The object of this study is the process of producing juice from pumpkin, persimmon, and rose hips. The task was to obtain a high yield of juice, while maintaining antioxidant properties and long-term storage.

During the experiment, it was found that heat treatment significantly increases the yield of juice and its quality indicators. Thus, with heat treatment, the yield of pumpkin juice increased to 55.4 %, while without heat treatment it was 41.6 %. Similar results were obtained for persimmon, with the juice yield increased from 64.1 % to 74.1 %. Juice from rose hips was not extracted at all without heat treatment, but with treatment, the yield was 42 %. The content of bioactive substances such as β-carotene, vitamin C, and total sugar was also recorded, which confirms the effectiveness of heat treatment for increasing the nutritional value of juices. A process flow chart for producing juices with pulp from pumpkin and rose hips, clarified juice from persimmons, and blended juice from pumpkin, persimmon, and rose hips in a ratio of 50:30:20 has been constructed. The results of the study show that scalding fruits and berries in rapidly boiling water with periodic stirring for 3–5 minutes gives a high juice yield and maximally preserves the nutritional properties of the final product.

An additional finding of this study relates to the use of pumpkin waste to obtain natural dyes, which opens up new opportunities for the use of environmentally friendly substances in the food industry.

The results of this work can be used in the production of natural juices, as well as in the development of environmentally friendly natural dyes for food products. These technologies can be implemented at small and large processing plants focused on making environmentally friendly and nutritious products

Keywords: juice extraction, heat treatment, waste recycling, bioactive components, natural dyes

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DEVELOPMENT OF TECHNOLOGY FOR PRODUCING JUICES FROM PUMPKIN, PERSIMMON, AND ROSEHIP CONSIDERING VARIOUS EXTRACTION METHODS

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1. Introduction

The production of natural juices is an important part of the food industry, meeting the needs of consumers for environmentally friendly and nutritious products. However, despite the growing demand for natural juices, the industry faces a number of problems related to increasing the yield of juice, preserving its biological value, and maximizing the use of raw materials. One of the main tasks is to optimize juice extraction technologies in order to increase production efficiency and improve the quality of the final product.

One of the significant challenges is the low juice yield from some types of fruits with standard processing methods. For fruits such as pumpkin, persimmon, and rose hips, conventional juice extraction methods can be ineffective, which leads to loss of nutrients and limited use of raw materials. In addition, at many stages of production, significant amounts of waste remain, which not only increase the cost but also represent an environmental burden.

Existing heat treatment methods could increase juice yield, but this is also associated with a change in the composition and loss of some bioactive substances, such as vitamins and antioxidants. In this regard, it is important to devise technologies that can preserve the beneficial properties of juice and at the same time increase its volume using new extraction and processing methods.

Another pressing issue is the need to use by-products of processing, such as peel and pulp, to make environmentally friendly natural dyes. This will not only reduce waste but also add additional value to the product.

In the context of growing interest in environmentally friendly and nutritious products, special attention should be paid to the development of innovative technologies for the efficient and rational production of juices, improving their quality and finding ways to use waste in other sectors of the food industry.

Therefore, research on the development of technology for the production of environmentally friendly juices from pumpkin, persimmon, and rose hips, as well as the extraction of natural dyes from their waste, is extremely relevant. This research topic solves important problems of food security, agricultural sustainability, and public health, which makes it extremely popular both in scientific and practical terms.

2. Literature review and problem statement

The task of providing the population with environmentally friendly and safe food products has become increasingly important in recent decades. It is important to note that pumpkin, persimmon, and rose hips do not require the use of chemicals in the process of their cultivation, which makes them promising for the production of natural juices. Very few food products, including juices, are produced industrially from these fruits and berries using modern technologies [1].

Rose hips have a rich composition, are known for their wealth of phenolic compounds and are a valuable source of vitamin C [2]. Various biologically active substances have been found in rose hips, such as polyphenols, flavonoids, carotenoids, ascorbic acid, anthocyanins, tannins, and tocopherols. The effect of heat plays a fundamental role in many products obtained from rose hips. Ascorbic acid and other compounds that are very sensitive to heat treatment are subject to extremely high losses during processing by conventional methods [3]. It should also be noted that even with the use of advanced technologies, in cases of improper adjustment of the hot processing mode, significant losses in product quality occur. Therefore, it is important to study the effect of various types of hot processing and technological methods on the quality of rose hips. This is due to the fact that rose hips have a solid structure and extracting juice from them causes great difficulties, so it is important to apply a technology for extracting nutrients that would give positive results.

Study [4] reported that valuable oil for medicinal use can be obtained from rose hip seeds, which are usually waste. Literature reviews show that rose hips are used in other industries in addition to the food industry. It is important to note that even their waste has found wide application in pharmaceuticals, cosmetology, and other industries. Here, the issue of preserving the nutritional value of the final product using more rational technological methods is also acute. Rose hip seeds are typical waste, obtained annually in large quantities as a by-product of a canning plant. Due to the low fatty oil content of rose hips (8 % by weight), pressing is not an economical extraction method; solvent extraction seems more suitable. For this purpose, various extraction methods were compared: conventional solvent extraction with ultrasound, microwave, sub- and supercritical fluid extraction (SFE). The oil yield in most of the new extraction methods was higher than in the case of conventional Soxhlet extraction. The authors concluded that the main advantage of supercritical FE with CO_2 is solvent-free oil, whereas other extractions require solvent evaporation. However, the proposed extraction methods cannot be extended to all food industry waste due to labor intensity and high cost. Conventional solvent extraction increases oil yield and is the best method for restoring rosehip oil with the highest carotene content.

As a result of study [5], a recipe for mixed juice based on watermelon with the addition of pumpkin juice and rosehip diffusion juice was devised. Mixed juice is a valuable source of biologically active compounds, has a refreshing and restorative effect on the body. The authors developed a recipe for mixed juice based on watermelon using apple, pumpkin juice, and rosehip diffusion juice. Organoleptic, physicochemical, and microbiological indicators of juices were studied. The results of physicochemical studies showed that the titratable acidity of the analyzed juices was within 0.9–1.9 mmol H+/100 g, active acidity was 3.9–4.3 pH units. The addition of rosehip juice had a positive effect on the content of vitamins C, B_1, and B_3. However, the issues of analyzing the mechanical composition of the materials used, calculating the yield of juices with and without pulp, as well as studying pectin substances and phenolic compounds, which is an important condition for the preparation of various juices, remained unresolved. After all, phenolic compounds are natural antioxidants and contribute to the long-term storage of finished products.

In general, rose hips contain high concentrations of ascorbic acid, phenolic compounds, and essential fatty acids. The fact that *Rosaceae* fruits perform important physiological functions may be related to their abundance of phenolic substances, which are widely known to have antioxidant, antimutagenic, and anticarcinogenic activities [6]. However, there are still unresolved issues in the juice production modes and preparation technology related to maintaining organoleptic properties at a high level. Organoleptic, physicochemical, and microbiological properties of juices have been studied. However, additional research is needed on the issues of product stabilization, preservation of active substances and long-term safety. It is not specified which specific processing methods were used to obtain the juice (e.g., heat treatment, cold pressing, etc.) and how this affected the preservation of active substances. Given the diversity of raw materials, it is also important to check the effect of each method on taste and nutritional value.

Paper [7] states that pumpkins belong to various species of the genus *Cucurbita* and are an important source of carotenoids. The major carotenoid in most species is β-carotene, with concentrations exceeding 70 μg/g, but other important carotenoids are also present. Carotenoid content in pumpkin can vary considerably even within a single species or cultivar, depending on growing conditions, stage of ripening, and harvesting and post-harvest handling methods. However, there are still unresolved issues related to the accuracy and stability of carotenoid content in pumpkin. It is recommended to examine in more detail the influence of specific factors (e.g., cultivar, handling, and storage methods) on carotenoid stability and to propose approaches to addressing the problem of carotenoid content variation.

Paper [8] reports the results of studying a technique for obtaining Hiakume persimmon syrup, mixtures of wheat flour and persimmon syrup, as well as bread with the addition of this syrup. It is shown that the addition of persimmon syrup can enrich products with important nutrients that improve health and prevent vitamin and mineral deficiencies in the diet. However, there are still unresolved issues related to long-term storage and stability of the quality characteristics of these products, as well as the possibility of standardizing the content of nutrients. This may be due to objective difficulties associated with the variability of the persimmon composition depending on the growing and processing conditions, as well as the high cost of producing and storing such products, which makes the relevant studies impractical at the moment without additional developments.

Work [9] investigated the technology for obtaining juices only from persimmon fruits. The quality indicators of juices from two types of persimmon, prepared with preliminary heat treatment and the use of an enzyme preparation, were studied. The analysis reveals that the juice yield increases with the use of the enzyme preparation, but it should be noted that the resulting product does not retain its original properties and therefore the choice of the persimmon juice production mode remains unresolved.

Paper [10] reports the results of a study on the effect of persimmon tannin on the digestion of starch with different levels of amylose both in vitro and in vivo. Regulation of postprandial blood glucose levels is an effective therapeutic proposal for the treatment of type 2 diabetes. It is known that the enzyme o-diphenol oxidase (FT.1.14.18.2.) belongs to aerobic dehydrogenases and catalyzes the conversion of a wide range of phenolic compounds, including ortho- and para-diphenols, into o-quinone. Peroxidase (FT.1.11.1.7.) belongs to anaerobic dehydrogenases and catalyzes the oxidation of polyphenols and a number of aromatic amines in the presence of hydrogen peroxide. Its action occurs in an oxygen-free environment. The authors do not study the relationship between enzymes that break down starch and phenolic compounds in their work since tannin is a hydrolysable phenolic compound and it is important to consider the enzyme activity, which remained outside the authors' field of vision.

Rosehip juice is used as a means of increasing the body's resistance to intoxication in diseases such as scarlet fever, diphtheria, pneumonia, whooping cough, accelerating the healing of wounds, and bone fusion in fractures [11]. This fact is associated with the high content of vitamin C in rose hips, but the authors did not take into account the fact that with conventional methods of obtaining juice from rose hips, the quantitative content of vitamin C decreases, which is associated with the activity of the enzyme ascorbate oxidase, which belongs to the class of oxidoreductases.

Enzymes belonging to the class of oxidoreductases catalyze oxidation-reduction reactions. Most representatives of oxidoreductases have been widely studied in the food industry, in fruits and berries. Ascorbate oxidase (FT.1.10.3.3.), being a representative of aerobic dehydrogenases, is one of the most important enzymes playing an important role in the ripening and processing of fruits. Aerobdehydrogenases or oxidases take hydrogen from oxidized substances and transfer it to oxygen. Anaerobic dehydrogenases take hydrogen from oxidized substances and transfer it instead of oxygen to another acceptor, other enzymes. Oxygen does not participate in the reactions they catalyze. The enzyme ascorbate oxidase is an aerobic dehydrogenase and catalyzes the conversion of ascorbic acid (vitamin C) into dehydro-L-ascorbic acid. Therefore, an increase in the activity of this enzyme is undesirable, the quantitative content of vitamin C decreases. Therefore, when obtaining juice, it is necessary to choose a processing mode under which it is possible to preserve the quantitative content of vitamin C.

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. Minerals participate in the metabolism of the human body. Thus, they participate in the biosynthesis of proteins, enzymes, hormones, and others. Lack of minerals in the human body is the cause of the formation of various unpleasant complications. Therefore, the presence of minerals in food products, including juices, is important [12, 13]. Each individual fruit juice has deficiencies in vital nutrients. The development of blended juice technology from various fruits and berries replenishes the human body with macro and micronutrients. Therefore, the issue of producing juices with high nutritional value is relevant.

The high content of phenolic compounds in persimmon juice contributes to the long-term preservation of its quality, richness, and also slows down the consumption of nutrients for the breathing process. This is due to the fact that phenolic compounds have antioxidant and antimicrobial properties [14]. Fruit juices without phenolic compounds are subject to rapid microbiological spoilage. Therefore, it is important to replenish juices with insufficient or no phenolic compounds by blending with persimmon juice obtained by a more rational method to preserve the nutritional value.

In study [15], the nutritional and mineral composition of *Diospyros kaki* fruits from the regions of Apulia, Campania, Lazio, Sardinia, and Sicily was assessed. The content of dietary fiber, minerals, pectin, polyphenols, and proteins was quantified. However, the work did not resolve issues related to the use of persimmon fruits for food purposes.

In paper [16], changes in the total amount of carotenoids in rosehip nectars during storage were not statistically significant. A statistically significant decrease in the antioxidant activity of rosehip nectars in glass bottles was found during storage at all temperatures used, while no significant changes in the antioxidant activity of rosehip nectars in cardboard packaging were observed.

In their study, the authors of [1] prepared a variety of juices that are beneficial for the human body, rich in functional nutritional components, natural, without additives, by mixing (blending) pumpkin juice with quince, rosehip, and persimmon juice separately with heat treatment (hot method). In the work, the authors were able to obtain a high juice yield and quantitative content of some nutritional components using the proposed technology, but the content of vitamin C and beta-carotene decreased due to the incorrect choice of heat treatment mode.

One of the reasons for the limited consumption of juices from individual fruits is the incomplete composition of the components and rapid spoilage. From the point of view of a healthy lifestyle, it is important to use juices throughout the year. The choice of the range of juices is associated with the duration of their storage and nutritional value. Separately, pumpkin juice, which is rich in beta-carotene, helps increase blood platelets, persimmon juice is rich in easily digestible sugars, phenolic compounds, but does not contain organic acids. Rosehip juice is rich in vitamin C but does not contain carotene and easily digestible carbohydrates.

All this suggests that it is advisable to conduct a study to optimize the technology of producing juices from pumpkin, persimmon, and rose hips, as well as natural dyes, which will improve their quality, reduce costs, and ensure the stability of the content of useful components in the final product.

3. The aim and objectives of the study

The aim of our study was to devise a technology for producing pumpkin, persimmon, and rosehip juices, taking into account various processing methods – with and without pulp. This will make it possible to obtain a high juice yield, while maintaining antioxidant properties that allow for long-term storage of finished products, as well as replenish the balance of missing nutrients.

To achieve this goal, the following tasks were set:

– to design a process flow chart for producing pumpkin, persimmon, and rosehip juices, taking into account various processing methods;

– to analyze the yield of unclarified juice and pulp during the processing of pumpkin, persimmon, and rosehip fruits;

– to analyze the quality indicators of juices and juice with pulp, prepared with heat treatment (hot method) and without from pumpkin, persimmon, and rosehip berries.

4. The study materials and methods

4. 1. The object and hypothesis of the study

The object of our study is the process of producing juice from pumpkin, persimmon, and rose hips.

The hypothesis of the study assumed that the use of a combination of pumpkin, persimmon, and rose hip juices in the development of a new production technology could lead to making a drink with improved organoleptic characteristics (taste, aroma) and increased nutritional value due to the balanced content of vitamins, minerals, and antioxidants.

The following assumptions were accepted: combining these juices would lead to making a drink with a pleasant taste and aroma, which could be of wide consumer interest, combining sweet and sour notes. Rosehip, persimmon, and pumpkin juices may have strong antioxidant properties, which makes them useful for maintaining health and preventing a number of diseases.

The study material was juices from the pumpkin variety "Palov-Kodu-268" widespread in the country, the persimmon variety "Hiakume", as well as from rose hips growing along mountain rivers.

4. 2. Research methods

Research methods: theoretical research – comparative analysis of the related literature, experimental research – experiments based on GOST standards. The varieties of pumpkin, persimmon, and rose hips used were purchased at the market in wooden boxes with a capacity of 10–15 kg. Persimmon and rose hip varieties were pre-sorted, cleaned, and fed for processing separately. Our studies were conducted at the Department of Food Engineering and Expertise of the Azerbaijan Technological University, as well as in the laboratories of the Georgian Research Institute. The juices were prepared at the AzGranata plant in the Agsu region.

During the study, juices with and without pulp were prepared. The juices were prepared in two versions: without preliminary heat treatment (naturally) and with heat treatment. In addition, during the production process, an environmentally friendly, natural food coloring without additives was prepared from the separated pulp, skin, and pulp parts (waste).

During the study, the yields of unclarified juices, both with and without pulp, from the pumpkin variety "Palov-Kodu-268", persimmon, and rose hips, as well as their main quality indicators were studied. The following were determined in juices prepared from fruits and berries [17, 18]:

– the quantitative indicators of β-carotene were determined by express method;

– quantitative indicators of total sugar (spectrophotometric analysis using reagents that react with sugars);

– quantitative indicators of vitamin C (titrimetric method using 2,6-dichlorophenol indicator);

– quantitative indicators of glucose, fructose (enzymatic methods using glucose oxidase or fructose oxidase);

– starch (by iodination method);

– sucrose (by refractometric method);

– pectin substances (method of acid hydrolysis with titration);

– cellulose (method of decomposition of all organic substances with a mixture of acetic and trichloroacetic acids with concentrated nitric acid.).

In addition, mineral substances and organic acids were quantitatively determined in juices with and without pulp using an Aanalyst 400 atomic absorption spectrometer (Perkin-Elmer, USA) [18]. The amount of phenolic compounds in the prepared juices with and without pulp was determined using chromatograph mass spectrometry [19].

Four variants of juices with and without pulp were prepared from the studied fruits and berries:

I. Juice with pulp from pumpkin of the Palov-Kodu-268 variety.

II. Juice without pulp from persimmon fruits.

III. Juice with pulp from rose hips.

IV. Juice prepared from a mixture of pumpkin, persimmon, and rose hip juices in a ratio of 50:30:20.

The prepared juices were tasted [20, 21] on a 10-point scale to determine the best option. 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.

To obtain juices with and without pulp from the specified fruits and berries, they are first cut, water is brought to a boil, they are placed in water, the stove is turned off, blanched while stirring for 3–5 minutes, in order to extract nutrients into the juice. Heating destroys the cellular structure and the transition of soluble nutrients into the juice improves. Then the resulting mixture is poured into another container, the juice is separated, and the yield of the pulp is determined. Blanching releases nutrients from the skin, including vitamins and β-carotene, into the water. Blanching in rapidly boiling water (usually around 100 °C) effectively inhibits the activity of oxidative enzymes while simultaneously neutralizing microorganisms, preventing microbiological spoilage. This reduces the loss of vitamins such as ascorbic acid by breaking down enzymes more quickly than at lower temperatures. In addition, blanching helps minimize losses by reducing the time of heat treatment. Since enzymes are broken down more quickly and the vitamins themselves do not have time to break down significantly, vitamin C is converted into D-hydro-L-ascorbic acid, and the product retains its biological properties. When the temperature reaches 60 °C and above, oxidative enzymes (for example, ascorbate oxidase) lose their activity, which prevents further destruction of vitamins, including vitamin C. This process is important for preserving the nutritional value of the product since after the destruction of enzymes, oxidation becomes less intense, and vitamins in the product are preserved longer. It is important to note here that pumpkin juice alone is rich in beta-carotene, persimmon in easily digestible sugars and phenolic compounds, and rose hips in vitamin C, and blended juice is saturated with all the above compounds and the nutritional value increases.

To obtain juices, a washing machine for persimmon and rose hips KUV-1 was used, and for pumpkin – a knife of the A9-KLM/4-2 type, a chopper of the A9-KLB/2 type, a sorting and control conveyor TPH, a screw scalder of the LE-18 type, for pumpkin – a scalder A9-KİB/15, a two-drum wiping machine of the Tİ-KP2D type, a vacuum heater of the M3C-320 type, homogenizers of the A1-OQM, A1-OQM-5 type, a digester of the KFA-0.5 type, a vacuum scalder of the M3C-320 type, a filter of the B9-VFS/423-53 type, a deaerator-pasteurizer of the DPU type, and tanks of the MZS-314 type were used.

4. 3. Obtaining food coloring from pumpkin and pumpkin pulp

Plant dyes are rich in carotenoids, which are important for the human body, as well as carotenes, which are substitutes for vitamin A, vitamins (especially water-soluble), and other useful food components. The waste obtained during the preparation of juices was used to obtain a natural food coloring as a substitute for synthetic dyes currently used in the food industry.

The dye was obtained from waste (peel, pulp, pulp) formed during the production of juice from an environmentally friendly melon crop – pumpkin, the reserves of which in the country are significant. The most common extraction method was used to obtain the dye.

This extraction method was chosen based on its high efficiency in extracting pigments from plant materials, such as pumpkin carotenoids. Extraction is one of the most popular and proven methods for obtaining food colorings from plant materials. The most commonly used extraction is with organic solvents such as ethanol, acetone, or mixtures of these substances. These solvents effectively extract carotenoids and other pigments from plant materials, preserving their active components. This method was chosen because it makes it possible to obtain dyes that meet safety and food standards. Studies have shown that when using pumpkin extraction with acetone-alcohol solutions, it was possible to obtain a high-quality dye with a high content of carotenoids, including β-carotene.

Technique for obtaining food coloring from pumpkin. Take 32 grams of dried pumpkin, chop finely, and place in a flask, add a mixture of 50 % alcohol and acetone, leave at room temperature for 48 hours. The resulting dark yellow solution is filtered. Then 15 grams are taken from the dried pumpkin again, ground to a size of 1–2 mm, 25 ml of a 50 % alcohol-acetone mixture are added, and the mixture is again left for 48 hours at a temperature of 18–22 °C, after which it is filtered. The resulting solutions are mixed and heated together at a temperature of 50 °C for 8–10 minutes, then cooled. In the next step, the solution contained in the solvent is transferred to a distillation device. The resulting mass (colloidal particles) is dried in a thermostat at 60 °C, ground into powder, from which a dark yellow dye rich in β-carotene and other carotenoids is obtained. As is known, the best solvent for carotenoids is refined raw vegetable oil, such as soybean oil. After filtering and drying, the vegetable dye obtained from pumpkin is packaged in such a way that its surface is covered by 0.02 % of the total volume of the package.

Technique for obtaining food coloring from pumpkin juice. A 1 % solution of citric acid is added to pumpkin juice obtained by squeezing and heated at 50–55 °C for 8–10 minutes. The resulting sediment is filtered and separated, then boiled down. The resulting concentrate is mixed until a homogeneous mass is obtained in a ratio of 1:1.

To obtain a good result, the pumpkin should be thoroughly washed, cut into small pieces (2–4 mm), pressed until the amount of dry residue reaches 7–8 %, after which the juice is extracted from it. Studies have shown that the main composition of the pumpkin juice pigment consists of carotenoids in an amount of 37.08–79.14 mg/l. As already indicated, pumpkin juice left at room temperature for 1 hour is separated from the sediment, and the latter is then evaporated at 60 °C in a vacuum device until the dry matter content reaches 60 %. The prepared dye is stored at room temperature until use.

The dye was obtained in two ways:

I. Obtaining food dye from dried pumpkin.

II. Obtaining food dye from pumpkin juice.

A comparison of the options showed that in option I, the dye yield was higher than in option II. Therefore, it is recommended to use the method for obtaining the dye according to option I. Based on a special technology, a natural dye obtained from pumpkin was used in the production of bread rolls, pasta, and for decorating cakes of various shapes. This contributed to the enrichment of the composition of food products with β-carotene, which is a substitute for vitamin A.

The results of the studies conducted to compare the two options showed that the method for obtaining food dye from dried pumpkin (option I) is more effective compared to the method based on the use of pumpkin juice (option II) since the dye yield was higher in the first option. This confirms the feasibility of using dried pumpkin as a raw material for the production of a natural dye.

5. Results of development of technology for production of juices from pumpkin, persimmon, and rose hips taking into account various processing methods

5. 1. Constructing the technological process flow chart

Pumpkin and rose hip juices with pulp were prepared according to the technological flow chart shown in Fig. 1.

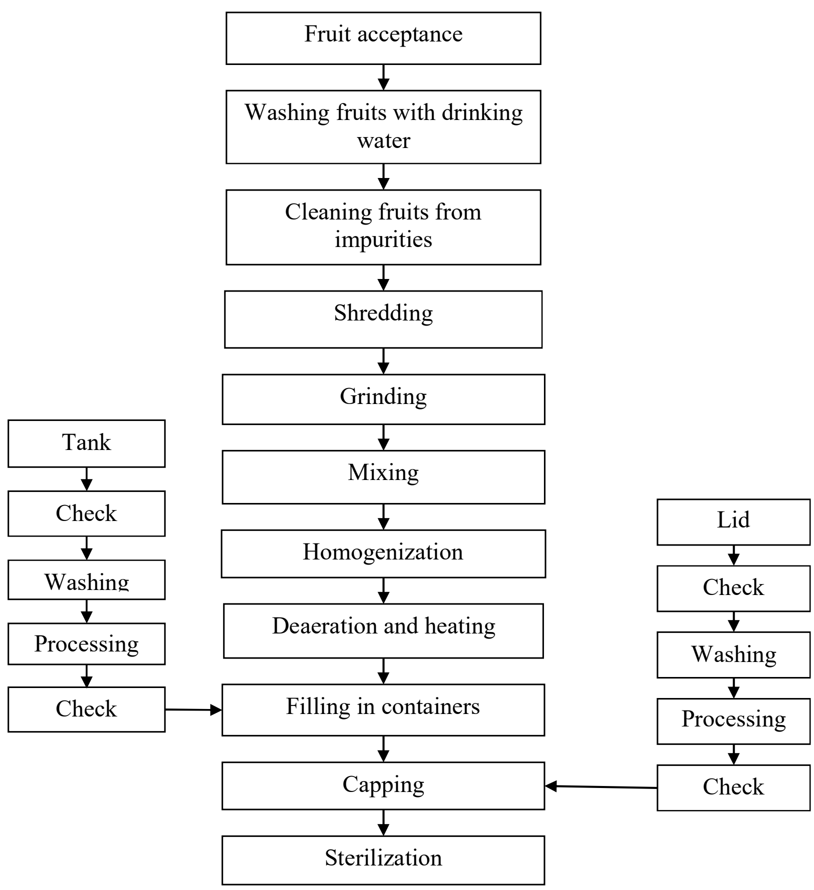

Fig. 1. Technological scheme for obtaining juices with pulp from pumpkin and rose hips

The technological scheme for obtaining pulpless juice from persimmon is shown in Fig. 2.

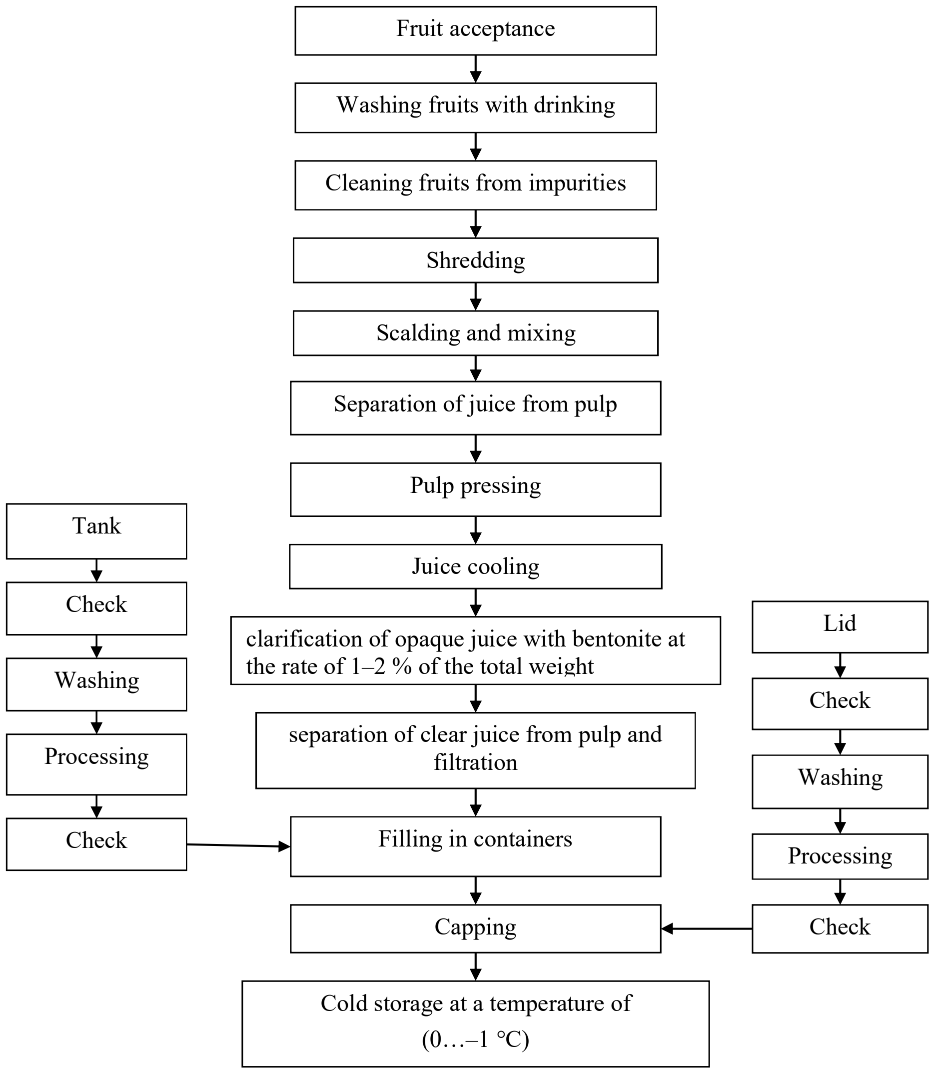

Fig. 2. Technological scheme for obtaining pulpless juice from persimmon

Acceptance and washing of raw materials. Pumpkin, persimmon, and rose hips delivered to the enterprise are fed to the washing machine. Water intended for washing the fruit must be clean and suitable for drinking. During the washing process, the fruit is cleaned of mechanical impurities, dust, pathogens, harmful chemicals, and other impurities.

Cleaning and sorting of fruit. At this stage, unripe, infected fruit, and various impurities (leaves, small tree trimmings, etc.) are removed. Clean, healthy fruit is used in the production of juice. Cleaning and sorting is performed on a conveyor.

Grinding machine. Washed and peeled fruits and berries are sent to the grinding machine. Here, the fruits and berries are crushed, chopped, and sent for heat treatment (scalding).

Heat treatment of raw materials. Crushed pumpkin, persimmon, and rose hips are fed into a scalder, where the water is heated to boiling point, the gas supply is turned off, and the fruits and berries are mixed in the container for 3–5 minutes. The main purpose of such heat treatment is to thoroughly mix the peel and pulp with the juice. At the same time, the bottom of the container does not burn, and the juice is easily separated from the pulp. Due to the destruction of the natural structure of colloidal particles and the effect of heat, the vital activity of pathogenic microorganisms ceases. When mixing, the juice is enriched with extractive substances and enzymes are inactivated to prevent oxidation of the juice, as well as to preserve nutrients, including vitamin C and beta-carotene. It should also be noted that protein turbidity due to the effect of temperature is prematurely prevented. In addition, due to the change in the natural structure of proteins, pectin substances subsequently appear in the juice, contributing to the turbidity of the juice. Most of the protein compounds and other biopolymers are converted into monomeric form, which contributes to an increase in the dry matter of juice, sugar, extractive substances, and other food components. As a result of heat treatment, oxidative enzymes that catalyze the breakdown of nutrients are inhibited and lose their mechanism of action. This means that during heat treatment, the breakdown of nutritional components that make up fruits and berries stops. It is known that enzymes, mainly polyphenol oxidase, cause a change in the color of the pulp or juice. Under the influence of heat treatment, due to the inactivation of polyphenol oxidase and other enzymes, the color of the juice does not change [1].

Homogenization. This process is used to obtain juices with pulp from pumpkin and rose hips. The essence of the process is the uniform distribution of certain substances in a liquid medium. This is necessary to impart homogeneity to the obtained juices.

Sterilization. Sterilization of juices makes it possible to destroy microorganisms and bacteria that can lead to various infections and diseases and also contributes to the long-term storage of finished products with specified properties.

Pressing (for persimmon juice). In the press, the pulp is separated and unclarified persimmon juice is obtained. In this process, the separated part is collected separately for other purposes and processed at subsequent stages. The juice extracted from the juicer is cooled and settled.

Juice clarification (for persimmon juice). To clarify persimmon juice, 0.5–1 % bentonite is added to it. Bentonite (montmorillonite) is an environmentally friendly fining material. Bentonite clays are widely used in the medical and food industries. Being a source of irrigating microelements, bentonite is used to make various dietary supplements and vitamins, it has a good effect on the gastrointestinal tract, has an analgesic and anti-inflammatory effect. It is used as a dietary supplement for the prevention and treatment of aflatoxin toxicity. Bentonite is a reliable food supplement for metal poisoning. Montmorillonite crystals have fat-absorbing properties, it has an antibacterial property. Bentonite adsorbs and removes a strong toxic substance, gossypol, from the body. Bentonite-based preparations have the properties of an ion exchange adsorbent and catalyst, replenish substances bioavailable to the body, help normalize general and especially mineral metabolism, improve digestibility and rational use of nutritional components, create the necessary conditions for increasing the overall resistance of the body [22]. Due to its effect, colloidal substances and small particles of juice settle to the bottom of the container. Then the clarified juice is poured into another clean container, separated from the sediment, and stored at a temperature of 0...–1 °C.

Cooling of juice (for persimmon juice). The main purpose of cooling is to prevent oxidation, fermentation, and turbidity of the juice. Since transparent juice contains up to 18–25 % of natural sugar, it must be constantly protected from the fermentation process. Otherwise, sugar may be lost during fermentation. Glucose and fructose are the main simple sugars of persimmon juice, which are more sensitive to the fermentation process. Fermentation reduces the quantitative content of dry substances in the juice and, accordingly, the yield of concentrated juice. Therefore, clarified juice should be stored cold before processing. The juice is also passed through a separator to ensure stability. Before processing, the juice is filtered cold.

Juice filtration (for persimmon juice). The main purpose of juice filtration is to achieve transparency and remove suspended particles from the juice. When using unclarified raw materials for the production of blended juice, the presentation and quality of the finished product deteriorates.

Packaging of the finished product. The prepared juices are placed in containers, labeled, and stored at a temperature of 0...–1 °C until sent for sale [23].

5. 2. Comparative analysis of the yield of unclarified juice and pulp during the processing of pumpkin, persimmon, and rose hips

A comparative analysis of the yield of unclarified juice and pulp during the processing of pumpkin, persimmon, and rose hips is summarized in Table 1.

Table 1

Yield of unclarified juice and pulp by total weight during processing of fruits and berries of pumpkin, persimmon, rose hips according to different options, %

Product ID		Option I. No heat treatment		Option II. Heat treatment (hot method)	
		Unclarified juice	Pulp yield	Unclarified juice	Pulp yield
1	Pumpkin Palov-Kodu-268	41.6	39.4	55.4	31.7
2	Persimmon (Hiakume)	64.1	29.0	74.1	25.9
3	Rosehip	–	–	42.0	58.0

From the data in Table 1 it is evident that the juice yield from pumpkin, persimmon, and rose hips (without heat treatment) is low, whereas with heat treatment it increases significantly.

5. 3. Comparative analysis of the quality indicators of juices, taking into account various processing methods

The study also included a comparative analysis of the quality indicators of juices with and without pulp, prepared according to different options. These indicators are given in Table 2.

Table 2

Comparison of quality indicators of juices prepared according to different variants from the pumpkin variety Palov-kodu-268

No.	Indicator	Option I. Heat treatment (hot method)	Option II. No heat treatment	Difference	%
1	β-carotene, mg/100 cm^3	2.0	1.5	+0.5	25.0
2	Total sugar, g/100 cm^3	5.4	4.3	+1.1	20.4
3	Vitamin C, mg/100 cm^3	8.0	6.8	+1.2	15.0
4	Monosaccharides, g/100 cm^3				
5	Glucose	2.4	2.1	+0.3	12.5
6	Fructose	1.1	0.8	+0.3	27.3
7	Disaccharide, g/100 cm^3				
8	Sucrose	0.7	0.5	+0.2	28.6
9	Polysaccharides, g/100 cm^3				
10	Starch	0.2	0.2	0	0
11	Cellulose	1.6	1.9	–0.3	18.8
12	Pectin substances	0.3	0.38	–0.08	26.7
13	Phenolic compounds, g/100 cm^3	0.18	0.15	+0.03	16.7
14	Juice yield, %	68.3	51.4	+16.9	24.7

A comparative analysis of pumpkin juices revealed that the content of β-carotene in the juice obtained using heat treatment was 25 % higher (Table 2). The data in Table 2 show that in juices prepared using the heat method, compared with the second option, the content of total sugar, glucose, fructose, sucrose, and phenolic compounds increased by 12.5–28.6 %.

During the study, persimmon juice was also prepared, the quality indicators of which are given in Table 3.

It is evident from the data in Table 3 that the quality indicators of the juice prepared by the thermal method are significantly higher compared to the control variant. In the persimmon juice obtained by the thermal method, compared to the control variant, an increase in the content of β-carotene by 18.7 %, vitamin C by 19.1 %, glucose (hexoses) by 15.0 %, and fructose by 14.9 % is observed.

A comparative analysis of the quality indicators of juices with pulp from rose hips is summarized in Table 4.

Table 4 shows that the heat-treated juice contained 620 mg/100 cm^3 of vitamin C, while the control version contained 530 mg/100 cm^3, which corresponds to data from other studies. The vitamin C content slightly increased.

Our study included a comparative analysis of the mineral content in juices prepared separately from pumpkin, persimmon, and rose hips. These indicators are given in Table 5.

It also follows from Table 5 that iodine was not detected in juices prepared from pumpkin and rose hips, while juices prepared from persimmon fruits have a high iodine content. In juice obtained from the pumpkin variety

Table 3

Comparison of quality indicators of juices prepared from persimmon of the Hiakume variety in different variants

No.	Indicator	Option I. Heat treatment (hot method)	Option II. No heat treatment	Difference	%
1	β-carotene, mg/100 cm^3	1.6	1.3	+0.3	18.7
2	Total sugar, g/100 cm^3	20.8	17.7	+3.1	14.9
3	Vitamin C, mg/100 cm^3	9.4	7.6	+1.8	19.1
4	Monosaccharides, g/100 cm^3				
5	Glucose	8.0	6.8	+1.2	15
6	Fructose	9.4	8.0	+1.4	14.9
7	Disaccharide, g/100 cm^3				
8	Sucrose	0.2	0.2	0	0
9	Polysaccharides, g/100 cm^3				
10	Starch	–	izi	–	–
11	Cellulose	0.28	0.36	– 0.06	21.4
12	Pectin substances	0.32	0.43	– 0.11	34.4
13	Phenolic compounds, g/100 cm^3	0.86	0.68	+0.18	20.9
14	Juice yield, %	73.6	68.8	+4.8	6.5

Table 4

Comparison of quality indicators of juices with pulp from rose hips, prepared according to different options

No.	Indicator	Option I. Heat treatment (hot method)	Option II. No heat treatment	Difference	%
1	β-carotene, mg/100 cm^3	2.7	2.2	+0.5	18.5
2	Total sugar, g/100 cm^3	6.2	5.1	+1.1	17.7
3	Vitamin C, mg/100 cm^3	620	530	+90.0	14.5
4	Monosaccharides, g/100 cm^3				
5	Glucose	1.8	1.5	+0.3	16.7
6	Fructose	4.1	3.3	+0.8	19.5
7	Disaccharide, g/100 cm^3				
8	Sucrose	0.3	0.2	+0.1	33.3
9	Polysaccharides, g/100 cm^3				
10	Starch	0.35	0.48	– 0.13	37.1
11	Cellulose	0.25	0.32	– 0.7	28.0
12	Pectin substances	0.78	0.64	+0.14	17.9
13	Phenolic compounds, g/100 cm^3	6.2	5.1	+1.1	17.7
14	Juice yield, %	46.9	–	–	–

Table 5

Comparison of mineral substances in juices prepared from pumpkin, persimmon, and rose hips in different variants, mg/100 cm^3

No.	Minerals	Heat treatment (hot method)	No heat treatment	Difference	%
Pumpkin Palov-Kodu-268					
1	Potassium	408.5	332.3	+76.2	18.6
2	Sodium	16.8	13.6	+3.2	19.0
3	Magnesium	421.1	349.7	+71.4	16.9
4	Iron	13.2	10.1	+3.1	23.5
5	Copper	4.5	3.4	+1.1	24.4
6	Zinc	6.4	5.1	+1.3	20.3
7	Iodine	–	–	–	–
Persimmon (Hiakume)					
1	Potassium	536.4	438.6	+97.8	18.2
2	Sodium	18.6	15.0	+3.6	19.3
3	Magnesium	450.4	364.2	+86.2	19.1
4	Iron	11.8	8.3	+3.5	29.7
5	Copper	3.4	2.5	0.9	26.5
6	Zinc	1.5	1.2	0.3	20.0
7	Iodine	2.4	0.7	+1.7	29.2
Rose hip					
1	Potassium	528.4	451.2	+77.2	14.6
2	Sodium	12.5	10.1	+2.4	19.2
3	Magnesium	420.3	351.9	+68.4	16.3
4	Iron	9.8	7.7	+2.1	21.4
5	Copper	3.4	2.7	+0.7	20.6
6	Zinc	7.6	1.3	+6.3	17.1
7	Iodine	–	–	–	–

"Palov-Kodu-268" with heat treatment, the content of minerals is 4.5–408.5 mg/100 cm^3, while in juices prepared without heat treatment, this indicator varies from 3.4 to 332.3 mg/100 cm^3. A comparative analysis of the quality indicators of juice prepared by the blending method is summarized in Table 6.

Table 6

Qualitative indicators of juices prepared from pumpkin, persimmon, and rose hips

No.	Indicator	Juice with pulp		Juice	Juice prepared by blending
		Pumpkin	Rose hip	Persimmon	
1	β-carotene, mg/100 cm^3	2.1	2.67	1.6	2.14
2	Total sugar, g/100 cm^3	5.43	6.21	20.81	8.73
3	Vitamin C, mg/100 cm^3	8.1	619	9.5	191.89
4	Monosaccharides, g/100 cm^3				
5	Glucose	2.3	1.7	8.0	3.33
6	Fructose	1.0	3.0	9.3	3.32
7	Disaccharide, g/100 cm^3				
8	Sucrose	0.7	0.3	0.2	0.47
9	Polysaccharides, g/100 cm^3				
10	Starch	0.21	–	–	0.12
11	Cellulose	1.6	0.24	0.27	0.92
12	Pectin substances	0.3	0.34	0.33	0.33
13	Phenolic compounds, g/100 cm^3	0.19	0.79	0.87	0.51
14	Tasting score, in points	7.9	8.2	8.5	9.8

From the data in Table 6 it is clear that pumpkin juice is rich in β-carotene. It is known that β-carotene is a substitute for vitamin A. The content of vitamin C in pumpkin juice is 8.1 mg/100 cm^3, while in rose hips this indicator is much higher – 619 mg/100 cm^3, and in persimmon juice – 9.5 mg/100 cm^3. As for total sugar, in persimmon juice its content is 20.81 g/100 cm^3, in pumpkin juice – 5.43 g/100 cm^3, and in rose hip juice – 6.21 g/100 cm^3. In rosehip and persimmon juices, the level of phenolic compounds fluctuates from 0.79 to 0.87 g/100 cm^3, while in pumpkin juice this indicator is significantly lower – 0.19 g/100 cm^3.

Mineral substances in juices prepared from pumpkin, persimmon, and rosehip berries can be represented in the form of Table 7 indicating the content of each mineral.

Table 7

Mineral substances of juices prepared from pumpkin, persimmon, and rose hips, mg/100 cm^3

No.	Minerals	Juice with pulp		Juice	Juice prepared by blending method
		Pumpkin	Rose hips	Persimmon	
1	Potassium	408.6	528.5	536.8	470.06
2	Sodium	16.9	12.6	18.7	15.88
3	Magnesium	421.2	420.4	450.5	426.73
4	Iron	13.3	9.9	11.9	11.92
5	Copper	3.6	3.5	3.5	3.96
6	Zinc	6.5	7.7	1.6	5.79
7	Iodine	–	–	2.3	0.47

Note: the amount of iodine is microgram/100 cm^3.

Table 7 shows that the prepared juices are rich in minerals. In the juice prepared by the blending method, the potassium level is 470.06 mg/cm^3, which indicates a balanced content of minerals in this combination. The sodium content in the juices is relatively low, especially in rosehip (12.6 mg/cm^3) and persimmon (18.7 mg/cm^3) juices.

6. Discussion of the scientific and experimental study

The development of a new technology for the production of pumpkin, rosehip, and persimmon juices and the development of an effective processing method allows us to obtain products of high nutritional value, with a long shelf life and use in the off-season. Unlike the classical method, in the designed technological scheme, preliminary heat treatment of fruits and berries helps increase the amount of nutrients, due to the destruction of the natural structure of colloidal particles and better extraction of substances from the vacuole into water. In addition, when mixing juices, the finished product is fortified with extractive substances and enzymes are inactivated to prevent oxidation of the juice, while nutrients are preserved, including vitamin C and beta-carotene.

Fig. 1 shows the technological scheme for obtaining juices with pulp from pumpkin and rosehip. The technological scheme for obtaining juice without pulp from persimmon is shown in Fig. 2. To obtain blended juice, pumpkin, persimmon, and rosehip juice are mixed in a ratio of 50:30:20. The prepared juices are poured into containers, labeled, and stored at a temperature of 0...–1 °C until sent for sale.

It follows from Table 1 that the juice yield from pumpkin, persimmon, and rose hips (without heat treatment) is relatively low, but with heat treatment it increases significantly. It is known that under the influence of heat, the cellular structure of fruits and berries is destroyed more effectively [1]. As a result, the juice yield increases, and water-soluble nutrients pass into the juice more easily. The amount of extractive substances, as well as biologically active components in the juice increases significantly. It is also evident from the data in Table 1 that with heat treatment of the studied fruits, the juice yield is significantly higher compared to another option, which makes this method more cost-effective.

Whereas when processing pumpkin of the Palov-Kodu-268 variety without heat treatment, the yield of unclarified juice was 41.6 %, then with heat treatment this indicator increased to 55.4 %, which is 13.8 % more. These indicators also apply to juice prepared from persimmon fruits. Unlike pumpkin and persimmon, it is very difficult to obtain juice from rose hips without heat treatment.

From the data in Table 1 it is clear that when pumpkin, persimmon, and rose hips are processed heat-wise, the pulp yield is lower compared to other options. For example, the pumpkin variety Palov-Kodu-268, when processed heat-wise, yielded a pulp yield of 31.7 %, while in another option (without heat treatment) this indicator was 39.4 %. When fruits and berries were processed heat-wise, the juice yield was 55.4 % for pumpkin, 74.1 % for persimmon, and 42 % for rose hips.

It is evident from the data in Table 2 that the yield of pumpkin juice with pulp prepared by heat treatment is higher than that prepared without heat treatment. If pumpkin juice obtained by heat treatment contains 2 mg/100 cm^3 of β-carotene, then the juice prepared without heat treatment contains 1.5 mg/100 cm^3. A comparative analysis of pumpkin juices revealed that the β-carotene content in juice prepared by heat treatment was 25 % higher. This value also applies to other quality indicators. For example, if pumpkin juice prepared by heat treatment contains 8 mg/100 cm^3 of vitamin C, then in juice prepared without heat treatment this indicator is 6.8 mg/100 cm^3. The data in Table 2 show that in the juices prepared by the thermal method, compared with the second variant, the content of total sugar, glucose, fructose, sucrose, and phenolic compounds increased by 12.5÷28.6 %.

In the persimmon juice prepared by the thermal method, compared with the control variant, the content of β-carotene was 18.7 % higher, vitamin C – by 19.1 %, glucose, representing the hexose group – by 15.0 %, and fructose – by 14.9 % (Table 3). Pectin substances and cellulose were contained in the control variant in greater quantities, while in the juice prepared by the thermal method, their content was significantly lower. Phenolic compounds in the persimmon juice prepared by the thermal method were 20.9 % higher compared with the second variant.

Our study also included rosehip pulp juice. From our review of the literature [3] and the study conducted, it became known that rosehip pulp juice contains a higher amount of β-carotene, vitamin C, and phenolic compounds.

From the data in Table 4, it is clear that the vitamin C content in the juice prepared with heat treatment (hot method) slightly increased compared to the control variant. These data coincide with other indicators (Table 4).

From the data in Table 5, it became known that the composition of juices prepared with heat treatment is significantly higher than the composition of juices prepared without heat treatment. Thus, juices prepared with heat treatment contain 536.4–408.5 mg/100 cm^3 of potassium, while in juices prepared without heat treatment, this indicator is 451.2–245.1 mg/100 cm^3. In juice obtained from the pumpkin variety "Palov-Kodu-268" by heat treatment, the amount of mineral substances is 4.5–408.5 mg/100 cm^3, while in juices prepared without heat treatment, this indicator is 3.4–332.3 mg/100 cm^3. These indicators are similar to those of persimmon and rosehip juices. From the data in Table 5, it also became known that iodine was not detected in juices prepared from pumpkin and rosehip. However, juices prepared from persimmon fruits are rich in iodine.

In order to fortify the prepared juices from pumpkin, rose hips, and persimmon with nutrients, a new juice was devised by mixing the three juices in a ratio of 50 % pumpkin, 30 % rose hips, and 20 % persimmon. The data in Table 6 show that pumpkin juice is rich in β-carotene. It is known that β-carotene is a substitute for vitamin A. A deficiency of this vitamin in the human body leads to deterioration of vision, rapid fatigue, and other negative consequences [15]. The data in Table 5 show that, despite the high content of β-carotene in pumpkin juice with pulp, it contains less total sugar, including glucose and fructose, vitamin C and phenolic compounds. Rose hip juice, unlike pumpkin juice, is richer in vitamin C, and persimmon juice contains more simple sugars and phenolic compounds. As stated above, phenolic compounds are extremely important for the normal functioning of the human body.

Therefore, the high content of phenolic compounds in prepared juices has a positive effect on their long-term storage in a high-quality state. Moreover, individual representatives of phenolic compounds help remove radiation from the human body, and also significantly reduce the risk of malignant and benign tumors.

Vitamin C is an extremely important component for human life. Therefore, the presence of foods rich in vitamin C in the daily diet is very important. For the normal functioning of the human body, sugars, especially monosaccharides, are of great importance. They have a positive effect on improving the emotional state of a person. Therefore, the presence of free simple sugars in natural juices is beneficial for the human body.

From the data in Table 6 it is evident that if pumpkin juice contains 8.1 mg/100 cm^3 of vitamin C; in rose hips, this indicator is 619 mg/100 cm^3, and in persimmon – 9.5 mg/100 cm^3. Whereas persimmon juice contains 20.81 g/100 cm^3 of total sugar, in pumpkin juice this indicator is 5.43 g/100 cm^3, and in rose hip juice – 6.21 g/100 cm^3. Rose hip and persimmon juices contain 0.79÷0.87 g/100 cm^3 of phenolic compounds, in pumpkin juice this indicator is significantly lower – 0.19 g/100 cm^3. In order to fortify pumpkin juice with nutritional components, it was mixed with rose hip and persimmon juices. As can be seen from Table 6, the product obtained from a mixture of three natural juices became more enriched with nutritional components: β-carotene, vitamin C, simple sugars, and other substances, i.e., vitamin C slightly changed towards an increase compared to the control variant.

From Table 7 it is clear that in the juice prepared by the blending method, the potassium level is at an average level of 470.06 mg/cm^3, which indicates a balanced content of minerals in this combination. The sodium content in the juices is relatively low, especially in rosehip juice, 12.6 mg/cm^3, and persimmon juice, 18.7 mg/cm^3. Sodium, as a rule, is found in smaller quantities in vegetables and fruits than potassium. Low sodium content in juices is useful for people monitoring blood pressure. Juice prepared by the blending method also has an intermediate sodium content of 15.88 mg/cm^3, which indicates a balance of this component. However, no iodine was found in pumpkin and rosehip juices, unlike persimmon juice, 2.4 mg/cm^3, which is explained by the natural feature of persimmon as a source of iodine. In the blended juice, the iodine content was 0.47 mg/cm^3, which is the result of mixing components with different iodine content. Minerals are of particular importance for the human body. They participate in the synthesis of proteins, enzymes, hormones, and other substances. Therefore, human health largely depends on minerals. Consequently, these tables illustrate the significant difference in the content of minerals in juices from different fruits and berries and also show how the blending process can affect the content of these substances, creating a balanced combination of useful elements.

Thus, as a result of our study, it was established that the juice prepared by the blending method using pumpkin, rose hips, and persimmon differs in its nutritional value from other juices. That is why during the tasting, pumpkin juice was rated 7.9 points, rose hip juice – 8.2 points, persimmon juice – 8.5 points, and blended juice – 9.8 points.

From the waste generated during the production of juice from the fruits and berries of pumpkin, rose hips, and persimmon, according to the above-mentioned method, individual dyes were obtained. The dye obtained from pumpkin has a light straw shade. In general, the obtained dye can be used in various areas of the food industry.

Limitations: The results of our study, especially those related to the heat treatment process and juice production methods, may be limited by certain types of fruits and berries used in the experiments (pumpkin, persimmon, rose hips). The applicability of the findings to other fruits or berries requires additional research.

Limitations of the study: Although the paper notes that juices obtained by the thermal method retain their beneficial properties, no long-term studies were conducted on the storage of these juices under various conditions. This is important to determine the shelf life and stability of nutrients during long-term storage. Therefore, in the future, we shall conduct additional studies on the long-term storage of juices to assess how long beneficial substances such as vitamins, minerals, and antioxidants are preserved under various storage conditions.

Further exploration of the use of juice production waste for the extraction of dyes and other useful substances requires the development of new processing technologies. This may require significant efforts to improve existing extraction methods and introduce new environmentally friendly methods, which may also be a challenge in terms of technology and funding.

7. Conclusions

1. A process flow chart for producing juices with pulp from pumpkin and rose hips and clarified juice from persimmons, as well as blended juice from pumpkin, persimmon, and rose hips in a ratio of 50:30:20, has been built. The results of our study show that scalding fruits and berries in rapidly boiling water with periodic stirring for 3–5 minutes gives a high juice yield and maximally preserves the nutritional properties of the final product.

2. In the study, heat treatment significantly increases the juice yield from pumpkin, persimmon, and rose hips, especially for pumpkin and persimmon, where this indicator increases by 33.1 % and reaches 55.4 % for pumpkin, and by 15.6 % reaching 74.1 % for persimmon. Since it is impossible to obtain juice from rose hips by conventional pressing, 42.0 % is obtained with heat treatment. However, with heat treatment, a decrease in pulp yield is observed, which confirms that temperature promotes better juice extraction but reduces the amount of remaining pulp.

3. It has been established that heat treatment increases the content of useful bioactive substances, such as β-carotene, vitamin C, and sugars. For example, the content of β-carotene in pumpkin juice increased by 25 % after heat treatment. Similar improvements were recorded for persimmon and rosehip juices. Heat treatment also helps increase the content of minerals (potassium, magnesium, iron, and zinc) in juices. Heat-treated juice turned out to be richer in important microelements, which makes it more useful and nutritious for consumers. It has been established that the prepared blended juice has a higher nutritional value compared to juices prepared from each component separately. This is confirmed by the tasting assessment, according to which the blended juice received 9.8 points.

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Authorship criteria

All authors contributed equally to the research and bear equal responsibility for the information reported in this paper.

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, as well as the results reported in this paper.

References

1. Nabiyev, A., Kazimova, I., Kazimova, İ., Gasimova, A., Nasrullayeva, G., Yusifova, M. (2023). Assessment of quality indicators in the technology of blended juices from the fruits and berries of pumpkin, quince, rose hips, and persimmon. Eastern-European Journal of Enterprise Technologies, 5 (11 (125)), 67–75. https://doi.org/10.15587/1729-4061.2023.289778
2. Demir, N., Yildiz, O., Alpaslan, M., Hayaloglu, A. A. (2014). Evaluation of volatiles, phenolic compounds and antioxidant activities of rose hip (Rosa L.) fruits in Turkey. LWT - Food Science and Technology, 57 (1), 126–133. https://doi.org/10.1016/j.lwt.2013.12.038
3. Fataliyev, H., Isgandarova, S., Gadimova, N., Mammadova, A., Ismailov, M., Mammadzade, M. (2024). Identification of the effect of ripening conditions on the yield of rose hips and their processed products. Technology and Equipment of Food Production, 4 (11 (130)), 26–35. https://doi.org/10.15587/1729-4061.2024.309597
4. Szentmihályi, K., Vinkler, P., Lakatos, B., Illés, V., Then, M. (2002). Rose hip (Rosa canina L.) oil obtained from waste hip seeds by different extraction methods. Bioresource Technology, 82 (2), 195–201. https://doi.org/10.1016/s0960-8524(01)00161-4
5. Chomanov, U. C., Zhumaliyeva, G. Y., Aktokalova, G. S., Zhumaliyeva, G. T., Muratkhanov, D. B., Idayatova, M. A. (2023). Production of Nutrient-Rich Watermelon-Based Juices. Hranenie i Pererabotka Sel'hozsyr'ya, 4, 32–44. https://doi.org/10.36107/spfp.2023.4.408
6. Elmastaş, M., Demir, A., Genç, N., Dölek, Ü., Güneş, M. (2017). Changes in flavonoid and phenolic acid contents in some Rosa species during ripening. Food Chemistry, 235, 154–159. https://doi.org/10.1016/j.foodchem.2017.05.004
7. Liubych, V., Novikov, V., Pushka, O., Pushka, I., Cherchel, V., Kyrpa, M. et al. (2023). Development of wheat bread recipe with pumpkin paste. Eastern-European Journal of Enterprise Technologies, 1 (11 (121)), 60–68. https://doi.org/10.15587/1729-4061.2023.274259
8. Omarov, Y., Gurbanova, S., Babayeva, U., Gasimova, A., Heydarov, E., Gasimova, G., Nabiyev, A. (2023). Improving the storage technology of persimmon fruit (Diospyros kaki L.) In the refrigeration chamber. Eastern-European Journal of Enterprise Technologies, 4 (11 (124)), 20–36. https://doi.org/10.15587/1729-4061.2023.285444
9. Mikayilov, V., Omarova, E., Kazimova, İ., Aliyeva, J., Fatma, A., Gasimova, A., Nabiyev, A. (2024). Development of technology for obtaining juice from persimmon fruit (Diospyros kaki L.). Eastern-European Journal of Enterprise Technologies, 2 (11 (128)), 34–45. https://doi.org/10.15587/1729-4061.2024.302282

10. Li, K., Yao, F., Du, J., Deng, X., Li, C. (2018). Persimmon Tannin Decreased the Glycemic Response through Decreasing the Digestibility of Starch and Inhibiting α-Amylase, α-Glucosidase, and Intestinal Glucose Uptake. Journal of Agricultural and Food Chemistry, 66 (7), 1629–1637. https://doi.org/10.1021/acs.jafc.7b05833
11. Nəbiyev, Ə. Ə., Cəfərova, S. F., İsgəndərova, T. H. (2017). Bitkilər aləminin ekoloji problemləri, səmərəli istifadəsi və mühafizəsi. Bakı, 442.
12. Mikayılov, V. Ş., Fərzəliyev, E. B. (2018). Qida məhsullarının ümumi texnologiyası. Bakı, 830.
13. Shevchenko, A., Litvynchuk, S., Drobot, V., Shevchenko, O. (2023). Influence of pumpkin cellulose on conformational transformations in the structure of dough and bread from wheat flour. Ukrainian Food Journal, 12 (1), 38–50. https://doi.org/10.24263/2304-974x-2023-12-1-5
14. Kanakis, C. D., Tarantilis, P. A., Polissiou, M. G., Diamantoglou, S., Tajmir-Riahi, H. A. (2005). DNA Interaction with Naturally Occurring Antioxidant Flavonoids Quercetin, Kaempferol, and Delphinidin. Journal of Biomolecular Structure and Dynamics, 22 (6), 719–724. https://doi.org/10.1080/07391102.2005.10507038
15. Duru, N., Karadeniz, F., Erge, H. S. (2011). Changes in Bioactive Compounds, Antioxidant Activity and HMF Formation in Rosehip Nectars During Storage. Food and Bioprocess Technology, 5 (7), 2899–2907. https://doi.org/10.1007/s11947-011-0657-9
16. Tardugno, R., Gervasi, T., Nava, V., Cammilleri, G., Ferrantelli, V., Cicero, N. (2021). Nutritional and mineral composition of persimmon fruits (Diospyros kaki L.) from Central and Southern Italy. Natural Product Research, 36 (20), 5168–5173. https://doi.org/10.1080/14786419.2021.1921768
17. Hasil, Y. (2004). Enstrumental qida analizleri. Türkiye: İzmir, 141.
18. Gerzhikovoy, V. G. (2009). Metody tehnohimicheskogo kontrolya v vinodelii. Simferopol’: Tavrida, 304.
19. Flamini, R., Traldi, P. (2009). Mass Spectrometry in Grape and Wine Chemistry. John Wiley & Sons. https://doi.org/10.1002/9780470552926
20. Mikailov, V. Sh. (2012). Degustaciya produktov pitaniya. Baku: Kooperativnoe izdatel’stvo, 384.
21. Tagiev, M. M., Bagirova, M. V. (2012). Perspektivy proizvodstva sokov lechebno-profilakticheskogo naznacheniya iz dikorosov. Pivo i napitki, 2.
22. Nazarova, F. Sh., Dzhumanova, N. E. (2021). Ispol’zovanie bentonita Azkamarskogo mestorozhdeniya dlya balansirovaniya mineral’nogo pitaniya. Academic research in educational sciences, 2 (9), 672–679.
23. GOST 32102-2013. Konservy. Produkciya sokovaya. Soki fruktovye koncentrirovannye.