Organizing proper and environmentally friendly nutrition is one of the most pressing problems. Widespread persimmon fruits are of great technological importance as raw materials for the production of concentrated juice, used as a natural sweetener. The object of this study is the processes of obtaining juices from persimmon fruits. Quality indicators were studied in juices prepared by preliminary heat treatment and the use of an enzyme preparation. The juice yield from the Khachia variety was 93.9 %, and from the Hiakume variety – 93.8 %. To prepare concentrated juice, persimmon juice was used, prepared by preliminary heat treatment, and using 0.1–0.2 % enzyme preparation. A scheme for preparing concentrated juice has been developed, which is recommended for use as an environmentally friendly sweetener in food production. The concentrate contained 7.25 μg/100 g of iodine. The prepared concentrate is rich in nutritional components necessary for human life, as well as sugars, phenolic compounds with antioxidant and antimicrobial properties, as well as vitamin C. Nutritional components perform a wide range of functions in the optimal functioning of the immune system and play an important role in metabolic processes. The use of persimmon concentrate in the preparation of various food products increases the bioavailability of many minerals. Therefore, to ensure the nutritional value of the finished product and increase long-term quality storage, it is recommended to use concentrated persimmon juice as a sugar substitute

Keywords: persimmon varieties, Khachia, Hiakume, quality indicators, heat treatment, technological scheme, sweetener, bioavailability

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DEVELOPMENT OF TECHNOLOGY FOR OBTAINING JUICE FROM PERSIMMON FRUIT (DIOSPYROS KAKI L.)

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1. Introduction

Persimmon fruits (*Dispyros kaki.L.*) are widely distributed in most regions. Its composition is rich in organic and inorganic substances necessary for the human body. The basis of the soluble dry matter of persimmon fruits is made up of simple sugars, phenolic compounds, proteins, vitamins, macro- and microelements, and other important components. Common persimmon varieties Khachia and Hiakume are characterized by high productivity [1]. Persimmon fruits are an environmentally friendly plant product. No drugs are used when growing, storing, and processing its fruits. This is explained by the fact that persimmon fruits are rich in biologically active substances, mainly individual representatives of phenolic compounds. Unlike other fruits, persimmons are not infected with microbiological diseases. However, food products are produced from persimmon industrially in limited quantities.

To increase the body's resistance to various diseases, it is important to add persimmon fruits to the diet, as well as food products prepared from it that have antioxidant, antiviral, antimutagenic, and antimicrobial properties. Since persimmon fruits are rich in simple sugars (glucose and fructose), they are important for meeting human energy needs. The high content of glucose and fructose creates favorable conditions for the preparation of various food products with natural sugar content.

Persimmon fruits are rich in phenolic compounds. It is known that phenolic compounds play an important role in

regulating the blood circulation process, removing radiation from the body, and stopping the activity of microorganisms that cause some infectious diseases. Biologically active substances, mainly individual representatives of phenolic compounds (flavonoids, oligomeric and polymeric phenolic compounds, etc.), significantly reduce the risk of developing malignant tumors. In everyday life, people are surrounded by technical means that contribute to radioactive radiation, so it is recommended to eat fruits and vegetables rich in phenolic compounds, as well as their processed products [2].

Therefore, research into development of technology for the production of concentrated juice using local raw materials is important. The high percentage of sugar content of persimmon fruits, low cost, and abundance of raw materials open up wide opportunities for their use in the preparation of various food products. The study on preserving the composition of nutrients during the preparation of juice and improving the organoleptic characteristics of the finished product is very relevant.

2. Literature review and problem statement

In [3], the authors indicate that persimmon fruits are rich in carotenoids, mainly β-carotene. It is known that β-carotene, a representative of carotenoids, which enters the body with food, is converted into vitamin A under the action of a specific enzyme, carotinase. This vitamin has a good effect on vision. Research shows that persimmon fruits and processed products are rich in carotene, i. e., provitamin A. But there are still unresolved issues related to changes in carotene under the influence of heat treatment that need to be studied in detail.

The authors of [4] note that persimmons are rich in vitamin C. Since vitamin C has antioxidant and antimicrobial properties, this vitamin has the ability to stop the activity of microorganisms that cause some infectious diseases. With a quantitative decrease in vitamin C, the body's immunity and resistance to various colds are weakened. Therefore, it is important to consume fruits and their processed products rich in vitamin C. All this suggests that it is advisable to conduct research to study its physiological role, which covers a variety of processes. After all, high doses of this vitamin act as a pro-oxidant, and not as an antioxidant.

Paper [5] reports the results of a study of the aromatic substances of persimmon, which are represented by tyrosine, tryptophan, phenylalanine, vanillin, as well as representatives of monomeric phenolic compounds confiryl, sinap, etc. It is shown that these substances have a calming effect on the nervous system, improve well-being and increase performance person. However, there are still unresolved questions related to the advisability of eating persimmon fruits and its processed products.

The authors of [6] note that persimmon fruits are rich in minerals – potassium, calcium, magnesium, and mainly iodine. When there is a lack of iodine in the body, problems occur in the thyroid gland, which ultimately leads to the appearance of a goiter. The reason for this is the lack of synthesis of thyroxine or ditriiodothyroxine, which are representatives of hormones containing aromatic amino acids. For their synthesis, tyrosine, a representative of aromatic amino acids, combines with iodine to form thyroxine, a thyroid hormone. With a lack of iodine in the human body, the synthesis of thyroxine is disrupted, and this process lasts a long time. The content of the macronutrient potassium contained in persimmon fruits has a positive effect on the regulation of the cardiovascular system, strengthening the heart muscle, and normalizing blood pressure. Persimmon fruits have been used since ancient times as a diuretic in the treatment of kidney diseases. Due to the high magnesium content in persimmons and juices prepared from it, it helps remove salts. Magnesium promotes the removal from the body of 80–90 % of carbon dioxide accumulated as an intermediate product as a result of metabolism. The high magnesium content also prevents the formation of kidney stones. Taking into account the fact that many products are very poor in minerals, it is important to find new methods for processing raw materials and new processed products, etc. A way to overcome these difficulties can be the use of persimmon fruits and its processed products.

According to work [7], persimmon fruits are widely used in the treatment of atherosclerosis and anemia. Studies have shown that the quantitative sugar content in persimmon fruits ranges from 17–25 %. Juices were obtained from persimmon fruits using various processing methods, which were used to enrich other fruit and berry juices using the blending method. The authors recommended the use of persimmon juice in the production of various compotes, jams, confectionery, alcoholic beverages, and other food products. All this suggests that it is advisable to conduct research on the use of persimmon fruits as fillers and food additives.

In [8], the authors address questions about the strength and shape of the dose-response relationship between fruit and vegetable consumption and the risk of cardiovascular disease, cancer, and mortality, as well as the impact of specific types of fruit and vegetables. They conducted a systematic review and meta-analysis to clarify these associations. The study found that fruit and vegetable consumption was associated with a reduced risk of cardiovascular disease, cancer, and all-cause mortality. These results support public health recommendations to increase fruit and vegetable consumption to prevent cardiovascular disease, cancer, and premature mortality. This approach was used in [9], which found that nutrition is a factor of potential importance for mental health in early life. The authors confirmed that potential foods include fruits and vegetables that may have an effect. A systematic review of observational studies examining the association between fruit and vegetable consumption and mental health in adolescents produced good results. A variety of variables were taken into account to assess mental health, including positive (happiness, self-esteem), neutral (health-related quality of life, mental health status), and negative (loneliness, general difficulties, anxiety, anxiety, stress and distress, depressive symptoms , depression, suicidal behavior). Based on a systematic review of observational studies, it was found that in groups of adolescents there was a positive association between the consumption of fruits and vegetables and mental health. However, the problem of our time is obtaining products with preventive and health-improving properties. Therefore, in terms of solving this problem, persimmon fruits are of particular interest.

Data reported in [10] confirm that increased intake of added sugar is a major cause of dental caries, glucose intolerance, diabetes mellitus, cardiovascular disease, obesity, hypertension, and behavioral complications such as hyperactivity in children. In many parts of the world, added sugar intake far exceeds dietary recommendations from health organizations. Some researchers have used dried fruit to

sweeten traditional foods because the functionality of the sugar included in the structure of intact fruit is different from added sugar for human health. Persimmon fruits have also been used in several forms such as syrups, pastes, sugar, and flour as a sweetener in food. The authors developed an acceptable idli (traditional Indian breakfast) with sliced persimmons and persimmon paste and determined their sensory and chemical properties. However, the authors did not study persimmon concentrate for the preparation of the developed product. The reason for this may be objective difficulties associated with the development of technology for preparing the concentrate since at elevated temperatures the color and aroma deteriorate. And when using such auxiliary raw materials, the organoleptic characteristics of the finished product deteriorate.

In [11], the authors note that the current links between nutrition and health are focusing on new dietary strategy to combat various physiological threats, including cardiovascular disease, oxidative stress, diabetes mellitus, etc. In this context, intake fruits and vegetables acquire great importance as a guarantee of maintaining human health. Moreover, their phytochemical and bioactive molecules are also becoming popular as promising soothing agents for various ailments. The authors have attempted to summarize information about persimmon fruit with particular emphasis on its phytochemistry and associated health claims. Accordingly, the role of some of its bioactive molecules such as proanthocyanidin, carotenoids, tannins, flavonoids, anthocyanidin, catechin, etc. has been emphasized. Due to their rich phytochemical composition, persimmon and its products are considered effective in mitigating oxidative damage caused by reactive oxygen species (ROS). The fundamental impossibility of determining the antioxidant potential, which is responsible for the anticancer and anti-melanogenic properties of the functional ingredients of persimmon, makes the corresponding studies impractical. There is some evidence that pharmacological use of persimmon or its functional ingredients such as proanthocyanidin may help with hyperlipidemia and hyperglycemia. However, the astringent taste and the formation of diospirobezoars create gaps that maintain its vitality. In general, persimmon and its components can potentially become one of the effective modules of diet therapy; however, comprehensive studies and meta-analyses are still needed to improve rigor.

Paper [12] reports the results of a study of pectin substances. It has been shown that the problem of removing heavy and radioactive metals from the human body is relevant all over the world. Research in recent years has shown that it is more effective to use substances contained in natural foods, including pectin. Pectin has a beneficial effect not only during acute exposure to metals but also during long-term exposure to metals, which is typical for the environmental load of residents of industrial regions and modern megacities. But there are still unresolved issues related to the use of pectin substances as natural detoxifiers, which requires research on the preservation of these substances in products and their further use. Therefore, an important condition for the use of pectin concentrates is to determine the expiration date, ensuring safe use. The authors studied pumpkin puree. However, it is important to note that the content of pectin substances in persimmon fruits, which have a beneficial effect on increasing appetite in people and regulating the digestive process, requires a special approach to creating a pectin-containing additive.

In [13], the author notes that from such a low-yielding fruit as persimmon, juices are obtained by diffusion with water, in which many biocolloids are extracted. Therefore, to facilitate the separation of diffusion juice from ripened persimmons, food additives E330, E509, Amylase XML, and Pectinex 5XL were tested. Experiments were carried out with ripened persimmons of 4 varieties, grown in the experimental farm at the Research Institute of Fruit and Tea Growing (Guba, Azerbaijan). The tested juice clarification technology included grinding ripened fruits for 10–14 minutes in a propeller mixer (500 min^{-1}) with the addition of water in an amount of 30–80 wt. %, heating the mixture to 50–55 °C, and stirring slowly for 30 minutes at this temperature with the introduction of food additives. The data showed that under these conditions it is quite effective to use both of the above enzymes at a concentration of 0.03 % by weight of persimmon. The optimal ratio between ripe persimmon (regardless of its variety) and water is 1:0.3, at which it is possible to obtain primary juice fractions with a dry soluble substance (DSS) content of 12–22° Brix, which must be restored. They must be mixed only with the expectation of obtaining clarified juice, ready for bottling and pasteurization, with a strictly regulated DSS content of 16° Brix, the yield of which is 80–85 % by weight of the raw material. However, the author did not take into account the fact that the action of these enzyme preparations reduces the amounts of nutritional components of persimmon; accordingly, it is necessary to choose a processing mode in order to preserve the set of biologically active substances.

It is also important to note that not every consumer could use juice with various additives obtained through artificial synthesis. In addition, the work did not study the chemical composition and did not identify the effect of these additives on the usefulness of juices, as well as their importance in the daily diet. Daily consumption of products, for example with the addition of E330, negatively affects the human body: it aggravates existing chronic diseases of the gastrointestinal tract, affects tooth enamel, and can lead to cancer. It should also be noted that pectolytic enzymes have a destructive effect on pectin, cellulose, and hemicellulose, causing destruction and rotting.

In [14], the authors studied the antioxidant properties of tea made from persimmon leaves, fruits, and fiber, taking into account their changes in the process of gastrointestinal digestion. The evolution of polyphenols, flavonoids, and antioxidant capacity was studied using a recent harmonized in vitro protocol published by Minekus et al. Digestion was carried out with and without digestive enzymes. The results showed that the aqueous extract of the leaves was richer in antioxidants than the fruit or extracted fiber. However, the antioxidants from persimmon leaves were more sensitive to the digestive environment. Overall, ingestion conditions had a strong effect on antioxidants, while gastric digestion resulted in little additional loss. The intestinal stage increases the solubility of polyphenols and flavonoids coming from fruits and fiber. In addition, the presence of digestive enzymes positively contributed to the release of antioxidants during the digestion process. The authors concluded that the bioavailability of polyphenols, flavonoids, and antioxidant activities of persimmon fruit were 1.4, 1.0, and 3.8 times higher than that of the aqueous leaf extract. To meet the human body need for these biologically active substances, adequate dietary adjustment is required. This approach was used in the work, but the specific astringent taste and low

bioavailability of the studied components were not taken into account. This makes it significantly more difficult to provide the body with polyphenols in adequate quantities. Therefore, there is a need to find technological solutions to create food products enriched with polyphenols with their high bioavailability. The development of such products could make a significant contribution to the prevention of many diseases, promote health, and improve the quality of life of the population, and expanding the range of such products is a very promising area of scientific research and production development.

In [15], the authors note that pancreatic lipase is the most important enzyme associated with hyperlipidemia and obesity. Their early studies showed that persimmon tannin was the main component responsible for the antihyperlipidemic effect of persimmon fruit, but the underlying mechanisms were unclear. However, in this study, the inhibitory effect of PT on PL was examined, and the possible mechanisms were assessed using fluorescence spectroscopy, circular dichroism (CD) spectra, isothermal titration calorimetry (ITC), and molecular docking. Research has shown that the strong inhibition of persimmon tannin in the gastrointestinal tract may be one of the mechanisms for its lipid-lowering effect. All this suggests that it is advisable to conduct a study of the influence of other representatives of phenolic compounds on the human body and find new technological methods that promote greater preservation of these minor compounds.

Work [16] 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. Regulating postprandial blood glucose levels is an effective therapeutic proposition for the treatment of type 2 diabetes. Oral administration of persimmon tannin starch complexes significantly suppressed the increase in blood glucose and area under the curve (AUC) in a dose-dependent manner compared with starch treatment alone in an in vivo rat model. Further studies showed that persimmon tannin can not only interact directly with starch but also strongly inhibit α-amylase and α-glucosidase, with IC50 values of 0.35 and 0.24 mg/ml separately. In addition, 20 μg/mL persimmon tannin significantly reduced glucose uptake and transport in the Caco-2 cell model. Overall, it has been shown that persimmon tannin may alleviate postprandial hyperglycemia by limiting starch digestion as well as inhibiting glucose uptake and transport. But questions remain unresolved regarding the effect of other representatives of phenolic compounds on the digestion of other carbohydrates.

According to [17], the phytochemical profile of persimmon fruit (*Diospyros kaki L.*) includes carotenoids, proanthocyanidins, and gallic acid, as well as other phenolic compounds and vitamins. Given this richness of antioxidant compounds, it has enormous antioxidant potential. These bioactive compounds have positive effects on health. The intersection of nutrition and sustainability can improve human health and reduce the global impact of food-related diseases such as cancer, heart disease, diabetes, and obesity, sparking the persimmon debate. Apart from the health implications of consuming it, it also adds value to highly perishable foods. Faced with a global food crisis and climate emergency, new and better everyday solutions are needed right now. Thus, the use of persimmon waste is also discussed as a good solution for the production of biofuel, eco-friendly alternative reducing agents for fabric dyes, green plant growth regulator, biodegradable and edible films for vegetable packaging, antimicrobial activity against food methicillin resistant Staphylococcus aureus. It has become clear that the use of persimmons extends far beyond the kitchen table, and the health benefits of its consumption have been demonstrated for many years. However, the work does not focus on the use of persimmon and its processed products as food additives.

Work [18] reports a study of the nutritional and mineral composition of *Diospyros kaki* fruits from the regions of Apulia, Campania, Lazio, Sardinia, and Sicily. The authors assessed the content of dietary fiber, minerals, pectin, polyphenols, and protein. Analyzes have shown that the content of dietary fiber and pectin is especially high. The mineral element profile is interesting due to its modest sodium content and high potassium concentration. The total polyphenol content of the fruits analyzed was highly variable, which is interesting due to the amounts of both total and gallic acid detected. The results confirmed the nutritional value of this fruit even for special dietary regimes. However, the use of persimmons for preparing food products with increased nutritional value has not been adequately studied. Therefore, research on preventive and health-improving properties, as well as recommendations of persimmon and its processed products for human illness, anemia, hypertension, goiter, and other diseases, is relevant.

In [19], the authors studied the use of molasses and invert syrup in the confectionery industry over a long period of time. It is known that they are included in almost all recipes for flour and sugar confectionery products. They are used as an anti-crystallizer to preserve the freshness of the product. The use of invert syrup instead of molasses makes it possible to improve the manufacturability of the production process. This is due to the increased fluidity of syrup compared to molasses. In addition, it is economical due to the possibility of eliminating the molasses tempering step. However, it practically does not contain the macro elements necessary for human life. The authors devised a syrup technology based on fruit and vegetable raw materials with increased amounts of native micronutrients. They used pumpkin as a raw material for the production of confectionery and semi-finished products. Until now, pumpkin has been little used as a raw material for the production of confectionery products. Pumpkin is a source of micro- and macronutrients, pectin, and β-carotene. But this does not critically solve the problem of increasing the usefulness of confectionery products with such useful substances as vitamins, easily digestible carbohydrates, and phenolic compounds. The use of a natural additive with easily digestible carbohydrates reduces fermentation time and saturation with flavor-forming components. Therefore, the recipe for confectionery products must include products that are rich in vitamins, carbohydrates, phenolic compounds, which prevent the development of pathogenic microorganisms and ensure the safety of finished products, as well as replenish the human body. In this regard, the most suitable, economically, and economically beneficial is the oriental persimmon, which is rich in carotene, pectin substances, phenolic compounds, and a number of mineral compounds such as potassium, calcium, iodine, and cobalt. Therefore, the use of persimmon concentrate in the preparation of confectionery products as a sweetener is more promising and economical.

The authors in [20] note that fresh persimmon fruits are a valuable food product. They are rich in sugars, phenolic compounds, enzymes, minerals, especially iodine. From an environmental point of view, persimmon fruits are a pure

food product since no chemicals are used in their cultivation. It is important to note that when persimmon fruits ripen, pest damage is also not observed. Therefore, persimmon is a promising valuable food product. Most of the crops available to the population spoil, rot, and are thrown away.

Persimmon fruits are high-yielding and capable of accumulating significant amounts of nutrients. Persimmon contains simple sugars, phenolic compounds and other components that determine its nutritional and biological value. Therefore, it is advisable to store persimmons in the refrigerator in order to provide people with fresh and environmentally friendly products throughout the year. However, recommendations for the use of persimmon fruits and its processed products as a concentrate and food additive have not been studied.

All this allows us to assert that research conducted with the aim of using concentrated persimmon juice as a sweetener is the most relevant. Research into the chemical composition, especially phenolic compounds, the use of persimmon as a raw material for the production of juices, as well as the technology for their preparation, is missing. One of the reasons for the limited consumption of persimmon fruits is due to its seasonality and unimproved technological methods for producing various food products from it. Fresh persimmon fruits with high nutritional value are consumed only for 1–2 months. Most of it remains at the top of the tree, deteriorates, and is thrown away as waste. Despite the rich composition of persimmon, represented by organic and inorganic substances beneficial to the human body, it is not used effectively enough. The fertile soil and climatic conditions of the country open up ample opportunities for growing persimmon trees for a long time. The widespread persimmon varieties Khachia and Hiakume are very productive. Due to the high nutritional value of persimmon fruits, the juice prepared from it is used as a natural medicine (taken a teaspoon early in the morning), and as a sugar substitute in many areas of the food industry (production of juices, compote, jam, jam, etc.). Persimmon fruits have high nutritional value; their composition is rich in organic and inorganic substances necessary for the normal functioning of the human body.

From the review of the literature, it became clear that for a more appropriate use of persimmon fruits, it is important to devise a technological scheme for obtaining juice. Complete extraction of sugars requires mechanical and thermal treatment of raw materials. In the process of processing in the classical way (i. e., without heat treatment), obtaining natural juice with and without pulp is very difficult and requires a lot of time and labor. The main reason for this is the strong connection between the tissue structure of persimmon fruits. This makes it difficult to extract juice from persimmons. With preliminary heat treatment, as a result of the complete destruction of the structure of fruit tissues, not only an increase in juice yield is ensured, but also an increase in the amounts of extractive substances compared to the classical method. The use of a hot method for pre-processing persimmons in the technology for obtaining juice ensures an increase in juice yield and a decrease in pulp yield compared to the classical method.

Various food additives and sweeteners are widely used in the food and confectionery industry. Sucrose and other sugars are not included. These additives, for example aspartame (E951), xylitol (E967), calcium and potassium saccharinate (E954), and others, are obtained chemically [21]. In the human body they play neither a plastic nor an energetic role. Their use is allowed as a taste and aroma regulator. Regular use of such additives contributes to the creation of many malignant diseases. However, the use of persimmon juice as an environmentally friendly food supplement, rich in easily digestible sugars, but also other important nutritional components, is more appropriate.

The intensification of the technogenic impact in the environment causes numerous microecological disturbances in the human body, and therefore it is important to develop the production of plant-based products aimed at regulating the functions of the body. In this regard, modern technologies must ensure the production of full-fledged products. Therefore, it is necessary to devise and improve technologies based on plant raw materials rich in vitamins, minerals, phenolic compounds, dietary fiber, and other food components. In this regard, the widespread use of local raw materials and their inclusion in technological processes remain insufficiently resolved problems. One of the reasons for this is the lack of an integrated systematic approach to the analysis of raw materials, including promising plant resources, due to the diversity of their chemical composition and technological processes during industrial processing.

In this regard, solving the problem of obtaining complete environmentally friendly natural food products is impossible without the theoretical and experimental development of technological solutions that guarantee the preservation of the native physiological value of the raw materials.

3. The aim and objectives of the study

The purpose of our research is to devise a technology for the production of concentrated persimmon juice. This will make it possible to use the prepared concentrate as a sweetener in the production of various environmentally friendly food products with high organoleptic and quality indicators.

To achieve this goal, the following tasks are solved:

– to determine the quality indicators of juices from persimmon varieties prepared by preliminary heat treatment and the use of an enzyme preparation;

– to develop a technological scheme for preparing concentrated juice.

4. The study materials and methods

4. 1. The object and hypothesis of the study

The object of our study is the processes of obtaining juices from persimmon fruits. The persimmon varieties Khachia and Hiakume, widespread in the territory of the Republic of Azerbaijan, were used as research material. To prepare concentrated juice, persimmon juice was used, prepared by heat treatment, and using 0.1–0.2 % enzyme preparation.

The research hypothesis assumed that during heat treatment and subsequent treatment with an enzyme preparation, the quality indicators of persimmon, in particular soluble solids, sugars, vitamins, and phenolic compounds, are transferred into juice. Pectolytic enzymes break down pectin substances and promote deeper discoloration of the juice. In the juice obtained using the proposed technology, the amount of cellulose is reduced. The most important thing in persimmon fruits is the amount of fructose, which exceeds the amount of glucose, therefore concentrated persimmon juice can be used as a sweetener in the production of dietary products

for patients with diabetes, hypertension, and other diseases. Phenolic compounds of persimmon ensure long-term storage and prevent microbiological spoilage of finished products prepared using concentrated juice, owing to their antioxidant and antimicrobial properties.

It was assumed that in order to completely extract sugar and other nutrients from persimmon fruits, the cellular structure must be destroyed. For more efficient use of persimmon fruits, it is important to devise a technological scheme for obtaining juice, which requires mechanical and thermal processing of raw materials.

4. 2. Methods for studying juice quality indicators

Research methods: theoretical research – comparative analysis of literary resources, experimental research – experiments based on GOST standards. The persimmon varieties used were purchased from the market in wooden boxes with a capacity of 10 kg. Individual persimmon varieties were pre-sorted, cleaned, and submitted for processing. The research was carried out at the Department of Food Engineering and Expertise of the Azerbaijan Technological University, as well as in the laboratories of the Georgian Scientific Research Institute. The juices were prepared at the AzGranata plant in Agsu district.

First, the mechanical composition of Khachia and Hiakume fruits and the yield of unclarified juice with and without pulp were studied. In the prepared juices, the amounts of soluble solids, total sugar, glucose, fructose, cellulose, pectin, vitamin C, and phenolic compounds were determined. The main quality indicators of persimmon juices were determined using the following procedure:

– amount of dry matter – by refractometric method [22];

– glucose, fructose – by chromo-mass spectrometry [22];

– cellulose – according to the modified Kogan method [23];

– pectin substances – by the carbazole method in a calorimeter [23];

– vitamin C – using the dichlorophenolindophenol reagent [23];

– mineral substances – in an atomic adsorption spectrometer – AAnalyst 400 (PerkinElmer, USA) [23];

– phenolic compounds – by gas chromatography-mass spectrometry [24];

– tasting the juice used to prepare concentrated juice and the concentrate itself [25].

During the study, a mathematical-statistical method was used for the accuracy and reliability of the assessment of each determined parameter.

To obtain concentrated juice, a KUV-1 washing machine, a TCI belt conveyor, an M2-TE elevator, and a G9-KOV separator were used; chopper KDP-4M, pump 36 M4-10-20, filter B9-VFS/423-53, vacuum apparatus MZS-320, scalder MZS-316, tanks MZS-314, condenser BK.

5. Results of a scientific and experimental study of the possibility of using persimmon juice for the production of concentrate

5. 1. Determining quality indicators of juices prepared by preliminary heat treatment and the use of an enzyme preparation

Table 1 gives the yield of juice from persimmon fruits prepared by preliminary heat treatment and the use of an enzyme preparation.

Table 1

Juice yield from persimmon fruits prepared by preliminary heat treatment and the use of an enzyme preparation, %

No.	Indicator	Persimmon varieties	
		Khachia	Hiakume
1	Yield of juice with pulp	93.9	93.8
2	Pulp	18.5	19.6
3	Yield of unclarified juice without pulp	75.4	74.2
4	Seeds	2.5	2.3
5	Skin	1.6	1.7
6	Fruit stem	2.0	2.2

Table 1 shows that the juice yield from the Khachia variety is 93.9 %, and from the Hiakume variety – 93.8 %. The yield of unclarified juice for the Khachia variety was 75.4 %, for Hiakume – 74.2 %. As waste, 100 kg of persimmon produces 2.3–2.5 % seeds, 1.6–1.7 % peel, and 2.0–2.2 % stalks. The lower yield of unclarified juice without pulp in the Hiakume variety compared to the Khachia variety is explained by soil and climatic conditions, the specificity of the variety, and the high content of skin and pulp.

As can be seen from Table 2, the amounts of soluble solids in the composition of juices prepared from persimmon fruits with heat treatment and the addition of an enzyme preparation after cooling was 25.2–25.6 g/100 cm^3. It was found that in the juice prepared from the fruits of the Khachia variety of persimmons, the dry matter content is 25.6 g/100 cm^3, and in the juice from the fruits of the Hiakume variety of persimmons – 25.2 g/100 cm^3.

Table 2

Qualitative indicators of juice prepared from persimmon fruits, previously subjected to heat treatment using an enzyme preparation (g/100 cm^3)

No.	Indicator	Persimmon varieties	
		Khachia	Hiakume
1	Soluble solids	25.6	25.2
2	Total sugar	22.8	21.9
3	Glucose	8.5	8.1
4	Fructose	9.7	9.2
5	Pectic substances	0.42	0.44
6	Pectin	0.24	0.24
7	Protopectin	0.18	0.20
8	Vitamin C	0.090	0.086
9	Phenolic compounds	0.74	0.70
10	Cellulose	0.34	0.36
11	Tasting assessment	9.0	8.6

The data in Table 2 show that in juices prepared by preliminary heat treatment and the use of an enzyme preparation, the content of total sugar, glucose, and fructose is much higher. Thus, in the juice from the Khachia persimmon variety, the content of natural total sugar was 22.8 g/100 cm^3, including 8.5 g/100 cm^3 of glucose and 9.7 g/100 cm^3 of fructose. In Hiakume, this indicator was correspondingly 21.9 g/100 cm^3; 8.1 g/100 cm^3, and 9.2 g/100 cm^3. As can be seen from Table 2, the sugar content in the juice obtained from the Khachia variety is significantly higher than that from the Hiakume variety. In the juice prepared from the Khachia variety, the total sugar content was 22.8 g/100 cm^3,

and in the juice obtained from the Hiakume variety this indicator was 21.9 g/100 cm^3. In the juice prepared from the Khachia variety, the content of glucose and fructose ranged from 8.5 to 9.7 g/100 cm^3, while in the Hiakume variety this indicator was recorded in the range of 8.1 to 9.2 g/100 cm^3. Studies have shown that the Khachia persimmon variety has a higher total sugar content compared to Hiakume.

As can be seen from Table 2, in the juices the content of pectin substances changed within the range of 0.42–0.44 g/100 cm^3, protopectin was found in the amount of 0.18–0.20 g/100 cm^3, and pectin in the juice from both varieties of persimmon was the same and amounted to 0.24 g/100 cm^3. The lower content of pectin substances is explained by the addition of a pectolytic enzyme preparation to the juice. It is known that pectin enzymes catalyze not only pectin substances found in juice but also promote the breakdown of pectin, protopectin, and polygalactronic acid, thereby increasing the yield of juice and reducing the number of colloidal particles.

In juices prepared by preliminary heat treatment and the use of an enzyme preparation, the content of vitamin C depends on the type of persimmon. In the juice from the Khachia variety, the vitamin C content is 0.090 g/100 cm^3, in the juice from the Hiakume variety of persimmon fruits – 0.086 g/100 cm^3. It is important to note that the presence of phenolic compounds in the prepared juice increases its antioxidant properties and increases the shelf life of the finished product. Studies have shown that in the juice prepared from the Khachia variety, the content of phenolic compounds was 0.74 g/100 cm^3, and in the Hiakume variety it was 0.70 g/100 cm^3.

It is known that raw materials with a lower cellulose content are suitable for preparing clarified juices. Since cellulose is not absorbed by the body and gives the juice a cloudy appearance, its presence in juice is undesirable.

During tasting, the juice from the Khachia persimmon variety was rated 9.0 points, and the juice from the Hiakume variety was rated 8.6 points.

During statistical processing of experimental data, the reliability of the resulting estimates was fixed at a certain level, taking the confidence probability value equal to 0.9. The t test value for 0.9 was 2.13.

At a significance level of ε=2.13, using the analysis of variance method, we checked the reliability of the qualitative indicators of persimmon fruits of the Khachia variety, in this case the amount of dry matter, total sugar, glucose, fructose, and phenolic compounds based on five measurements for five factor levels (Table 3).

Table 3

Quantitative content of indicators of persimmon variety Khachia depending on the number of measurements

Number of measurements, n (X)	Indicator				
	Amount of dry matter	Total sugars	Glucose	Fructose	Phenolic compounds
x_1	26.3	22.3	8.3	9.5	0.76
x_2	25.7	22.8	8.4	9.5	0.75
x_3	25.8	22.4	8.6	9.7	0.73
x_4	25.4	23.0	8.7	9.9	0.74
x_5	24.8	23.5	8.5	9.9	0.72
x_{cp}	25.6	22.8	8.5	9.7	0.74
σ	0.54	0.48	0.025	0.2	0.15
V	0.003	0.004	0.002	0.001	0.009

As can be seen from Table 1, coefficient of variation does not exceed 5 %. This proves the fact that there are no systematic errors in the determination methods used. The number of components determined does not exceed a certain range.

5. 2. Technological scheme for preparing concentrated juice

Concentrated juice was produced from juices prepared by preliminary heat treatment and the use of an enzyme preparation, which was used as an environmentally friendly sweetener in the production of juices, compotes, and other products.

The technological scheme for obtaining concentrated juice is shown in Fig. 1.

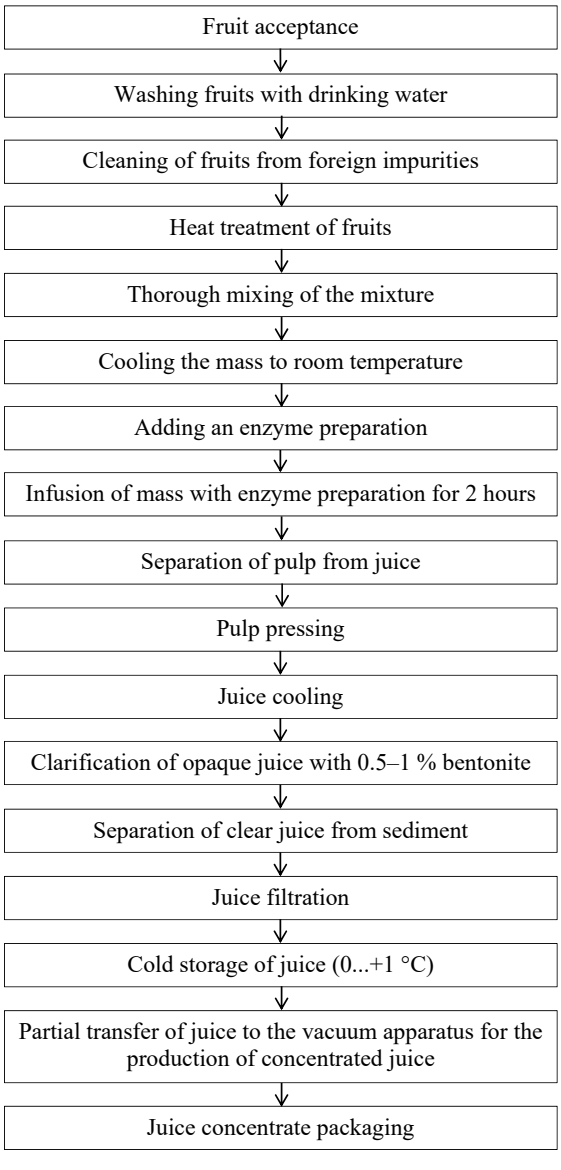

Fig. 1. Technological scheme for obtaining concentrated persimmon juice

Acceptance and washing of raw materials. Persimmon fruits delivered to the enterprise are fed into a washing machine. Water intended for washing fruits must be clean and suitable for drinking. During the washing process, fruits are

cleaned of mechanical impurities, dust, pathogens, harmful chemicals, and other impurities.

Cleaning and sorting of fruits. At this stage, unripe, infected fruits, and various impurities (leaves, small tree trimmings, etc.) are removed. When producing juice, cleanly washed healthy fruits are used. Cleaning and sorting are carried out on a conveyor.

Grinding machine. The washed and peeled fruits are sent to a grinding machine. Here the persimmon fruits are crushed, chopped, and sent for heat treatment (blanching).

Heat treatment of raw materials. Chopped persimmon fruits are placed in a container intended for heat treatment with a volume of up to ¾. We add 10–15 % clean drinking water to the mixture and heat it at 80–90 ℃ for 8–10 minutes. The main purpose of adding water to the juice and cooking it is to mix the skin and pulp well into 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 exposure to heat, the vital activity of pathogenic microorganisms ceases. When mixed, the juice is enriched with extractive substances and enzymes are inactivated to prevent oxidation of the juice. It should also be noted that protein haze due to temperature is prevented prematurely. In addition, due to changes in the natural structure of proteins in the juice, pectin substances subsequently appear, which contribute to the cloudiness of the juice. Most of the protein compounds and other biopolymers are converted into monomeric form, which increases the dry matter of the juice, sugar, extractives, 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 heat treatment stops the breakdown of the nutritional components that make up the persimmon fruit. Enzymes, mainly polyphenol oxidase, are known to cause discoloration 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 [26]. At the next stage, the mixture is cooled to room temperature, and 0.1–0.2 % pectolytic enzyme preparation is added [27]. The mixture is kept together with the enzyme preparation for 2 hours and mixed well several times. The mixture is then transferred to a press to separate the juice. The enzyme preparation and the proposed processing mode reduce the duration of the process of obtaining juice, increase its yield, and improve quality.

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

Juice clarification. To clarify the juice, 0.5–1 % bentonite is added to it. Bentonite (montmorillonite) is an environmentally friendly gluing material. Bentonite clays are widely used in the medical and food industries. Being a source of irrigation microelements, bentonite is used for the manufacture of various dietary supplements and vitamins; it has a good effect on the functioning of 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 dietary supplement for metal poisoning. Montmorillonite crystals have fat-absorbing properties, and it has antibacterial properties. Bentonite adsorbs and removes a strong toxic substance, gossypol, from the body. Preparations based on bentonites have the properties of an ion exchange adsorbent and catalyst, replenish substances bioavailable to the body, contribute to the normalization of general and especially mineral metabolism, improve digestibility and rational use of nutritional components, and create the necessary conditions for increasing the overall resistance of the body [28]. Owing to its action, 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

Juice cooling. The main purpose of cooling is to prevent oxidation, fermentation, and cloudiness of the juice. Since clear juice contains up to 18–25 % natural sugar, it must be constantly protected from the fermentation process. Otherwise, sugar loss may occur during fermentation. Glucose and fructose are representatives of the main simple sugars in persimmon juice, which are more sensitive to the fermentation process. During fermentation, the quantitative content of dry substances in the juice decreases and, accordingly, the yield of concentrated juice decreases. Therefore, clarified juice should be kept cold until processed. The juice is also passed through a separator to ensure stability. Before processing, the juice is strained cold.

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

Supplying juice to a vacuum apparatus. The filtered clarified juice is fed into a vacuum apparatus for concentration. In a vacuum apparatus, under the influence of heat, the amount of dry matter increases due to the evaporation of water in the juice. The main purpose of using a vacuum device in the production of concentrated juice is to save energy and prevent darkening of the color or oxidation of the finished product. The process is stopped when the dry matter content in the juice reaches 70–75 %. Then the produced concentrated juice is transferred to clean containers with a capacity of 250–500 grams and sent for storage to special warehouses.

Packaging of the finished concentrate. The produced concentrated product is placed in containers, labeled, and stored at a temperature of 15–18 °C until sent for sale [29].

The concentrated juice made from the juice of the Khachia variety was rated 9.4 points during tasting, and the juice made from the Hiakume variety was rated 9.2 points.

6. Discussion of experimental results from investigating the possibility of using persimmon for the production of concentrated juice

The creation of a new technology for the production of concentrate from persimmon juice is an effective processing method that will allow obtaining products of high nutritional value, storing and using them in the off-season. In contrast to the classical method, in the developed technological scheme (Fig. 1), preliminary heat treatment of persimmon fruits helps increase the amount of soluble pectin, the use of an enzyme preparation ensures a uniform occurrence of the concentration process due to a decrease in the effective viscosity associated with the content of highly methoxylated pectin substances acting as thickeners. During the process of enzymatic hydrolysis, plant tissue cells are destroyed due to

depectinization, which leads to a decrease in the viscosity of the initial mass of the product. The proposed technological scheme makes it possible to preserve the native properties of persimmon as much as possible, provide a high amount of concentrate, and ensure a continuous concentration process. In addition, the process of moisture removal is accelerated, the efficiency of vacuum evaporators increases, and helps improve the organoleptic characteristics of the finished product.

For the prepared clarified juice from the persimmon varieties Khachia and Hiakume, the mechanical composition indicators and the yield of juice with pulp were previously calculated. Table 1 shows that the yield of juice from the Khachia variety is 93.9 %, and from Hiakume – 93.8 %. The yield of unclarified juice for the Khachia variety was 75.4 %, for the Hiakume variety – 74.2 %. From 100 kg of persimmon, 2.3–2.5 % of seeds, 1.6–1.7 % of peel, and 2.0–2.2 % of stalks are obtained as waste. The data in Table 1 show that the pulp yield for the Hiakume variety was 19.6 %, and for the Khachia variety 18.5 %. This difference in the yield of unclarified juice without pulp is explained by soil and climatic conditions, the specificity of the variety, and the high content of skin and pulp [30].

Analysis of studies of the quality indicators of juice prepared by preliminary heat treatment and using an enzyme preparation showed that the amounts of soluble solids was 25.2–25.6 g/100 cm^3. It was found that in the juice prepared from the fruits of the Khachia variety of persimmons, the dry matter content is 25.6 g/100 cm^3, and in the juice from the fruits of the Hiakume variety of persimmons – 25.2 g/100 cm^3. The content of total sugar, glucose, and fructose is higher compared to other carbohydrates. In the juice from the Khachia persimmon variety, the total sugar was 22.8 g/100 cm^3, in which the glucose content was 8.5 g/100 cm^3, and the fructose content was 9.7 g/100 cm^3. In the Hiakume variety, this indicator was correspondingly 21.9 g/100 cm^3; 8.1 g/100 cm^3, and 9.2 g/100 cm^3. From the data in Table 2 we can conclude that the sugar content in the juice obtained from the Khachia variety is significantly higher than from the Hiakume variety. In the juice prepared from the Khachia variety, the total sugar content was 22.8 g/100 cm^3, and in the juice obtained from the Hiakume variety this indicator was 21.9 g/100 cm^3. In the juice prepared from the Khachia variety, the glucose and fructose content ranged from 8.5–9.7 g/100 cm^3, while in the Hiakume variety this indicator was recorded in the range of 8.1–9.2 g/100 cm^3. Due to the increased sugar content, the possibility of preparing concentrated juice increases.

From the analysis of the quality indicators of juices prepared by heat treatment and using an enzyme preparation, it became clear that the content of pectin substances due to the addition of a pectolytic enzyme preparation to the juice was recorded in small quantities. In the juice prepared from the Khachia variety, the content of pectin substances was 0.42, and in the juice from the Hiakume variety it was 0.44 g/100 cm^3. Protopectin in juices changed in the amount of 0.18–0.20 g/100 cm^3, and pectin in juice from both varieties of persimmon was the same and amounted to 0.24 g/100 cm^3.

It is known that pectin enzymes catalyze not only pectin substances found in juice but also promote the breakdown of pectin, protopectin, and polygalactronic acid, thereby increasing the yield of juice and reducing the number of colloidal particles [31]. During the hydrolysis of pectin substances, as representatives of heteropolysaccharides, along with galacturonic acid, other simple monosaccharides are formed: glucose, arabinose, mannose, rhamnose, etc. The formation of monosaccharides is a key factor in the preparation of concentrated juice.

Analysis of juices prepared by preliminary heat treatment and the use of an enzyme preparation confirmed the fact that the vitamin C content depends on the persimmon variety. In the juice from the Khachia variety, the vitamin C content was 0.090 g/100 cm^3, and in the juice from the Hiakume persimmon variety it was 0.086 g/100 cm^3 (Table 2). To reduce vitamin deficiency, it is necessary to enrich the daily diet with products with functional additives [31]. Ascorbic acid is a natural antioxidant. Therefore, juices with a high content of this acid are stored for a long time and become infected with microbiological diseases.

From the analysis of studies of phenolic compounds, it became clear that in the juice prepared from the Khachia variety, the content of phenolic compounds was 0.74 g/100 cm^3, and in the Hiakume variety it was 0.70 g/100 cm^3. It is important to note that the presence of phenolic compounds in prepared juices increases its antioxidant properties and increases shelf life [33]. Phenolic compounds have high antioxidant, antimicrobial and even antiviral properties. Phenolic compounds affect mainly the fullness of the juice, the enrichment of aromatic substances, long-term quality storage, as well as the slowing down or cessation of the activity of oxidative enzymes.

Analysis of the quantitative change in cellulose showed that in the juice from the Khachia persimmon variety its content was 0.34 g/100 cm^3, and in the juice from the Hiakume persimmon variety it was 0.36 g/100 cm^3. It is known that raw materials with a lower cellulose content are suitable for preparing clarified juices. Since cellulose is not absorbed by the body and gives the juice a cloudy appearance, its presence in juice is undesirable. As a result of the tasting, the clarified juice from the Khachia persimmon variety was rated 9.0 points, and the juice from the Hiakume variety was rated 8.6 points (Table 2).

Concentrated juice was prepared from juices prepared by preliminary heat treatment and the use of an enzyme preparation, which is advisable to use as an environmentally friendly sweetener in the production of juices, compotes, and other products.

It is known that powdered sugar or refined sugar consists only of sucrose, which is a representative of disaccharides. When powdered sugar is rectified, 99.75 % of sucrose remains in it. We can say that sugar contains only one component – sucrose. However, the composition of 45–50 % of the concentrate obtained from persimmon fruits is rich in nutritional components, mainly simple sugars, aromatic and other organic and inorganic substances necessary for the human body.

Calcium is responsible for the efficiency of various processes, and its intake in food is necessary for the normal functioning of the human body. In addition to being an important component of the skeleton, calcium also helps maintain the structure of cellular organelles and regulates the homeostasis of intracellular and extracellular fluids. The bioavailability of calcium is influenced by endogenous and exogenous factors. Endogenous factors include such physiological conditions and factors as pregnancy, infancy, menopause, old age, hormones, growth factors associated with calcium metabolism, diseases that limit its absorption, and intestinal microbiota. Although calcium reserves in the

body are genetically determined and individual for each person, its qualitative and quantitative composition can be modified by external factors. Exogenous factors include dietary modifications using specific nutrients and pharmacological treatments [34]. The use of persimmon concentrate in the preparation of various food products increases the bioavailability of calcium.

Minerals perform a wide range of functions in the optimal functioning of the immune system. Mineral intake is important for optimal functioning of the innate immune system as well as components of the adaptive immune defense; this includes defense mechanisms against pathogens in addition to a long-term balance of pro- and anti-inflammatory regulation. Typically, a balanced diet is sufficient to provide the necessary balance of minerals to support the immune system. Although mineral deficiencies are rare, there are still at-risk groups who should be careful to ensure they are getting enough minerals. Mineral deficiency may temporarily reduce immune competence or even disrupt the regulation of systemic inflammation in the long term. Therefore, knowledge of the mechanisms and supply of these minerals is important. In exceptional cases, the deficiency should be compensated for with environmentally friendly additives [35].

The sweetness of simple sugars in concentrate is approximately 1.5 times greater than that of powdered sugar. In this regard, when using concentrate in the production of canned products, the sweetness of the product is higher compared to added powdered sugar. This is mainly due to the fact that more than 50 % of the sugar in concentrate consists of fructose, which has a higher sweetness.

One of the predominant properties of the concentrate compared to powdered sugar is that powdered sugar, used in the production of juices, compotes, and other products, is absorbed by the human body enzymatically. Under the action of the enzyme invertase, sucrose is broken down into glucose and fructose, only then it enters the metabolic system. However, when consuming canned foods with the addition of concentrate, the simple sugars they contain enter directly into the blood and are absorbed more easily, rather than enzymatically. Concentrated juice also plays an important role in meeting the body's energy needs.

As a result of research, it has been established that the shelf life of juices, compotes, and other products with the addition of concentrate instead of powdered sugar increases. Therefore, the use of concentrate in the production of juices and compotes significantly increases the nutritional value of the product. The main advantage of canned foods with added concentrate is that they can be preserved by sterilization or pasteurization. When using concentrated juice in the preparation of various food products, their nutritional value increases significantly due to the high concentration of sugar.

It is also important to note the limitations of the study conducted. To prepare clarified juice, you need to choose fully ripened persimmon fruits. Otherwise, the juice yield decreases. When processing unripe fruits along with a lower juice yield, the amount of insoluble pectin and protopectin increases. And this limits the production of clarified juice. When using overripe fruits, the amount of methyl alcohol formed during the oxidation of pectin under the influence of pectin esterase increases and the taste and presentation of the final product worsens. There are limitations associated with the technological mode of preparation of the concentrate. When the juice concentration increases above 45–50 %, the color of the concentrate deteriorates and acquires a dark brown tint. At the same time, the taste and smell of the concentrate changes and, when added as a sweetener, worsens the aroma of the finished product. Therefore, you must strictly adhere to the specified temperature and technological regime for preparing the concentrate.

The disadvantage of the research work is the incomplete extraction of sugars and the loss of some vitamins and other beneficial substances of persimmon. Therefore, pectolytic enzymes were used, the use of which is extremely expensive. However, a new generation of biocatalysts (immobilized enzymes) has now been created, which will help expand the scope of their application. These enzymes will also act to reduce the viscosity of the juices, which will subsequently significantly increase the filtration rate.

In the future, it is possible to continue research to determine technological regimes that allow the most complete preservation of the nutrients of raw materials. During concentration, the basic properties of the product continuously change, so the selection of conditions and devices for concentration can become the main object of research. The development of new schemes for producing concentrates with a long shelf life and high nutritional value may be promising for use as a replacement for perishable fruit concentrates.

7. Conclusions

1. It has been established that for prepared clarified juice from the persimmon varieties Khachia and Hiakume, it is first necessary to calculate the mechanical composition and the yield of juice with pulp. The juice yield from the Khachia variety was 93.9 %, and the juice yield from the Hiakume variety was 93.8 %. The yield of unclarified juice for the Khachia variety was 75.4 %, for the Hiakume variety – 74.2 %. This difference in the yield of unclarified juice without pulp is explained by soil and climatic conditions, the specificity of the variety, agrotechnical cultivation conditions, and a high content of skin and pulp. The amounts of soluble solids in the juice prepared by preheating and using an enzyme preparation was 25.2–25.6 g/100 cm^3. In the juice prepared from persimmon fruits of the Khachia variety, the dry matter content was 25.6 g/100 cm^3, and in the juice from persimmon fruits of the Hiakume variety – 25.2 g/100 cm^3. The content of total sugar, glucose, and fructose was higher compared to other carbohydrates. In the juice prepared from the Khachia variety, the total sugar content was 22.8 g/100 cm^3, and in the juice obtained from the Hiakume variety this indicator was 21.9 g/100 cm^3. In the juice prepared from the Khachia variety, the content of glucose and fructose ranged from 8.5–9.7 g/100 cm^3. Owing to the increased sugar content, the possibility of preparing concentrated juice has increased. The quantitative content of pectin substances in the juice prepared from the Khachia variety was 0.42 g/100 cm^3, and in the juice from the Hiakume variety it was 0.44 g/100 cm^3. The research results show that the analyzed components in the fruits of the Khachia persimmon variety are superior to those of the Hiakume persimmon variety. As a result of the tasting, the clarified juice from the Khachia persimmon variety was rated 9.0 points, and the juice from the Hiakume variety was rated 8.6 points. Therefore, for the production of concentrated juice, it is advisable to use the Khachia persimmon variety.

2. A technological scheme for preparing concentrated juice has been developed. According to this scheme, clarified juice was used to prepare the concentrate using the method of

preliminary heat treatment and the use of an enzyme preparation. This contributes to the complete extraction of sugars due to mechanical and thermal processing of persimmon fruits. In the process of heat-free processing, obtaining natural juice with and without pulp is difficult and requires a lot of time and labor. During heat treatment, as a result of complete destruction of the structure of fruit tissues, the juice yield increased, and the quantitative content of nutrients increased due to extraction. This reduced the yield of pulp. Owing to the enzyme preparation, the amount of insoluble protopectin and pectin decreased, clarification and filtration of juice improved. Condensing the juice to a solid concentration of 45–50 % contributed to obtaining a concentrate with improved organoleptic characteristics. The color of the resulting concentrate was light brown with orange tones, the taste was characteristic of persimmon, and the appearance was transparent without sediment. When tasting, the concentrate made from the juice of the Khachia variety was rated 9.4 points, and the concentrate made from the juice made from the Hiakume variety was rated 9.2 points. The use of concentrate as a sweetener not only increases the nutritional value of products but, owing to phenolic compounds, it facilitates their long-term storage. They retain their high quality characteristics and can be widely used in human nutrition.

When tasting, the concentrate made from the juice of the Khachia variety was rated 9.4 points, and the concentrate made from the juice made from the Hiakume variety was rated 9.2 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.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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