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## **ВИЗНАЧЕННЯ ПОКАЗНИКІВ БЕЗПЕЧНОСТІ ЗАМОРОЖЕНОГО ФРУКТОВОГО НАПІВФАБРИКАТУ ДЛЯ ВИРОБНИЦТВА НАПОЮ СМУЗІ**

**Д.М. Одарченко, Є.Б. Соколова, О.Ф. Аксьонова, А.Г. Абабова**

*Наведено результати досліджень показників безпеки замороженого фруктового напівфабрикату для виробництва напою смузі. Установлено, що вміст важких металів, мікотоксинів, нітратів, пестицидів та радіонуклідів не перевищує встановлених нормативів. Розглянуто вплив інгредієнтів на радіозахисні властивості та безпеку замороженого фруктового*

напівфабрикату для виробництва напою смузі. Дослідження показників безпечності напівфабрикату підтверджують його відповідність вимогам державної системи контролю харчових продуктів.

**Ключові слова:** безпечність, токсичні елементи, нітрати, пестициди, радіонукліди, напівфабрикат, смузі.

## **ОПРЕДЕЛЕНИЕ ПОКАЗАТЕЛЕЙ БЕЗОПАСНОСТИ ЗАМОРОЖЕННОГО ФРУКТОВОГО ПОЛУФАБРИКАТА ДЛЯ ПРИГОТОВЛЕНИЯ НАПИТКА СМУЗИ**

**Д.Н. Одарченко, Е.Б. Соколова, Е.Ф. Аксенова, А.Г. Абабова**

*Приведены результаты исследований показателей безопасности замороженного фруктового полуфабриката для приготовления напитка смузи. Установлено, что содержание тяжелых металлов, микотоксинов, нитратов, пестицидов и радионуклидов не превышает установленных нормативов. Рассмотрено влияние ингредиентов на радиозащитные свойства и безопасность замороженного фруктового полуфабриката для приготовления напитка смузи. Исследование показателей безопасности полуфабриката подтверждают его соответствие требованиям государственной системы контроля пищевых продуктов.*

**Ключевые слова:** безопасность, токсичные элементы, нитраты, пестициды, радионуклиды, полуфабрикат, смузи.

## **DETERMINATION OF SAFETY INDICATORS OF FROZEN FRUIT SEMI-FINISHED PRODUCTS FOR THE PRODUCTION OF SMOOTHIES**

**D. Odarchenko, E. Sokolova, O. Aksonova, A. Ababova**

*The actual level of toxic elements content, namely heavy metals, mycotoxins, nitrates, pesticides and radionuclides in dried apples, strawberries, oat flakes is established. And as these indicators are set in fresh and frozen semi-finished products for smoothies made from these ingredients.*

*Investigation of the content of toxins and mycotoxins in fresh samples showed that the content of residual quantities of these indicators does not exceed the established standards. To determine the content of toxic elements and their changes during storage, the studies were carried out immediately after the manufacture of the semi-finished product, and then after 30 days of storage at  $-18 \pm 2$  °C. The study of fresh and frozen fruit semi-finished products confirms their compliance with the requirements of the state system for quality control of food products .*

*Requirements to the maximum permissible concentrations (MPC) of nitrates in semi-finished products for smoothies of similar composition are not available, but comparing the content of nitrates in the product with the requirements for baby food products makes it possible to consider that the product obtained meets even these*

напівфабрикату для виробництва напою смузі. Дослідження показників безпечності напівфабрикату підтверджують його відповідність вимогам державної системи контролю харчових продуктів.

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*Requirements to the maximum permissible concentrations (MPC) of nitrates in semi-finished products for smoothies of similar composition are not available, but comparing the content of nitrates in the product with the requirements for baby food products makes it possible to consider that the product obtained meets even these*

*stringent requirements. So for canned fruit on the basis of MPC is 50 mg / kg, while the resulting semifinished product contains 47 mg / kg. It is noted that smoothies of similar composition contain ascorbic and folic acids, synergism of these vitamins strengthens the body's ability to excrete nitrates.*

*Frozen fruit semi-finished product for the production of smoothie drinks successfully combines those nutrients that reduce the intake of radionuclides into the body and increase the body's resistance to radiation. These substances include apple pectin, which binds radionuclides and prevents their absorption in the intestine, natural antioxidants, which increase the body's resistance to various infections and negative environmental effects.*

*Given the safety indicators, it can be argued that a frozen fruit semi-finished product for the production of a smoothie is safe for the human body.*

**Keywords:** *safety, toxic elements, nitrates, pesticides, radionuclides, semifinished products, smoothies.*

**Statement of the problem.** One of the most important problems of modern society is minimization of negative environmental impact on a person. Pollution of environmental ecology and deformed diet result in illness and decrease of the general resistance of the human body. The rapid development of industry, energy and transport, violation of ecological requirements for environmental protection has led to the fact that in the environment, and as a result, in food and beverages there is a large number of chemical and radioactive substances that are harmful to human health. Harmful substances can enter the food in the form of contaminants and sometimes they are added as food additives, which is associated with production technology [1].

Producers should control not only the finished products, but also ensure the quality and safety of food raw materials at the stages of agricultural production, food pretreatment and processing, their transportation and storage.

At the present stage of development of the Ukrainian society, the issue of quality control and safety of goods is acute. The effectiveness of the state control system for the implementation of safeguards in this area should also be increased. Heavy metals: mercury, cadmium, lead, copper, zinc, nickel, chromium and require the greatest attention from the standpoint of toxicology and sanitation [2]. The detection of the content of toxic elements is becoming an increasingly important and urgent issue for the food industry and the public. In addition, there is a constant growth of nitro compounds of anthropogenic and technogenic origin in the general nitrogen cycle, which leads to an increase in the content of nitrates in products of plant and animal origin and increases the nitrate-nitrite load on the human body [3].

**Review of the latest research and publications.** A common mycotoxin for fruits and vegetables is patulin. Most often it is present in

apples, pears, apricots, peaches, strawberries, red bilberries. The content of patulin in fresh and boiled apples was determined. In fresh apples, the patulin content was 15,7 and 17,8 mg/kg, and after cooking the fruit, the mycotoxin concentration was 13,8 and 15,9 mg/kg. After the heat treatment of apples, the content of mycotoxins decreased compared to fresh ones [4]. Taking into account that mycotoxins, in addition to the general toxicity, have mutagenic, teratogenic and carcinogenic properties, even in very small concentrations, they should be considered as one of the most important problems in the safety of fruit and vegetable products.

A typical diet of the population of most countries of the world includes products with a certain content of nitrates, nitrites and nitrosamines. Vegetables and fruits that naturally contain nitrates and nitrites are considered an important part of healthy eating because of the positive effects on human health, in particular as factors of counteracting cancers [5; 6]. At the same time, nitrates and nitrites are used as food additives in the production of meat products to slow down microbial spoilage, giving an attractive appearance and taste. The authors of [7] suggest that a high level of consumption of such meat products is the cause of the risk of developing gastric cancer, due to the content of nitrates and nitrites. Nitrosamines are products of chemical reactions in which nitrates, nitrites and proteins take part. N-nitrosodimethylamine (NDMA) is one of the nitrosamines most commonly found in foods [8; 9]. NDMA is a powerful carcinogen that can activate the processes of the appearance of malignant tumors in various types of tissues (including the liver, lungs, stomach) [10; 11]. In work [12] it is shown that with a too high consumption of nitrates, a weak but statistically significant reduction in the risk of developing gastric cancer can be associated. While increased consumption of nitrites and nitroso compounds can be considered a risk factor for cancer. Nitrates accumulate mainly in roots, root crops, stems, much less in fruits [13]. The content of nitrates in products of vegetable origin, namely red pepper, radish, strawberry, cucumber, cabbage was determined. It is determined that the content of nitrate ions exceeds the maximum permissible standards by 2,5 times in radish roots, 2 times in strawberry fruits, which indicates that these products are unfit for consumption [14].

The actual level of the content of toxic elements, nitrates, pesticides, mycotoxins, radionuclides in vegetable and fruit raw materials is grown, which is grown in the western and southern regions of Ukraine. It is established that the content of nitrates in fruits is in the range from 17 to 70 mg/kg, in some fruits (apples, pears) the content of nitrates exceeds the allowable level by almost 20%. It should also be noted that in the skin of

fruit, the content of nitrates exceeds their allowable level in comparison with the flesh, by 10–30% [15].

**The objective of the article** – the determination of safety indicators, namely, the actual level of toxic elements, namely heavy metals, mycotoxins, nitrates, pesticides and radionuclides in dried apples, strawberries, oat flakes and fresh and frozen semi-finished products for smoothies.

**Presentation of the research.** The following safety criteria are determined: the content of toxic elements, nitrates, pesticides, mycotoxins and radionuclides in fruit raw materials, which is grown in Ukraine. The object of the study was a strawberry of the middle early variety "Dukat", dried apples "Borovinka" and oatmeal flakes "Hercules".

The content of residual amounts of toxic elements was determined by the following methods:

1. Mercury – atomic absorption method according to State industry standart (Sit) 26927-86.

2. Arsenic – by colorimetric method according to State industry standart (Sit) 26930-86.

3. Copper – colorimetric method according to State industry standart (Sit) 26931-86.

4. Lead – polarographic method according to State industry standart (Sit) 26932-86.

5. Cadmium – polarographic method according to State industry standart (Sit) 26933-86.

6. Zinc – polarographic method according to State industry standart (Sit) 26934-86.

The content of residual amounts of nitrates was determined by the ionometric method in accordance with GOST 29270-95, and the content of radionuclides by mass spectrometry.

Fresh samples for research were prepared as follows: strawberries were inspected, miles, peeled from the peduncle, dried apples, and blanched in boiling water for 3 to 5 minutes, and the oat flakes were ground. Frozen fruit semi-finished product for the production of a smoothie drink was prepared as follows, dried apples washed, blanched in boiling water for 3–5 minutes. The fruits of strawberries were checked, washed, cleaned from the stem. Sugar and oat flakes were added. The prepared components were mechanically crushed to particles of  $38.114 \cdot 10^{-5}$  m. The obtained mixture was immediately packed into polymeric containers immediately after grinding and frozen to  $-18 \pm 2^\circ\text{C}$ .

To determine the content of toxic elements and its changes during storage, the studies were carried out immediately after manufacture, and then after 30 days of storage at a temperature of  $-18 \pm 2^\circ\text{C}$ .

Table 1 shows the results of an investigation of the content of toxins and mycotoxins in fresh samples.

Table 1

**The content of toxins and mycotoxins in fresh strawberry, dried apples and oatmeal flakes**

Indicator	Permissible levels not more than, (mg/kg)	Actual content not more than (mg/kg)		
		Strawberries	Dried apples	Oat flakes
Toxic elements:				
lead	0,4	0,2	0,1	0,2
cadmium	0,03	0,003	0,002	0,004
arsenic	0,2	not found	not found	not found
mercury	0,02	not found	not found	not found
copper	5,0	0,25	0,26	–
zinc	10,0	0,78	0,94	–
Mycotoxins:				
patulin	0,05	not found	not found	not found
ochratoxin A.	0,0005	not found	not found	not found

Investigation of the content of toxins and mycotoxins in fresh samples showed that the content of residual quantities of these indicators does not exceed the established standards. Table 2 shows the results of studies on the content of toxins and mycotoxins during storage for 30 days in freshly prepared and frozen fruit semi-finished products for the production of a smoothies beverage.

Table 2

**The content of toxins and mycotoxins in fresh and frozen fruit semi-finished products for the production of smoothies**

Indicator	Permissible levels not more than, (mg/kg)	Actual content not more than (mg/kg)	
		Fresh semi-finished product	Frozen semi-finished product
1	2	3	4
Toxic elements:			
lead	0,4	0,2	0,2

Continuation of table 2

1	2	3	4
cadmium	0,03	0,003	0,003
arsenic	0,2	not found	not found
mercury	0,02	not found	not found
copper	5,0	0,26	0,26
zinc	10,0	0,95	0,95
Mycotoxins:			
patulin	0,05	not found	not found
ochratoxin A.	0,0005	not found	not found

According to the results of the study, the content of toxic elements does not exceed permissible levels, both in fresh and in frozen fruit semi-finished, which was stored for 30 days. Thus, the study of the content of toxins and mycotoxins in fresh and frozen fruit semi-finished products confirms their compliance with the requirements of the state system of food quality control.

Table 3 presents the results of research on the content of nitrates and pesticides in fresh samples.

Table 3

### Research on the content of nitrates and pesticides in fresh samples

Indicator	Permissible level of daily norm, mg/kg, no more	Actual content not more than (mg/kg)		
		Strawberries	Dried apples	Oat flakes
Nitrates	300–325	100	18	400
Pesticides: hexachlorocyclohexane	0,05	not found	not found	not found

Table 4

### Research on the content of nitrates and pesticides in fresh semi-finished product and frozen semi-finished product

Indicator	Permissible level of daily norm, mg/kg, no more	Actual content not more than (mg/kg)	
		Fresh semi-finished product	Frozen semi-finished product
Nitrates	300–325	47	47
Pesticides	0,05	not found	not found



The UN FAO Commission has set a maximum permissible concentration (MPC) for nitrate consumption by humans. This figure should be no more than 500 mg per day. In the CIS countries for an adult, the daily allowable dose of nitrates is 300–325 mg. For children, it is determined at a rate of 5 mg per 1 kg of body weight. In Switzerland, safe for children is a norm of 400 mg/kg, in Germany – 250, in France and Belgium – 50. In many developed countries, there are no restrictions on "vegetable" nitrates, but in some countries, the total limit is set at no more than 3,500 mg / kg for any vegetables. In the EU countries, the standards are set only for deciduous and salad vegetables (up to 3000–2500 mg/kg) and for baby food, to which the requirements are more tough – 200 mg/kg. In the European Union, the rules for the content of nitrates in vegetable products are regulated by the EC Regulation No. 1258/2011. According to this document, the maximum amount of nitrates in spinach, swamp and leafy salad, in a crispy salad (iceberg type), in a broomstick is set. In cucumbers, tomatoes, green onions, watermelons, melons and other vegetables and melons, the content of nitrates in the European Union is not limited [16].

There are no requirements for (MPC) nitrates in semifinished products for a similar composition, but comparing the results on the content of nitrates with the requirements for infant food products allows us to assume that the product received meets even these stringent requirements. So for canned fruit-based MPC is 50 mg/kg, while the half-finished product contains 47 mg/kg.

In addition, it should be noted that products of this composition contain ascorbic and folic acid, since the presence of these vitamins is proved for apples and strawberries [17]. According to literary data, the synergism of these vitamins increases the body's ability to excrete nitrates [18].

To date, the issue of contamination of food products and raw materials with radioactive substances is acute. Radioisotopes (radionuclides) with a prolonged half-life, strontium-90 and cesium-137, are the most dangerous for humans. The content of radionuclides in food is regulated by state hygiene standards [19]. Table 5 shows the results of the study of the content of radionuclides in the samples.

Table 5

**The content of radionuclides in investigated samples**

Sample	Acceptable levels, Bq/kg, no more		Actual content, Bq/kg, no more	
	<sup>137</sup> Cs	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>90</sup> Sr
1	2	3	4	5
Strawberries	70	10	2,0	3,0
Dried apples	240	40	16,0	5,0
Oat flakes	60	-	10,0	-
Fresh semi-finished product	70	10	30,0	5,0
Frozen semi-finished product	70	10	30,0	5,0

Frozen fruit semi-finished product for the production of smoothie drinks successfully combines those nutrients that reduce the intake of radionuclides into the body and increase the body's resistance to radiation. These substances include apple pectin, which binds radionuclides and prevents their absorption in the intestine [20]. Oat flakes contain a lot of natural antioxidants - substances that increase the body's resistance to various infections and negative effects of the environment. Also smoothies of similar composition contain a large amount of potassium and calcium, which are antagonists of radioactive cesium and strontium.

**Conclusions.** The content of heavy metals, mycotoxins, nitrates, pesticides and radionuclides is determined. It is shown that the residual concentrations for all parameters in all samples do not exceed the established standards. During the storage of fruit semi-finished product for the production of smoothie drink for 30 days the content of toxic elements and radionuclides practically did not change and corresponds to the permissible level. Given the safety indicators, it can be argued that the frozen fruit semi-finished product is safe for the human body and can be recommended for baby food. In addition, the radioprotective properties of the ingredients reduce the threat of the deposition of radionuclides in the human body.

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## **ОЦІНЮВАННЯ КОНКУРЕНТОСПРОМОЖНОСТІ БОРОШНЯНОГО КОНДИТЕРСЬКОГО ВИРОБУ «БУЛЬБАШКА»**

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*Наведено розрахунок перспективної конкурентоспроможності борошняного кондитерського виробу «Булбашка», який оцінювали за методикою моделювання. За результатами розрахунку показника конкурентоспроможності встановлено, що мафін «Булбашка» з високим вмістом глютину і вираженими біопротекторними властивостями буде конкурентоспроможним на споживчому ринку України за рахунок поліпшення органолептичних показників і підвищення харчової та біологічної цінності.*

**Ключові слова:** конкурентоспроможність, показники якості, мафін, біопротекторні властивості.

## **ОЦЕНКА КОНКУРЕНТОСПОСОБНОСТИ МУЧНОГО КОНДИТЕРСКОГО ИЗДЕЛИЯ «БУЛЬБАШКА»**

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*Приведен расчет перспективной конкурентоспособности мучного кондитерского изделия «Булбашка», который оценивали по методике моделирования. По результатам расчета показателя конкурентоспособности установлено, что маффин «Булбашка» с высоким содержанием глютина*