for the human body. The chemical composition of pumpkin fruits largely depends on various technological methods of cultivation, species and varieties, as well as soil and climatic conditions and other factors.

Pumpkin fruits contain 85–94% water. Carbohydrates (8–12%) are mainly represented by polysaccharides. Of the total amount of sugar (4–8%), some table varieties contain from 11 to 14%, including sucrose up to 8%, especially after autumn and winter storage. Pumpkin fruits contain from 2.5 to 16% of starch, which turns into soluble sugars during storage. Since pumpkin contains a lot of sugars and few organic acids (acidity - 0.8–2.9%), it is widely used in confectionery factories for the production of candies and pastilles.

There is relatively little protein in pumpkins (0.5–1.1%), but they are very rich in pectin (2.6–14.0%), which promotes the removal of cholesterol from the body. The high content of pectin substances makes it possible to consider pumpkin as a promising raw material for the production of gelling materials widely used in confectionery production and in the preparation of sweet dishes. A characteristic feature of pumpkin is its low fiber content (0.3–1.2%), which is easily digested, not fibrous, and easily digestible in pureed form.

Pumpkins are the main source of carotene in the plant world. The content of carotene in pumpkin fruits is 16–17 mg per 100 g of raw product, and in some forms it reaches 35–38 mg. The more brightly colored the pulp of orange-yellow varieties of pumpkin, the more carotenoids it contains. It should be noted that their content increases in the first months of storage in medium- and late-ripening table varieties. Therefore, pumpkins are a valuable raw material for the vitamin industry, which produces carotene concentrates.

The vitamin composition of pumpkins is very diverse. Thiamin (vitamin B1 – 0.04–0.06 mg per 100 g) is found in the fruits, the lack of which causes various disorders of the nervous system, rapid mental and physical fatigue; riboflavin (vitamin B2 – 0.03–0.06 mg), the lack of which causes a violation of appetite, weakness, and a decrease in body weight; tocopherol (vitamin E), the lack of which causes a disorder of the body's sexual functions; nicotinic acid (vitamin PP – 0.4–0.5 mg), the lack of which causes pellagra, as well as ascorbic acid (vitamin C – 10.0–50.0 mg), pantothenic acid (vitamin B3 – 0.2–0.4 mg), pyridoxine (vitamin B6 – 0.11–0.13 mg), folic acid (vitamin B9 – 4–19 µg), methylmethionine (vitamin U – 0.1 mg). Pumpkins also contain vitamin D, which is especially valuable for the children's body, which accelerates the growth of children, helps to better and faster digest coarse food, and increases the vitality of the body.

Pumpkin fruits are rich in mineral salts, especially potassium (170–380 mg per 100 g of raw material), iron (0.4–0.8 mg), calcium (fruits – 25–40 mg, seeds – 51 mg) and phosphorus (fruits – 25 mg, seeds – 1144 mg). Pumpkins also contain salts of sodium (4–14 mg), magnesium (14 mg), copper (0.4–3.5 mg), cobalt (0.16 mg) and other elements. Ash in pumpkins is 0.6–0.8%, fat – 0.08–0.13%, nitrates – 23–255 mg/kg.

We have proposed a resource-saving technology of vegetable and berry semi-finished products based on pureed pumpkin and sea buckthorn fruits, which allows you to extract a product with an increased content of low-esterified pectins. The developed semi-finished product in the form of puree is also recommended for use in the technology of toppings for drinks, cocktails, confectionery, desserts.

The specifics of raw materials and semi-finished products based on pumpkin puree and sea buckthorn fruits with high pectin content require a detailed study of the safety indicators of ready-made purees based on it, since food safety is one of the main priorities in the development of new food products.

Objective of the article is to determine the main indicators of quality and safety of a semi-finished product based on mashed pumpkin and sea buckthorn fruits.

Presentation of the main study material. The specificity of the raw material and the technology of the developed semi-finished product require a detailed study of the safety indicators of ready-made canned mashed potatoes based on it. According to regulatory documentation, during the storage period (up to 90 days in canned form), the product should not undergo processes that will affect the quality properties of the puree. Organoleptic, physicochemical, and microbiological indicators were used to determine changes in the quality of "Amber" puree (dessert and spicy). Quality indicators were determined before and after storage for 90 days. The study of quality indicators of products was carried out using instrumental methods.

In order to obtain objective data on the value of the developed purees, physico-chemical studies were conducted, the results of which are shown in Table 1. It was established (Table 1) that the obtained purees are characterized by a high content of dry soluble substances, which are in an easily digestible form.

Dry substances in puree are represented mainly by pectins, mono- and disaccharides. "Amber" spicy puree is characterized by the lowest content of simple sugars.

Table 1 – Physico-chemical indicators of puree quality (n=3, $\leq 0,05$)

Name of the product	Mass fraction, %			Pectin substances, %	β -carotene, 10^{-3} %
	dry soluble substances	mono- and disaccharides	titrated acids		
Pumpkin puree	18,3	14,9	0,3	4,12	21,33
Purée "Amber" for dessert	22,1	12,8	0,8	5,52	70,15
Spicy "Amber" puree	21,9	5,6	0,8	5,44	68,22

The content of titrated acids, which take part in the formation of aroma and taste, in apple puree is lower than in "Amber" puree by 0.50.. 0.57%, which makes them more valuable. The highest content of them was found in "Amber" dessert puree. The presence of acids is determined by the composition of purees, which in their natural form are characterized by high acidity.

The level of safety of mashed potatoes is characterized by their microbiological and toxicological indicators (tables 2, 3).

Table 2 – Microbiological indicators of puree (n=3, $\leq 0,05$)

Indicator	Acceptable level	Actual value	
		Purée "Amber" for dessert	Spicy "Amber" puree
Amount of mesophilic aerobic and facultatively anaerobic microorganisms, CFU in 1.0 g, no more	$5,0 \times 10^1$	1×10^1	1×10^1
Coli bacteria in dm^3	Not allowed	Not identified	
Lactic acid microorganisms, CFU in 1.0 g	Not allowed	Not identified	
Yeast, CFU in 1.0 g	Not allowed	Not identified	
Mold mushrooms, CFU in 1.0 g	Not more 5,0	1,0	1,0

The investigations carried out showed (Table 4) that coli bacteria, lactic acid microorganisms, yeast in dm^3 and 1.0 g were not detected in the prepared "Burshtynovy" puree; The quantity of

MAFAnM in 1 g is 1×10^1 KUO, mold fungi in 1 g CFU, which does not exceed the established standards.

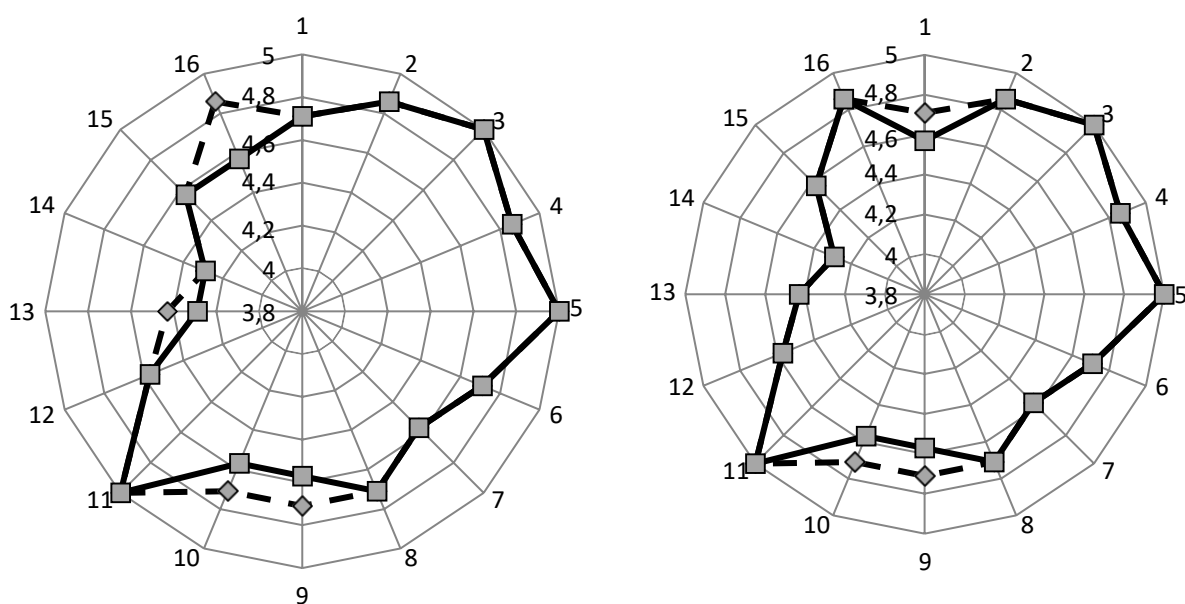
The indicators that are normalized in purees include toxicological elements, as presented in Table 3.

Table 3 – Results of toxicological studies of puree ($n=3, \leq 0,05$)

Indicator	Unit of measurement	Maximum permissible levels, mg/kg, not more than	Actual value, mg/kg	
			Purée "Amber" for dessert	Spicy "Amber" puree
Lead	mg/kg	0,4	$0,15 \pm 0,01$	$0,12 \pm 0,01$
Cadmium	mg/kg	0,03	Not identified	Not identified
Arsenic	mg/kg	0,2	Not identified	Not identified
Mercury	mg/kg	0,02	Not identified	Not identified
Copper	mg/kg	5,0	$1,26 \pm 0,02$	$1,09 \pm 0,02$
Zinc	mg/kg	10,0	$0,53 \pm 0,01$	$0,49 \pm 0,01$

The results of studies of toxicological indicators prove that mashed potatoes made according to the developed recipes meet the requirements of the standards.

To determine the changes in the organoleptic parameters of puree during storage, a sensory evaluation scale was developed, which is presented graphically in the form of separate descriptors on circular organoleptic profiles, where the value of each component of the organoleptic evaluation is marked on a 5-point scale.



Purée "Amber" for dessert

Spicy "Amber" puree

Figure 2 – Organoleptic profiles of puree:

- - - freshly made mashed potatoes; ----- puree after storage

Descriptors:

appearance (1 – homogeneity; 2 – fluidity);

consistency (3 – density; 4 – viscosity);

color (5 – intensity; 6 – purity; 7 – homogeneity; 8 – naturalness);

smell (9 – purity; 10 – expressiveness; 11 – balance);

taste (12 – sweetness; 13 – intensity; 14 – uniformity; 15 – texture; 16 – naturalness)

According to the results of the study (Fig. 2), after 90 days of storage in the dessert puree, a slight decrease in the expressiveness of the smell, as well as the intensity and naturalness of the taste of sea buckthorn, was noted, and in the spicy puree, the smoothness of the surface, gloss and expressiveness of the smell of spices decreased.

Thus, according to the results of physico-chemical, organoleptic, microbiological and toxicological studies, it was established that purees meet the quality and safety requirements. The obtained results will be used in the development of technical conditions for new purees.

Conclusions. The work is based on the main safety indicators of "Ambershtynove" dessert and spicy puree based on pumpkin and sea buckthorn. It was determined that according to microbiological, toxicological and radiological indicators, the developed purees do not exceed the established limit-permissible concentrations and meet the requirements of the standards. Physico-chemical indicators and indicators of biological value indicate that the developed purees have a number of advantages compared to the control (apple puree): the ash content is 4.3-4.4 times higher (due to the increased content of potassium, calcium, magnesium and phosphorus), the content of carotenoids - 1.9-4.6 times, L-ascorbic acid - 13.1 times (dessert puree) and 4.5 times (spicy puree).

Prospects for further research in this direction are the study of changes in the quality and safety indicators of the developed purees during the storage process and substantiation of their storage parameters.

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Мета – визначити основні показники якості та безпеки напівфабрикату на основі пюре гарбуза та плодів обліпихи.

Методи. Відбір проб проводився згідно з вимогами ДСТУ ISO 874-2002, готування проб до лабораторних аналізів – згідно ДСТУ 7040:2009. При дослідженні фізико-хімічних

показників визначалися: вміст сухих речовин у сировині – за ДСТУ ISO 751-2004; масову частку розчинних сухих речовин – рефрактометричним методом за ДСТУ ISO 2173:2007; pH – за ДСТУ 6045:2008; масову частку титрованих кислот (у перерахунку на яблучну кислоту) – за ДСТУ 4957:2008; вміст аскорбінової кислоти – за Плешковим Б.П.; вміст поліфенольних речовин – методом Фоліна-Чокольтеу; мінеральний склад – атомно-абсорбційним методом з використанням хроматографа Z-8000 (Хітачі, Японія). Відбір проб для мікробіологічного аналізу проводився за ГОСТ 26668-85, підготовка проб здійснювалася за ГОСТ 26669-85, культивування мікроорганізмів – за ГОСТ 26670-91. Визначення дріжджів та пліснявих грибів проводилося за ГОСТ 10444.12-88, бактерій групи кишкових паличок за ГОСТ 30518-97, молочнокислих мікроорганізмів за ГОСТ 10444.11-94. Визначення токсичних елементів здійснювалося: кадмію – за ДСТУ ISO 6561:2004, свинцю – за ДСТУ ISO 6633:2001, мми 'яку – за ДСТУ ISO 6634:2004, цинку – за ДСТУ ISO 6636-2:2004, ртуті – за ДСТУ ISO 6637:2001.

Результати. Встановлено, що за мікробіологічними та токсикологічними показниками розроблені пюре не перевищують встановлених гранично-припустимих концентрацій та відповідають вимогам стандартів. Розроблені пюре мають ряд переваг у порівнянні із контролем (пюре гарбузовим) за фізико-хімічними показниками: вміст золи вищий у 4,3-4,4 рази (за рахунок підвищеного вмісту калію, кальцію, магнію та фосфору), вміст каротиноїдів – у 1,9-4,6 разів, пектинів – у 1,4 рази (пюре десертне) та у 1,3 рази (пюре пряне). Після 90 діб зберігання в пюре десертному було відзначено незначне зниження вираженості запаху, а також інтенсивності і натуральності смаку обліпихи, а в пюре пряному знизилася гладкість поверхні, блиск і виразність запаху прянощів.

Ключові слова: пюреподібний напівфабрикат, гарбуз, обліпиха, показники безпеки, показники якості.