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ASSESSMENT OF QUALITY INDICATORS IN THE TECHNOLOGY OF BLENDED JUICES FROM THE FRUITS AND BERRIES OF PUMPKIN, QUINCE, ROSE HIPS, AND PERSIMMON

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The fruits and berries of pumpkin, quince, persimmon, and rose hips, widely distributed in most regions of Azerbaijan, are environmentally friendly food produce. Their composition is rich in nutritional components beneficial to the human body.

The objects of the study were the fruits and berries of ecologically clean varieties of pumpkin, widespread in Azerbaijan: Palov-Kodu-268, Perexvatka-69; Yellow quince; Xiakume persimmon; and rose hips. During the study, a variety of juices were prepared that are beneficial for the human body, rich in nutritional components for functional purposes, natural, without additives, by mixing (blending) pumpkin juice with the juice of quince, rose hips, and persimmons separately. To achieve the goal, quality indicators were studied in the production technology of juices from pumpkin, quince, and persimmon fruits in a ratio of 50:30:20; juices from pumpkin, rosehip, and quince fruits, 50:30:20; juices from fruits and berries of pumpkin, rosehip, persimmon, 50:30:20.

As a result of the study, it was established that natural juices prepared by blending fruits and berries are of high quality and nutritional value. These fruit juices contained large amounts of aliphatic organic acids and vitamin C. However, juices prepared from a mixture of fruits and berries contain less total sugar than individual juices, including glucose and fructose. Therefore, they are recommended to be used as a functional, dietary juice in the treatment of certain diseases (diabetes, etc.).

As a result of the tasting, it was found that juices prepared from fruits and berries were rated at 7.8÷8.5 points. However, natural juices without chemical additives, prepared by blending using a special technology, are estimated at 9.2÷9.8 points.

The recommendations reported here could be used by small and medium-sized juice production enterprises

Keywords: quality indicators of fruits and berries, pumpkin, quince, persimmon, rose hips, blended juices

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1. Introduction

Providing people with environmentally friendly food products to solve the problem of food safety is one of the most pressing tasks of our time [1]. From this point of view, the fruits and berries of pumpkin, quince, persimmon, and rose hips, which are widespread in most regions of the country, are environmentally friendly food products. Their composition is rich in simple sugars, easily digestible by the human body, vitamins, organic acids, phenolic compounds, minerals, and other nutritional components beneficial to the human body [2].

The Republic of Azerbaijan has favorable soil and climatic conditions for planting and growing pumpkin, quince, persimmon, and rose hips. When growing and maturing these products, virtually no chemicals are used [3]. Pumpkin, quince, and persimmon fruits are not only environmentally friendly but also widely distributed near the place of residence of the population [4].

Rosehip is a high-quality food product found in the mountains, foothills, and along the banks of rivers in Azerbaijan. Rosehip juice regulates metabolism and increases the body's resistance. Owing to vitamin C, rosehip juice helps a person get stronger after an illness and increases

performance. In addition, vitamins B2, K, P, A help stop inflammatory processes in the stomach, heal ulcers, burns, and wounds [5].

Pumpkin is an agricultural product rich in useful components, has a high content of pectin, biologically active substances, beta-carotene, vitamin A, tocopherol, and other vitamins. High levels of dietary fiber, particularly pectin, can help regulate insulin levels and lower blood sugar levels. It can also improve glucose tolerance and provide protection against various diseases such as diabetes, cardiovascular disease, constipation, and colon cancer [6].

Pumpkin contains 2.4±0.10 % sugar, 0.26±0.09 vitamin C, 0.50±0.08 % carotenoid by wet weight. In addition, pumpkin carotene has antioxidant properties that can neutralize free radicals and prevent the development of malignant tumors. Therefore, the addition of pumpkin processing products will help fortify the products with useful components [6].

From the literature [7] and research work, it has become clear that although the content of pumpkin is rich in β-carotene and other nutritional components, it is not so rich in simple sugars, organic acids, phenolic compounds, and even vitamin C, which are important for the human body.

Quince, which is often called a false apple due to its external resemblance to the fruits of an apple tree, is rarely eaten in its natural form due to its astringency and hardness. Quince contains much more antioxidants and phenolic compounds than other fruits, in particular apples. The flavonoids contained in quince juice effectively protect cells from oxidation and damage, from premature aging and chronic diseases of the body [8]. Quince is rich in aliphatic acids (malic, succinic, citric, etc.), and rose hips are rich in minerals, mainly vitamin C.

Persimmon has a high immune defense system, it is not damaged by diseases and microorganisms, and is more resistant to spoilage. Frost resistance of persimmon, especially oriental one, is higher than that of most other subtropical crops [9]. Persimmon fruits are rich in simple sugars, phenos lic compounds, and iodine.

One of the reasons for the limited consumption of persimmon fruits or juice is their seasonality and unimproved storage methods [10].

Thus, pumpkin, persimmon, rose hips, and quince are valuable raw materials for the development of functional food products. In this regard, the study of quality indicators of juices from fruits and berries of pumpkin, quince, rose hips, and persimmon using the blending method is a relevant topic.

2. Literature review and problem statement

Pumpkin-containing semi-finished products are widely used in the technology of flour products. Usually, preference is given to fruit and vegetable flour. This is due to the easier storage and use of such a product when formulating products. However, the cost of drying pumpkin is significantly higher compared to pumpkin paste production [11].

Not everyone has fruits and vegetables in their food rations. Therefore, with a high degree of probability we can say that there is a lack of nutrients in peoples' bodies, which eventually leads to illness. A study was conducted on the method of obtaining persimmon syrup of the "Hyakume" variety, mixtures of wheat flour and persimmon syrup, and bread with the addition of persimmon syrup [12].

Rosehip juice is a storehouse of vitamins. Rose hips contain 4–6 % ascorbic acid, up to 18 mg % carotene, vitamins B2, P, K, PP, E. The berries contain organic acids (malic, citric, oleic, linoleic), iron salts, manganese, phosphorus, magnesium , calcium, coloring and tannins, essential oil, flavonoids, pectin, up to 3 % tannins, up to 14 % sugars. It also contains rare elements such as molybdenum, copper, and zinc. Rosehip juice has multivitamin properties, is a choleretic and diuretic, anti-inflammatory and regulating agent in the gastrointestinal tract. It also lowers cholesterol in the blood, slows down the deposition of fat-like masses in blood vessels, reduces the permeability and fragility of capillaries, improves the use of vitamin C by the body, increases the body's overall resistance, and improves vision. Rosehip juice is used as a means of increasing the body's resistance in the fight against intoxication in diseases such as scarlet fever, diphtheria, pneumonia, whooping cough, accelerating the treatment of wounds, and bone healing in fractures [13].

Thus, persimmon fruits are rich in organic and inorganic substances beneficial to the human body, mainly simple sugars, iodine, and some representatives of phenolic compounds. Persimmon fruits and their processed products should be included in the daily human diet. Analysis of literature data confirms that the nutritional value of persimmon and its processed products has been sufficiently studied [14].

One of the reasons for the limited consumption of persimmon fruits or juice is their seasonality and unimproved storage methods. Data from paper [8] make it possible to regulate the quality indicators of persimmon varieties depending on their storage conditions and use them to provide people with fresh fruit not seasonally, but for a long time.

Article [15] examines the effect of different quantities and shapes of freshly chopped pumpkin on the culinary quality of the cake. A change in the culinary qualities of the cupcake has been established depending on the amount of chopped pumpkin. It was found that the color of the surface and crumb of the cake depended on the amount of freshly cut pumpkin. The shape of the slice did not change these parameters of the cake.

According to [16], pumpkins are the fruit of different species of the genus *Cucurbita* and are an important source of carotenoids. β-carotene is the major carotenoid in most species, with concentrations greater than 70 μg/g, and other important carotenoids have been noted. Variations in the carotenoid content of pumpkin occur even within the same species or variety, depending on growing conditions, stage of ripening, and harvesting and post-harvest processing.

The quince fruit (*Cydonia oblonga*), a member of the *Rosaceae* family, has been studied for decades for its unique value in food and medicine. This fruit is rich in vitamins, minerals, as well as fiber, pectin, and tannins. Quince is known for its numerous therapeutic effects, including antioxidant, anti-inflammatory, antimicrobial, antiulcer and anticancer effects. However, this fruit is underutilized at the food industry level due to its sensory properties and limited understanding of its benefits by both farmers and consumers [17].

In the production of various types of functional juices from pumpkin, rose hip juice is also important. From literary materials [18] and the results of research work, it was established that, compared to other fruits, the content of vitamin C in rose hips is higher. Along with other vitamins, human health and longevity also depend on vitamins.

Unlike pumpkin, quince juice contains a lot of vitamin C, fructose, and phenolic compounds. The amount of β-carotene in yellow quince is less than in pumpkin juice [19].

Fruit juices should also be rich in minerals. So, when the human body lacks minerals, the metabolic process is disrupted. Minerals in the human body are used in the synthesis of proteins, enzymes, hormones, vitamins, etc. [20].

However, no data have been identified in the literature on the technology for obtaining juices by blending pumpkin, quince, persimmon, and rose hips. In addition, no research has been carried out on the technology of obtaining juices by blending these fruits or berries. Therefore, to further justify the technology using the blending technique, it is necessary to improve this technology.

In order to evaluate the quality indicators in the technology of blended juices, we first obtained them using a new technology and then evaluated them. We also noted the importance of the composition of these juices from the point of view of public health since they are environmentally friendly, have a purely functional purpose, and do not contain additives. They are used in therapeutic nutrition for almost all diseases.

3. The aim and objectives of the study

The purpose of this study is to assess quality indicators in the production technology of blended juices from the fruits and berries of pumpkin, quince, rose hips, and persimmons. This will make it possible to produce functional juices that do not contain additives and are rich in nutritional components.

To achieve the goal, the following tasks were set:

– to study quality indicators in the production technology of blended juices from pumpkin, quince, and persimmon fruits;

– to study quality indicators in the production technology of blended juices from pumpkin, quince, and rose hips;

– to study quality indicators in the production technology of blended juices from the fruits and berries of pumpkin, rose hips, and persimmons.

4. The study materials and methods

4. 1. The object and hypothesis of the study

The object of our study was the ecologically clean varieties of pumpkin, widely distributed in Azerbaijan, Palov-Kodu-268, Perexvatka-69, Yellow quince, Xiakume persimmon, and rose hips. Using them, juices with and without pulp were prepared using various technologies.

The hypothesis of the study assumed that the nutritional value and quality indicators of juices prepared using a new technology from a joint mixture with and without pulp of juices prepared from fruits and berries Perexvatka-69, Palov-Kodu-268, quince, persimmon, rose hips were assessed by 9.5÷9.8 points.

4. 2. Research methods

During the study, the following quality indicators were quantitatively determined in fruits and berries, as well as juices: β-carotene, total sugar, vitamin C, glucose, fructose, sucrose, starch, pectin substances, cellulose, phenolic compounds [21–23].

Quantitative determination of minerals in juices from pumpkin (Palov-Kodu-268, Perexvatka-69), Yellow quince, rose hips, persimmon variety (Hyakume), as well as organic acids was carried out in Analyst 400 (Perkin-Elmer, USA) [22, 23].

Quantitative determination of phenolic compounds in prepared juices with and without pulp was carried out using the chromo-mass spectrometry method, which is a modern analytical method [24]. The prepared juices were tasted according to the generally accepted procedure [20]; 7 tasters participated.

The following techniques for preparing blends/juices were used:

– Technique 1. First, juices with and without pulp were prepared using pumpkin fruits of the Perexvatka-69 variety, Yellow quince, and Hyakume persimmon. Using the technology described in [2], a new type of blended juice was prepared from a mixed mixture of 50 % pumpkin, 30 % quince, and 20 % natural persimmon juice.

A comparative analysis of quantitative changes in β-carotene, total sugar, vitamin C, glucose, fructose, cellulose, and pectin substances in juices prepared with and without pulp, as well as by the blending method, was carried out. In addition, the amount of minerals and organic acids in juices with and without pulp was determined using an Analyst 400 atomic adsorption spectrometer (Perkin-Elmer, USA) [23]. The prepared juices were tasted using a 10-point system to determine the optimal option [20].

The developed 10-point scale was divided into 5 main indicators, for which the following points were allocated: transparency – 0.5; color – 0.5; aroma (smell) – 3; taste – 5, and typicality – 1 (Table 1).

Table 1

Tasting quince juice on a 10-point scale, in points

Tasters, persons	Indicator					Total
	Transparency	Color	Aroma	Taste	Typicality	
Taster 1	0,5	0,4	2,6	4,7	0,8	9,0
Taster 2	0,4	0,2	2,9	4,3	0,9	8,7
Taster 3	0,3	0,4	2,5	4,2	0,5	7,9
Taster 4	0,5	0,5	2,7	4,4	0,6	8,7
Taster 5	0,2	0,3	2,5	4,6	1,0	8,6
Taster 6	0,5	0,1	2,9	4,8	0,6	8,9
Taster 7	0,4	0,2	2,1	4,5	0,5	7,7
Average	0,4	0,3	2,6	4,5	0,7	8,5

– Technique 2. The study found that pumpkin juice is not that rich in nutrients. Thus, it contains trace amounts of vitamin C, organic acids, and phenolic compounds important for the human body. To further fortify pumpkin juice with nutrients, mixing it with rosehip and quince juices was studied. Unlike pumpkin, rosehip juice is rich in vitamin C and phenolic compounds, and quince juice is rich in organic acids (malic, citric, oxalic, etc.). Therefore, 50 % of the total pumpkin juice is mixed, 30 % with rosehip juice and 20 % with quince juice. The research methodology, the quantitative determination of organic and inorganic substances in the finished juices were carried out according to the rule given in [23], and the assessment of organoleptic indicators was carried out by tasting;

– Technique 3. Pumpkin of the Palov-kodu 268 variety, rose hips, and Hyakume persimmon were used as the object

of study for the production of sweet juice. During processing, the blended juice was prepared using 50 % pumpkin juice with pulp, 30 % natural rose hips, and 20 % natural persimmon juice. Quantitative changes in β-carotene, vitamin C, total sugar, as well as glucose and fructose, starch, pectin, and fiber in prepared juices were studied. In addition, the quantitative change in phenolic compounds, organic acids and minerals in juices was determined by the atomic adsorption method using Analyst 400 (Perkin Elmer, USA) applying chromatography-mass spectrometry [24]. The juices were tasted and rated on a 10-point scale.

During processing, fully ripe fruits of the pumpkin variety were used, as well as rose hips and persimmons. The development of technology for the production of pumpkin juice with pulp was carried out as follows. First of all, pumpkin, rose hips, and persimmons were cleaned of foreign impurities, sorted, and washed with clean drinking water. The washed pumpkin was cut into pieces, separated from the stalks. Then the chopped pumpkin parts were sent for blanching. Here the crushed parts of the pumpkin were stewed to a temperature of 85÷95 °C. During boiling, 5÷10 % of the mass volume of pure water was added. The boiling process was carried out for 10–15 minutes. Then the resulting mass was transferred to the rubbing unit. The stewed mass was passed through machines with 3 rubbings, in which the diameter of the sieve holes was 0.5÷0.7 mm. Then the grated juice with pulp (without peel) was mixed well, homogenized, placed in special containers, and sterilized by heating.

Rosehips and persimmons, after separate cleaning, were processed using a hot technique. In it, 5÷10 % pure water was added to the mixture (juice with pulp). The juice and pulp were then mixed well. The pulp with juice was pressed hot and separated from the juice. Then the juice was cooled to a temperature of 0 °C. The opaque juice was allowed to rest, separated from the sediment, clarified with 1÷2 % bentonite. Clarified juices of rose hips and persimmons were filtered, kept at a temperature of 0÷1 °C, then sterilized at a temperature of 105 °C. Prepared blended juices of pumpkin with pulp, rose hips, and persimmons were mixed in a ratio of 50:30:20, homogenized, and sterilized. Finished products are packaged and stored in warehouses until they are sold.

Table 2

Quality indicators of juices with pulp from pumpkin, quince, and persimmon fruits and their mixtures using the blending method [21]

No.	Indicator	Juice with pulp		Juice	Juice prepared by blending method
		Peraxvatka 69	Quince	Persimmon	
1	β-carotene, mg/100 cm^3	1,8	0,7	1,6	1,43
2	Vitamin C, mg/100 cm^3	7,0	21,5	9,4	11,83
3	Total sugar	5,2	6,8	20,8	8,80
Monosaccharides, g/100 cm^3					
4	Glucose	2,6	1,8	8,0	3,44
5	Fructose	0,9	4,3	9,4	3,62
Дисахарид, г/100 см^3					
6	Sucrose	0,5	0,6	0,2	0,47
Polysaccharides, g/100 cm^3					
7	Starch	0,3	0,4	–	0,27
8	Pectic compounds	0,4	0,5	0,32	0,41
9	Cellulose	1,2	0,9	0,28	0,93
10	Phenolic compounds, g/100 cm^3	0,23	0,65	0,86	0,48
11	Tasting assessment, score	8,2	8,5	8,4	9,6

5. Results of investigating quality indicators of juices from fruits and berries of pumpkin, quince, rose hips, persimmon prepared by a blending method

5. 1. Study of quality indicators in the production technology of juices from pumpkin, quince, and persimmon fruits

During processing, fully ripened pumpkin, quince, and persimmon fruits were used. Tables 2–4 give the main indicators of the quality of juice prepared by the blending method.

To quantify the quality indicators of juice prepared by blending pumpkin, quince, and persimmon fruits, the following formula was used. The quality indicators of juice prepared by blending using vitamin C as an example are calculated as follows:

$$\overline{x} = \frac{m_1 \cdot x_1 + m_2 \cdot x_2 + m_3 \cdot x_3}{M} = \frac{50 \times 7{,}0 + 30 \times 21{,}5 + 20 \times 9{,}4}{100} = 11{,}83\ mg/100\ cm^3,$$

where M is the total concentration of the mixture; 100 %:

m_1 – concentration of the first component in the mixture; (pumpkin juice with pulp – 50 %);

m_2 – concentration of the second component in the mixture; (Yellow quince juice with pulp – 30 %);

m_3 – concentration of the third component in the mixture (persimmon juice – 20 %);

x_1 – value of the quality indicator of the first component; (7.0 mg/100 cm^3);

x_2 – value of the quality indicator of the second component. (21.5 mg/100 cm^3);

x_3 – quality indicator value of the third component (9.4 mg/100 cm^3);

$\overline{x}$ – amount of vitamin C in blended juice.

The mineral content of pumpkin, quince, and persimmon juices is given in Table 3.

Minerals are involved in the metabolism of the human body [25]. Thus, they participate in the biosynthesis of proteins, enzymes, hormones, and others. The lack of minerals in the human body is the cause of various unpleasant complications. Therefore, the presence of minerals in food products, including juices, is important.

The values of organic acids in pumpkin, quince and persimmon juices are given in Table 4.

Table 3

Mineral content of pumpkin, quince and persimmon juices, mg/100 cm^3

No.	Mineral substance	Juice with pulp		Juice	Juice prepared by blending method
		Peraxvatka 69	Quince	Persimmon	
1	Potassium	505,9	307,5	536,4	452,48
2	Sodium	17,9	12,5	18,6	16,42
3	Magnesium	460,8	142,8	450,4	363,32
4	Iron	15,92	21	11,8	16,62
5	Copper	5,49	12,45	3,4	7,16
6	Zinc	8,58	8,4	1,5	7,11
7	Iodine	–	–	2,4	0,48

Note: iodine content is measured in μg/100 cm^3

Table 4

Organic acids of pumpkin, quince, and persimmon juices, g/100 cm^3

No.	Organic acids	Juice with pulp		Juice	Juice prepared by blending method
		Peraxvatka 69	Quince	Persimmon	
1	L-malic acid	0,08	4,58	0,07	1,43
2	D-malic acid	0,02	0,49	0,01	0,16
3	Oxalic acid	traces	0,125	traces	0,04
4	Wine acid	–	0,035	–	0,01
5	Citric acid	traces	0,078	0,01	0,03
6	Lactic acid	–	0,08	–	0,02
7	Total acidity	0,1	5,4	0,09	1,7

At the final stage of the study, it was found that the blended juice has a light straw color, a pleasant aroma, a slight astringent property and a harmonious taste. During tasting, the blended juice was rated 9.6 points (for clarity, color, aroma/smell, taste, and typicality).

5. 2. Study of quality indicators in the production technology of juices from pumpkin, quince, and rose hips

The quality indicators of juices prepared from the studied pumpkin, rosehip, quince, and their mixture by blending are given in Tables 5–7.

Organic acids from pumpkin, rose hip, and quince juices are given in Table 6.

The mineral content of pumpkin, rosehip, and quince juices is given in Table 7.

Table 7 demonstrates that no iodine was found in pumpkin and rosehip juice. It has been established that quince juice contains 2.4 μg/100 cm^3 of iodine. It is known that in the absence of iodine in the human body, the synthesis of certain hormones, including thyroxine, is disrupted. The result is a disease called goiter. In order for people to live healthy, it is important to have minerals, including iodine, in their daily diet along with organic compounds.

Table 5

Quality indicators of juices prepared from the studied pumpkin, rosehip, quince, and their mixture by blending [20]

No.	Indicator	Juice with pulp	Juice	Juice with pulp	Juice prepared by blending method
		Peraxvatka 69	Rose hip	Quince	
1	β-carotene, mg/100 cm^3	1,8	2,7	0,7	1,85
2	Vitamin C, mg/100 cm^3	7,0	620	21,5	193,8
3	Total sugar	5,2	6,2	6,8	5,82
Monosaccharides, g/100 cm^3					
4	Glucose	2,6	1,8	1,8	2,2
5	Fructose	0,9	4,1	4,3	2,54
Disaccharide, g/100 cm^3					
6	Sucrose	0,5	0,3	0,6	0,46
Polysaccharides, g/100 cm^3					
7	Starch	0,3	–	0,4	0,23
8	Pectic compounds	0,4	0,32	0,5	0,4
9	Cellulose	1,2	0,25	0,9	0,86
10	Phenolic compounds, g/100 cm^3	0,23	0,78	0,65	0,48
11	Tasting assessment, score	8,2	8,1	8,5	9,5

Table 6

Organic acids from pumpkin, rose hip and quince juices, g/100 cm^3

No.	Organic acids	Juice with pulp	Juice	Juice with pulp	Juice prepared by blending method
		Peraxvatka 69	Rose hip	Quince	
1	L-malic acid	0,08	0,05	4,58	1,11
2	D-malic acid	0,02	0,11	0,49	0,14
3	Oxalic acid	traces	1,2	0,125	0,39
4	Tartaric acid	–	–	0,035	0,007
5	Citric acid	traces	1,8	0,078	0,56
6	Lactic acid	–	0,06	0,08	0,034
7	Total acidity	0,1	3,22	5,388	2,241

Table 7

Minerals of pumpkin, rosehip, and quince juices, mg/100 cm^3

No.	Mineral	Juice with pulp	Juice	Juice with pulp	Juice prepared by blending method
		Peraxvatka 69	Rose hip	Quince	
1	Potassium	505,9	528,4	307,5	472,97
2	Sodium	17,9	12,5	12,5	15,2
3	Magnesium	460,8	420,3	142,8	385,05
4	Iron	15,92	9,8	21	15,1
5	Copper	5,49	3,4	12,45	6,26
6	Zinc	8,58	7,6	8,4	8,25
7	Iodine	–	–	2,4	0,48

Note: iodine content is measured in μg/100 cm^3

5. 3. Study of quality indicators in the production technology of juices from fruits and berries of pumpkin, rose hips, and persimmons

The main quality indicators of juice prepared by the blending method are given in Tables 8–10.

Table 8

Quality indicators of juices from fruits and berries of pumpkin, rose hips, persimmons and their mixtures using the blending method [20]

No.	Indicator	Juice with pulp	Juice		Juice prepared by blending method
		Palov-Kodu 268	Rose hip	Persimmon	
1	β-carotene, mg/100 cm^3	2,0	2,7	1,6	2,13
2	Vitamin C, mg/100 cm^3	8,0	620	9,4	191,88
3	Total sugar	5,4	6,2	20,8	8,72
Monosaccharides, g/100 cm^3					
4	Glucose	2,4	1,8	8,0	3,34
5	Fructose	1,1	3,1	9,4	3,36
Disaccharide, g/100 cm^3					
6	Sucrose	0,7	0,3	0,2	0,48
Polysaccharides, g/100 cm^3					
7	Starch	0,2	–	–	0,1
8	Pectic compounds	0,3	0,35	0,32	0,32
9	Cellulose	1,6	0,25	0,28	0,93
10	Phenolic compounds, g/100 cm^3	0,18	0,78	0,86	0,50
11	Tasting assessment, score	7,8	8,1	8,4	9,8

Values in Table 8 show that pumpkin juice is rich in β-carotene. It is known that β-carotene is a substitute for vitamin A. When the human body lacks this vitamin, complications arise: vision deteriorates, fatigue quickly sets in, etc.

The content of organic acids in juices from fruits and berries of pumpkin, rose hips, and persimmons is given in Table 9.

Table 9

Organic acids of juices from fruits and berries of pumpkin, rosehip, persimmon, g/100 cm^3

No.	Organic acids	Juice with pulp	Juice		Juice prepared by blending method
		Palov-Kodu-268	Rose hip	Persimmon	
1	L-malic acid	0,06	0,05	0,07	0,06
2	D-malic acid	0,01	0,11	0,01	0,04
3	Oxalic acid	traces	1,2	traces	0,36
4	Tartaric acid	–	–	–	–
5	Citric acid	traces	1,8	0,01	0,54
6	Lactic acid	–	0,06	–	0,02
7	Total acidity	0,07	3,22	0,09	1,02

Data in Table 9 show that rosehip juice is rich in organic acids compared to pumpkin and persimmon juices. Rose hips contain citric and oxalic acids 1.2÷1.8 g/100 cm^3 while pumpkin juice does not contain these acids, and persimmon juice contains only citric acid 0.01 g/100 cm^3.

The mineral content of pumpkin, rosehip, and persimmon juices is given in Table 10.

Table 10

Mineral substances of juices from pumpkin, rosehip, and persimmon, mg/100 cm^3

No.	Minerals	Juice with pulp	Juice		Juice prepared by blending method
		Palov-Kodu-268	Rose hip	Persimmon	
1	Potassium	408,5	528,4	536,4	470,05
2	Sodium	16,8	12,5	18,6	15,87
3	Magnesium	421,1	420,3	450,4	426,72
4	Iron	13,2	9,8	11,8	11,9
5	Copper	3,5	3,4	3,4	3,95
6	Zinc	6,4	7,6	1,5	5,78
7	Iodine	–	–	2,4	0,48

Note: iodine content is measured in μg/100 cm^3

Table 10 demonstrates that the prepared juices are rich in minerals. However, unlike persimmon juice, iodine was not found in pumpkin and rosehip juices.

6. Discussion of results of investigating quality indicators of juices from fruits and berries using the blending method

Data in Table 2 shows that pumpkin juice is rich in β-carotene and pectin substances. However, the content of vitamin C, phenolic compounds, glucose, and fructose, which is important for the human body, is lower in pumpkin juice. Table 2 demonstrates that pumpkin juice with pulp is not very rich in nutrients. That is why quince and persimmon juices were used in the production of pumpkin juice with pulp.

The main purpose of adding quince juice to pumpkin juice is to enrich the juice with organic acids. Organic acids are involved in the metabolic process, that is, in the formation of certain amino acids and other important components. In addition, organic acids normalize blood pressure, improve blood circulation, and participate in the Krebs cycle. Pumpkin juice contains 7.0 mg/100 cm^3 of vitamin C, while in quince juice this indicator was 21.5 mg/100 cm^3. This indicator also applies to phenolic compounds. While pumpkin juice contains 0.23 g/100 cm^3 of phenolic compounds, in quince juice this value was significantly higher – 0.65 g/100 cm^3. High fiber content in produced juices is not desirable. This reason is explained by the fact that cellulose is not absorbed by the human body; in addition, it causes cloudiness in the juice. Pumpkin juice is richer in fiber compared to quince juice.

Our study revealed that persimmon juice is richer in simple sugars (glucose and fructose) than pumpkin juice. In pumpkin juice, fructose was 0.9 g/100 cm^3, while in persimmon juice this value was 9.4 g/100 cm^3. Persimmon juice is richer in phenolic compounds compared to pumpkin and quince juice.

Values in Table 2 show that there are 4 times more phenolic compounds in persimmon juice than in pumpkin juice. Due to the fact that phenolic compounds, including vitamin C, have high antioxidant and antimicrobial properties, they have a positive effect on the high-quality long-term storage of juice prepared by blending.

Analysis of Table 2 revelas that the nutritional value of juices prepared using the blending method is higher than that of juices prepared from pumpkin with pulp. While the content of vitamin C in pumpkin juice is 7 mg/100 cm^3, in the joice prepared by blending it is 11.83 mg/100 cm^3. Compared to pumpkin juice, the composition of blended prepared juice is rich in glucose, fructose, and other phenolic compounds.

Values in Table 3 demonstrate that all prepared juices are rich in minerals. However, pumpkin and quince juice do not contain iodine, while persimmon juice is rich in iodine. Therefore, the combination juice contains iodine along with other minerals. Thus, as a result of the study, the nutritional value of juice made from pumpkin, quince, and persimmon is higher.

Data in Table 4 show that there are very few aliphatic acids in pumpkin and persimmon juices. Given the lack of organic acids in pumpkin juice, they decided to enrich the pumpkin juice with them. Therefore, to fortify pumpkin juice with organic acids, quince juice, which contains a sufficient volume of aliphatic acids, was used for blending.

Thus, environmentally friendly juice prepared by blending contains a significant amount of free glucose and fructose, various phenolic compounds, a sufficient volume of organic acids, minerals, including iodine, and other food components that determine its nutritional value.

Values in Table 5 show that the prepared juices are rich in β-carotene. While in pumpkin juice with pulp the content of β-carotene was 1.8 mg/100 cm^3, in rosehip juice this value was 2.7 mg/100 cm^3, in yellow quince juice 0.7 mg/100 cm^3, in juice prepared using the blend it was 1.85 mg/100 cm^3. The table shows that, compared to pumpkin juice, rose hip juice is rich in vitamin C. Compared to juice prepared from pumpkin juice, juice prepared by blending contains 27 times more vitamin C. Analyzing the quality indicators of the prepared juices, it is clear that while pumpkin juice contains 7 mg/100 cm^3 of vitamin C, in rose hips this value is 620 mg/100 cm^3, in quince – 21.5 mg/100 cm^3, in juice prepared by blending – 193.8 mg/100 cm^3.

Prepared juices contain small amounts of simple sugars in free form. Pumpkin juice contains 0.9÷2.6 %, rose hips 1.8÷4.1 %, quince juice 1.8÷4.3 %, juice prepared by blending contains 2.2÷2.54 % glucose and fructose. When producing functional juices, it is more advisable to have more fructose and vitamin C in their composition than simple sugars.

It is known that vitamin C is very important for the human body. With a deficiency or low level of this vitamin in the human body, the risk of early fatigue, colds, and infectious diseases increases significantly. Therefore, it is very important to have foods rich in vitamin C in a person's daily diet. Vitamin C is practically absent in foods of animal origin. It is mainly found in food products of plant origin. There is especially a lot of it in fruits and berries. Recently, scientists involved in human nutrition have recommended that 60–65 % of the daily diet be consumed from plant-based foods.

As a result of research, it was found that, compared to pumpkin juice, the amount of fructose in juice prepared by the blending method is higher. While juice prepared by blending contains 2.54 % fructose, in pumpkin juice this value is 0.9 %. In functional juices, it is advisable to contain more fructose than glucose. This principle is explained by the fact that fructose has a sweet taste more than 2 times that of glucose. Prepared juices contain small amounts of sucrose, starch, and pectin. However, there is more fiber in pumpkin juice than in other juices (Table 2).

The rich composition of functional juices with phenolic compounds has a positive effect on their quality and stable long-term storage. Phenolic compounds are known to have high antioxidant and antimicrobial properties. Juices rich in phenolic compounds are fuller and more concentrated.

The study also revealed that rosehip and quince juice are richer in phenolic compounds than pumpkin juice. Even juice prepared by blending contains more than twice the amount of phenolic compounds compared to pumpkin juice. This indicates that the nutritional value of juice prepared by blending is higher. The benefits of phenolic compounds for the human body are irreplaceable. They are also important for maintaining normal blood pressure in the human body, eliminating atherosclerosis (memory) and various headaches. Phenolic compounds significantly reduce the removal of radiation from the human body and even the risk of developing tumors. Therefore, it is very important to have foods rich in phenolic compounds in a person's daily diet.

Data in Table 6 show that rosehip and quince juices are richer in organic acids than pumpkin juice. From an analysis of the literature [2, 4], it is known that organic acids contained in food products are very important for the normal functioning of the human body. Organic acids are more often found in foods of plant origin, mainly in fruits and vegetables. They participate in the process of metabolism (anabalism) in the human body. Organic acids play an important role in the synthesis of amino acids necessary for life in the human body. The presence of aliphatic and aromatic organic acids in the daily human diet is very important.

Organic acids are of particular importance in purifying the blood, maintaining normal cholesterol levels, synthesizing enzymes, even increasing their activity, and digesting food taken [26].

From the data in Table 6 it is known that pumpkin juice contains almost no organic acids. However, rosehip juice, especially quince juice, is richer in organic acids. Therefore, it was proposed to mix rosehip and quince juice with pumpkin juice in order to enrich the pumpkin juice with organic acids. The juice prepared using a new method using a special technology is richer in organic acids than pumpkin juice with pulp. Table 6 demonstrates that the amount of malic acid in juice prepared by blending is 10 times higher than in pumpkin juice. It has been established that the juice prepared by the proposed blending method contains malic, citric, lactic, and oxalic acids, while pumpkin juice with pulp contains only malic acid.

Data in Table 6 show that there are practically no organic acids in pumpkin juice, and in juices prepared by blending, the amount of organic acids is much higher. It has been established that the quality indicators (organic acids) of juice prepared using the blending method are higher than those of pumpkin juice with pulp.

The amount of minerals in the prepared juices was also studied and is given in Table 7. Values of Table 7 demonstrate that juice prepared from rose hips and quince, especially juice prepared by blending, is rich in minerals, potassium, and magnesium. Potassium helps strengthen the heart muscle, and magnesium helps remove excess salts from the body.

Minerals are involved in the metabolic process in the human body. Even the synthesis of aliphatic organic acids, some enzymes, vitamins, and other biologically active substances important for life is impossible without the participation of minerals. Otherwise, the synthesis of these organic compounds is disrupted. As a result, conditions arise in the human body for the formation of some unpleasant diseases [8].

Thus, as a result of the study, it became clear that the presence of organic and inorganic substances in the daily diet of

people is very important for their health. Compared to other juices, juice prepared by blending is also environmentally friendly. No chemical additives were used in the prepared functional juice. Juice prepared using pumpkin, rose hips, and quince differs from other juices in terms of quality. Pumpkin juice was rated at 8.2 points, rosehip juice at 8.1 points, quince juice at 8.5 points, and blended juice at 9.5 points.

Data in Table 8 show that although pumpkin juice is rich in β-carotene, its content of total sugars, including glucose and fructose, vitamin C and phenolic compounds, is low. Unlike pumpkin juice, rosehip juice is rich in vitamin C, and persimmon fruits are rich in simple sugars and phenolic compounds. Phenolic compounds are extremely important for the normal functioning of the human body.

Thus, prepared juices are rich in phenolic compounds, which has a positive effect on their long-term quality storage. This is mainly due to the fact that phenolic compounds have antioxidant, antimicrobial and even antimutagenic properties.

Sugars, mainly monosaccharides, are important for the normal functioning of the human body. They have a positive effect on improving people's mood. In this regard, the presence of free simple sugars in natural juices is beneficial for the human body. Simple sugars, mainly glucose and fructose, do not undergo enzymatic hydrolysis. They go directly to cellular organs and are used for energy consumption by the body [4].

Data in Table 8 show that while pumpkin juice contains 8 mg/100 cm^3 of vitamin C, in rosehip juice this value is 620 mg/100 cm^3, and in persimmon juice – 9.4 mg/100 cm^3. While persimmon juice contains 20.5 g/100 cm^3 of total sugar, in pumpkin juice this value was 4.8 g/100 cm^3, and in rosehip juice – 6.2 g/100 cm^3.

While rosehip and persimmon juices contain 0.78÷0.86 g/100 cm^3 of phenolic compounds, in pumpkin juice this value is much less – 0.18 g/100 cm^3. To further enrich pumpkin juice with nutritional components, it is mixed with rosehip and persimmon juices. Table 8 demonstrates that the product, obtained from a joint mixture of three natural juices, is enriched with nutritional components: β-carotene, vitamin C, simple sugars, etc.

Table 9 demonstrates that when mixing rosehip and persimmon juices with pumpkin juice, the resulting juice is also enriched with organic acids.

The composition of fruit and berry juices, fortified with natural aliphatic and aromatic organic acids, has a good effect on their quality. Organic acids, mainly citric, oxalic, succinic, etc., have a positive effect on the human body, they have a good effect on blood transparency, maintaining cholesterol levels and regulating metabolism [8].

Table 10 demonstrates that the prepared juices are rich in minerals. However, unlike persimmon juice, iodine was not found in pumpkin and rosehip juices. In addition to other minerals, it was found that the blended juice contains 0.48 mg/100 cm^3 of iodine. Minerals are of particular importance to the human body. Minerals are involved in the synthesis of proteins, enzymes, hormones, etc. in the human body. Therefore, human health largely depends on minerals.

Thus, as a result of research, it has been established that juice prepared by blending using pumpkin, rosehip, and persimmon fruits differs in nutritional value from other juices. Therefore, during tasting, pumpkin juice was rated 7.8; rosehip – 8.1; persimmon – 8.4; blended juice – 9.8 points.

Participants of the tasting board came to the conclusion that the nutritional value and quality indicators of juices prepared using new technology from a joint mixture with and without pulp of juices prepared from fruits and berries Perexvatka-69, Palov-Kodu-268, quince, persimmon, rose hips, were rated at 9.5÷9.8 points. The importance of the composition of these juices from the point of view of public health is noted since they are environmentally friendly, have a purely functional purpose, and do not contain additives.

7. Conclusions

1. Quality indicators in the production technology of juices from pumpkin, quince, and persimmon fruits have been studied. Juices with and without pulp were prepared using the fruits of the Perexvatka-69 pumpkin variety, yellow quince, and persimmon. During the production process, a new type of juice was prepared using a special technology from a mixture of 50 % pumpkin, 30 % quince, and 20 % natural persimmon juice. A comparative analysis of quantitative changes in β-carotene, total sugar, vitamin C, glucose, fructose, cellulose, and pectin substances in juices prepared with and without pulp, as well as by the blending method, was carried out. An environmentally friendly juice was obtained, prepared using the blending method. It contains a large amount of free glucose and fructose, various phenolic compounds, a sufficient volume of organic acids, minerals, including iodine, and other nutritional components that determine its nutritional value. The prepared juices were tasted using a 10-point system to determine the optimal option. During the tasting, the environmentally friendly blended juice was rated 9.6 points.

2. The quality indicators in the production technology of juices from pumpkin, quince, and rose hips have been studied. The study found that pumpkin juice is not as rich in nutrients. It contains small amounts of vitamin C, organic acids, and phenolic compounds important for the human body. To further enrich pumpkin juice with nutrients, mixing it with rosehip and quince juices was studied. Unlike pumpkin juice, rosehip juice is rich in vitamin C and phenolic compounds, and quince juice is rich in organic acids (malic, citric, oxalic, etc.). Therefore, 50 % pumpkin juice of the total volume was mixed with 30 % rosehip juice and 20 % with quince juice. A quantitative determination of organic and inorganic substances in the finished juices and an assessment of organoleptic indicators were carried out. While pumpkin juice was rated at 8.2 points, rosehip juice – at 8.1 points, quince juice – at 8.5 points, the blended juice – at 9.5 points.

3. The quality indicators in the production technology of juices from fruits and berries of pumpkin, rose hips, and persimmons have been studied. The pumpkin variety Palov-kodu 268, as well as the rosehip and persimmon varieties Hyakume, were used as the object of study for the production of sweet juice. During processing, the juice was prepared using 50 % pumpkin juice with pulp, 30 % natural rose hips, and 20 % natural persimmon juice. Quantitative changes in β-carotene, vitamin C, total sugar, as well as glucose and fructose, starch, pectin, and fiber in prepared juices were studied. The juices were tasted and rated on a 10-point scale. During tasting, pumpkin juice was rated 7.8; rosehip – 8.1; persimmon – 8.4; blended juice – 9.8 points.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

All data are available in the main text of the manuscript.

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