

RESEARCH TECHNOLOGY OF PRODUCTION OF HERBAL AND NATURAL PRESERVES

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Abstract. *This research work is devoted to the technology of production of dietary and herbal natural preservatives for people with diabetes. Scientific work on hydrolysis of inulin from Jerusalem artichoke with citric acid, acid-rich fruit juices was carried out. The hydrolyzate was purified, transformed into syrup, and used as a sugar substitute in the preparation of canned sugar.*

Keywords. *Fructose, inulin, sugar substitute, canned, acid, extract, pomegranate, lemon, juice.*

Introduction. It is well known that diabetes is a common and very costly disease and one of the most serious problems of the global health care system. Up to date, the number of people with diabetes is 415 million, and by 2025 it will reach 830 million. It is noted that 7.8% of the population of Uzbekistan is suffering from this disease.

Diabetes mellitus is one of the endocrine diseases caused by complete or partial deficiency of the hormone insulin. Insulin is a protein hormone of animal and human nature and is produced in the islets of Langergans in the pancreas. Its main function is to regulate carbohydrate metabolism and control blood sugar levels. Under the influence of insulin, intracellular transport of glucose is increased, glycogen synthesis in the liver is increased, gluconeogenesis and glycogenolysis are stopped, and therefore blood glucose is reduced. The hormone insulin is not required for fructose to enter the cell.

The increase in the number of patients from year to year requires the organization of a healthy diet, the expansion of the production of functional foods that are low in calories, rich in various nutrients, as well as natural and that have healing properties [1,2].

In particular, it is important to replace sucrose with sugar substitutes that are easily assimilated and do not adversely affect health, to separate natural sugar substitutes from non-traditional raw materials and to use them extensively in the food industry.

Currently, synthetic sweeteners such as saccharin, aspartame, xylitol, sorbitol are used as sugar substitutes in the production of confectionery and sweet canned food for patients with diabetes. But these sweeteners do not fully meet the healing nutritional requirements. In particular, studies of metabolic processes in patients and children have shown that xylitol causes gastrointestinal upset and diarrhea, sorbitol has a negative effect on lipid metabolism, saccharin causes serious diseases of the gastrointestinal tract, and aspartame has a negative effect on the human nervous system. detected. The United States, Canada, France, and many other European countries have banned the use of these sugar substitutes in the food industry. Therefore, a lot of research is devoted to obtaining natural sugar substitutes.

One of the natural sweeteners with such a functional property is fructose. Fructose is higher in sweetness than sucrose and glucose, and the body absorbs fructose more easily than other sugars. The value of fructose is that it reduces the need for insulin preparations in patients with diabetes and normalizes blood sugar levels. As a result of the replacement of glucose and sucrose with fructose, people with diabetes will be able to consume [3].

Due to the wide spectrum of technological and functional properties of fructose, it is used as a supplement to beverages, ice cream, yogurt, flour confectionery, salads and other food products, as well as in the pharmaceutical industry. This monosaccharide is not only a sugar substitute, but also unexpensive (by 10-40%), quickly digested by the body, helping to reduce calories by 1/3 when consumed in a variety of foods and beverages. Therefore, it can be added to the recipe of medicinal and prophylactic foods [4, 5].

Methods. Hydrolysis of Jerusalem artichoke inulin is one of the main methods of obtaining fructose-glucose syrup. Inulin is a natural polysaccharide consisting mainly of 95% fructose. In the molecular formula of inulin, polyfructosans are located in the same size. Its molecule consists of 30-35 monosaccharide residues with a total molecular mass of 5000-6000, chemically composed of β -D-fructofuranose, a fructosane polymer, which is bound together by β -2 \rightarrow 1 glycoside bonds. Hydrolysis of Jerusalem artichoke inulin is one of the main methods of obtaining fructose syrup. Inulin is hydrolyzed by the enzyme inulinase or various acids [6].

Numerous scientific studies are currently focused on the technology of obtaining fructose, and inulin-containing plants, including Jerusalem artichokes, dahlias, are selected as a source of fructose.

This research consists of acidic hydrolysis of inulin from Jerusalem artichoke fruits to obtain fructose syrup and its use as a sugar substitute in the production of natural sweet and dietary canned products.

U.B. In Dzhanikulova's dissertation the technology of obtaining fructose syrup from Jerusalem artichoke using inulinase of the microorganism was developed. In this case, the hydrolysis of inulin to monosaccharides with a conservation rate of 93% using the yeast *Saccharomyces cerevisiae* 17 was revealed. Optimal conditions for the growth of yeasts have been selected so that they are modified in the nutrient medium and the enzyme is actively formed. The growth dynamics of yeasts in the culture fluid, the processes of formation of inulinase, proteins and free carbohydrates were considered, the technology of non-alcoholic beverage "Kovsar" based on fructose syrup was developed [9].

[10] The study focused on the food industry, mainly in the production of fructose-glucose syrup from roots or tubers containing inulin polysaccharide. According to the study, the juice was extracted from Jerusalem artichokes, the juice was purified and hydrolyzed with inulin food acids. The hydrolyzate was then clarified and concentrated until it became a syrup. When extracting the juice from the bottle, the object is crushed to a size of 0.3-1.0 mm, pressed. When cleaning the juice from solid particles, it is kept at a temperature of 80-85°C for 1-3 min. The precipitated protein and colloid-disperse additives are then filtered and separated. In the filtered juice, inorganic substances and inulides with a molecular chain length of less than 4,000 daltons are nanofiltered. A mixture of activated carbon and perlite is used to quench the hydrolyzate. The invention simplifies the technology of obtaining fructose-glucose syrup, provides process savings.

M.N. In a study by Nazarenko, inulin and fructose syrup were obtained enzymatically from artichoke tubers. On the basis of the obtained syrup and prepared dairy products enriched with β -carotene, as well as a recipe for making milk ice cream with the addition of inulin and β -carotene was developed [11, 12].

E.A. In a study by Yakovlev, one of the rich plants inulin was hydrolyzed by the acid method of inulin in a puree derived from the cycary plant, and its physicochemical properties were determined. Fructose-rich puree has been dried and used in the manufacture of functional foods, including confectionery. The low energy value of the finished product has been proven to be harmless to the body of people with diabetes [13].

Research has been conducted on the production of fructose syrups under the action of the enzyme inulinase isolated by inulin microorganisms in artichokes [14, 15, 16].

In research at the Voronezh State Academy of Technologies, the enzyme inulinase was used in the production of fructose syrup from Jerusalem artichokes, and this syrup was used as a substitute for sucrose in the production of diet drinks, ice cream and dairy dissertations. It has also been used in the production of dietary drinks, combining the valuable properties of artichoke and whey. The roots of Jerusalem artichoke stored for different periods of time can be used instead of sucrose in the preparation of dietary kvass. Fructose-glucose syrup from Jerusalem artichoke was used in the production of ice cream. It has a high sweetness and the presence of biologically valuable compounds further enhances its quality [17].

In a study conducted by researchers at the Belarusian State Academy of Agriculture, fructose extracted from inulin-rich plant raw materials was used as a sugar substitute in the production of confectionery and bakery products. The obtained product was found to be superior to confectionery products obtained on the basis of traditional technology in terms of appearance, organoleptic characteristics and biological significance [18].

In addition, many studies have been conducted to obtain fructose syrups from inulin-rich plant extracts [19, 20, 21].

Results and Discussion. In the laboratory, fructose syrup was obtained from Jerusalem artichoke tubers, and the resulting syrup was used as a sugar substitute to make canned goods. The object of research was selected species of artichoke "Fayz-baraka". It is known from the literature that inulin ($C_6H_{10}O_5$)_n is readily soluble in hot water (80⁰C). Therefore, we crushed the finished fruits and extracted in water at a temperature of 80-90⁰C. The extract was filtered and the process of hydrolysis of inulin using 1% and 1.5% solutions of citric acid was studied [7, 8].

Under the influence of heat and acid, water-insoluble substances, including minerals, proteins, pectin, contained in the crushed sediment, fell to the bottom of the vessel in the form of sediment. Once the juice had cooled, it was filtered using a cloth. The ambient acidity of juices with slaked lime is pH ~ 3.2, respectively; from pH ~ 2.5, the ambient acidity was brought to pH ~ 5, and it was again filtered with a help of fabric. The extracted clear portion was passed through an activated carbon column.

Pomegranate and lemon fruits were selected from the acid-rich fruits as the object of the research. The juices of these fruits were extracted. The flask was filled with lemon juice and Jerusalem artichoke extract in a 1: 1 ratio. A mixture of ignorant pomegranate and Jerusalem artichoke extract was also prepared in a 1: 1 ratio. The flasks were placed at 80–90⁰C for 3 h.

The flasks were cooled, the juices were filtered, and was passed through the activated charcoal column and clarified. The hydrolyzed juices were tasted organoleptically. The color of the juice is clear and light yellow color, the taste is very pleasant, sweet. Juice that was hydrolyzed in pomegranate juice showed the best result.

During the hydrolysis process, a sample was taken every 20 minutes, placed in a dialysis bag to separate the undigested inulin polysaccharide and the resulting monosaccharides, and placed in distilled water. After 4 h, the water in the dialysis bag was evaporated at 55⁰C in a rotor evaporator until 1/3 of the total water remained, and the amount of fructose was determined. The results of the experiment are presented in table 1.

The results showed that the volume of the mixture of sour pomegranate juice and Jerusalem artichoke juice before heat treatment was 40 mg / ml, while at the end of the hydrolysis process it was 83 mg / ml, i.e., the amount of fructose doubled as a result of inulin breakdown. It was also found the increase of 2.2 times with lemon juice, 2.6 times with 1.5% citric acid, and 2.5 times with 2% citric acid. Juices hydrolyzed in sour pomegranate juice and with 2% citric acid for 160 minutes showed the best results.

Table 1: The amount of fructose formed as a result of hydrolysis of Jerusalem artichoke inulin by various methods

Duration time, <i>min</i>	The amount of fructose, <i>mg/ml</i>			
	Pomegranate juice and artichoke extract	Lemon juice and artichoke extract	1.5% lemon acidic artichoke extracts	2% lemon acidic artichoke extracts
Initial fructose-clear amount	40	36	34	34
20	45	40	42	45
40	51	48	50	54
60	57	51	59	65
80	62	67	65	69
100	69	70	70	72
120	73	72	75	77
140	78	76	79	84
150	83	78	81	85

Organoleptic characteristics of hydrolyzed juices were analyzed by different methods. Jerusalem artichoke juice hydrolyzed with sour pomegranate juice is dark red in color, clear and sweet in taste. Juices hydrolyzed with citric acid and lemon juice are reddish in color, clear and sour-sweet in taste.

The sugar content and quality characteristics of hydrolyzed juices by different methods were determined by paper chromatography using solutions of 6: 4: 3-butanol-pyridine-water ratio. An aniline solution of phthalic acid and a 1% urea solution were used to actively show stains on the instrument paper. FN-8, FN-11 paper was used for paper chromatography.

In 1.5% citric acid hydrolysis mainly fructose, small amounts of glucose and sucrose residues as well as fructose-containing oligosaccharides were found. During the 2% citric acid hydrolysis process, the main sugars were arabinose, fructose, and glucose, and small amounts of sucrose residues were detected.

During the experiment, the organoleptic characteristics of the hydrolyzed fructose syrup were evaluated. The performance of the hydrolyzed artichoke juice using lemon, pomegranate juice and briar extract was evaluated as the best.

According to the results, in hydrolyzed Jerusalem artichoke juice with pomegranate juice the main sugars (monosaccharides) that are consist of fructose, arabinose and glucose, and only traces of sucrose were found.

Jerusalem artichoke juice hydrolyzed with lemon juice was found to contain fructose and arabinose as the main sugars, and traces of sucrose and galactose.

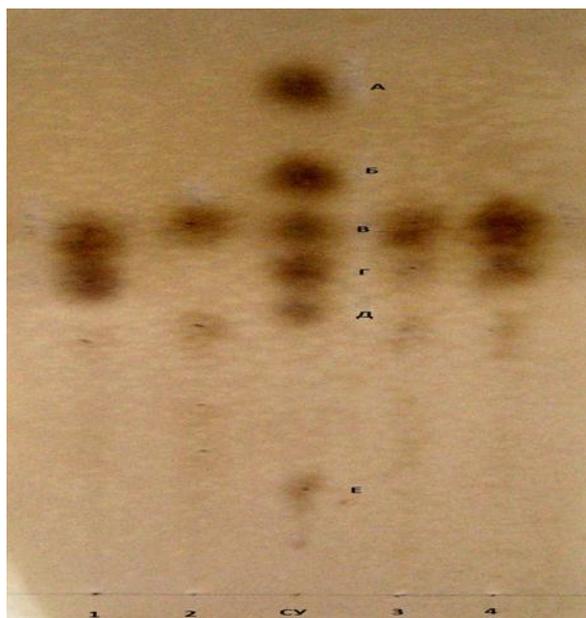


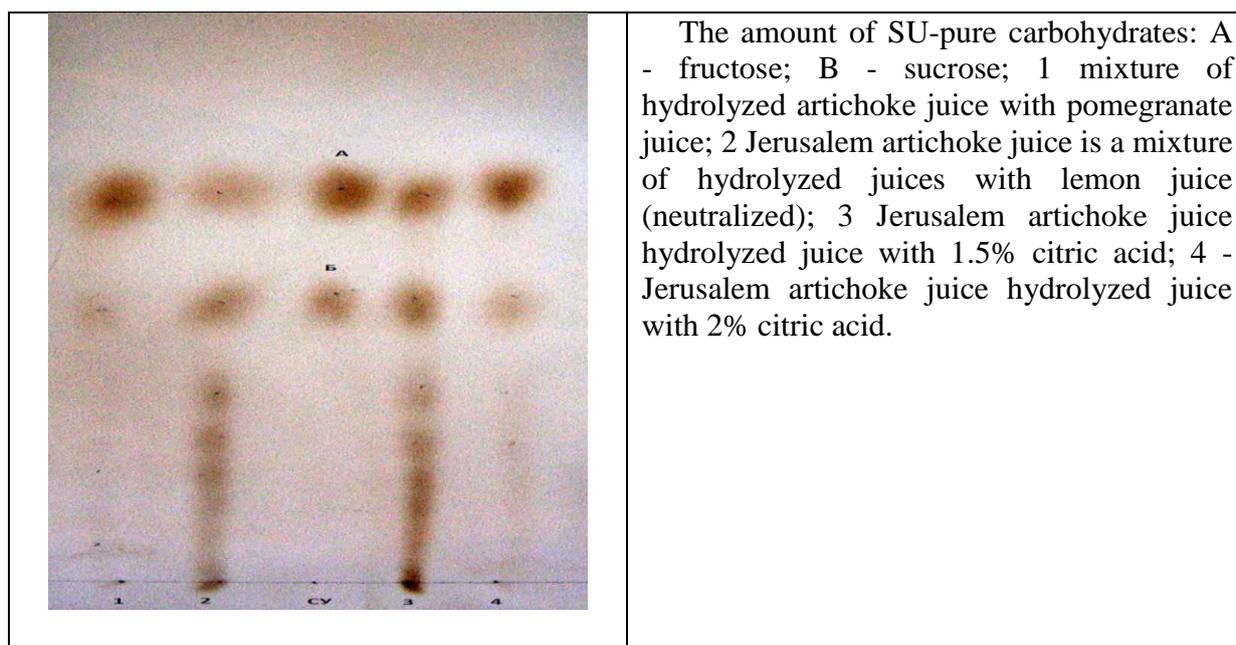
Figure 1. Paper chromatography of Jerusalem artichoke juice hydrolyzed in various ways.

SU-pure carbohydrates: A-ramnose; B-xylose; V-arabinose; G-glucose; D-galactose; E-glucuronate acid; 1- the amount of Jerusalem artichoke juice hydrolyzed with pomegranate juice; 2- Jerusalem artichoke juice hydrolyzed with lemon juice (juice mixture, neutralized); 3 Jerusalem artichoke juice hydrolyzed with 1.5% citric acid; 4 Jerusalem artichoke juice with 2% citric acid.

No traces of glucuronic acid were detected in the hydrolyzed juices by different methods.

The amount of fructose was assessed on paper chromatography with 1% urea solution. The amount of remaining sugars was assessed using aniline phthalate.

Figure 2. Paper chromatography of Jerusalem artichoke juice hydrolyzed in various ways.



With a 1.5% solution of citric acid, the inulin polysaccharide in Jerusalem artichoke juice was broken down to produce a fructose-rich juice. The resulting juice is purified. To obtain fructose syrup, fructose juice was evaporated in the rotor-evaporator 6 times relative to the previous mass until 17% of the total mass remained.

Organoleptic and physicochemical properties of the obtained fructose syrup were determined. The results are given in the table below.

Table 2: Physicochemical properties of fructose syrup

№	Product name	Solid content,%	Total carbohydrates,%	Fructose amount,%	Organoleptic characteristics
1	Fructose syrup	62	59	50	Color: red Smell: fragrant Taste: sour-sweet

In the laboratory, this syrup was used instead of sucrose to make sweet canned food.

Washed and cleaned from the seed chamber, the apple was soaked in fructose syrup for 4 hours to absorb the syrup and given a 10-minute heat treatment at 80–85°C. It was cooled for 10 minutes, boiled at 100°C for another 8 minutes and packed in sterilized jars.

To prepare the quince jam, the fruit was washed and crushed after being cleaned from the seed chamber. The fruit was treated with hot water for 10 min to stop the activity of the enzymes and to soften the flesh portion of the fruit, expelling air from the intercellular space. Fructose syrup was added and boiled for 8 minutes in the closed state in order to prevent oxidation and darkening of the fruit and to maintain quality indicators. The poured finished product was packaged in sterilized jars. Quince compote, prepared on the basis of fructose syrups, was prepared in the laboratory. Preparation was carried out in the following sequence. Quince was washed, separated from the seed chamber, cut into pieces and put in a jar. It was blanched in order to expel air from the intercellular spaces and stop the activity of enzymes. The fructose juice was added and boiled in a water bath for 5 minutes and the jar was hermetically sealed.

Organoleptic and physicochemical properties of canned products based on fructose syrup were determined in the laboratory.

Table 3: Physical and chemical properties of canned products based on fructose syrup

№	Product name	The amount of solids	Total amount of carbohydrates	The amount of fructose
1	Quince compote	34	32,2	27
2	Apple jam	66	65	59
3	Quince marmalade	58	57,2	48,7

The compliance of toxic elements and organochlorine pesticides in cans with the requirements of SanPin №0283-10 was determined in accordance with Standards 30178-96, 51429-99. The results obtained are presented in table 3.

The results show that Cd, As, Hg and hexachlorocyclohexane were not detected in all types of canned food.

Table 4: Toxic elements and organochlorine in canned food amount of pesticides

№	Canned type	The detected amount is mg / kg. not more than							
		Zn	Cd	Pb	Cu	As	Hg	HCH	DDT
1	Quince compote	6,8758	-	0,0536	1,5326	-	-	-	0,0026

2	Apple jam	5,1114	-	-	1,0856	-	-	-	0,0087
3	Quince marmalade	8,2740	-	-	1,8174	-	-	-	0,0052
	MAC	10,0	0,03	0,4	5,0	0,2	0,02	0,05	0,1

Pb is only 0.0536 mg / kg in quince compote, which is 7.5 times lower than the allowable norm. Zn is 1.5 times lower than the permissible limit in quince compote, apple compote is 2 times lower and quince is 1.2 times lower. Cu metal was found in very small amounts in all canned goods. We can also see that dichlorodiphenyltrichloethane (DDT) is present in very small amounts. So we can say that this canned product meets the requirements of SanPin - №0283-10.

This process is explained by the fact that the polysaccharides in the juice and the vitamin bound to various organic substances are released under the influence of acid and temperature. In vitamins C and V6, a sharp decrease was observed as a result of the breakdown of vitamins under the influence of temperature.

In the laboratory, this syrup was used instead of sucrose to make sweet canned food.

Washed and cleaned from the seed chamber, the apple was soaked in fructose syrup for 4 hours to absorb the syrup and given a 10-minute heat treatment at 80–85 oC. It was cooled for 10 minutes, boiled at 100oC for another 8 minutes and packed in sterilized jars.

To prepare the quince jam, the fruit was washed and crushed after being cleaned from the seed chamber. The fruit was treated with hot water for 10 min to stop the activity of the enzymes and to soften the flesh portion of the fruit, expelling air from the intercellular space. Fructose syrup was added and boiled for 8 minutes in the covered state in order to prevent oxidation and darkening of the fruit and to maintain quality indicators. The poured finished product was packaged in sterilized jars.

Quince compote, prepared on the basis of fructose syrups, was prepared in the laboratory. Preparation was carried out in the following sequence. Washed, quince separated from the seed chamber, blanched, placed in a jar. Fructose juice was added and boiled in a water bath for 5 minutes and the mouth of the jar was hermetically sealed.

Organoleptic and physicochemical properties of canned products based on fructose syrup were determined in the laboratory.

Table 5: Physicochemical properties of canned products based on fructose syrup

№	Product name	The amount of dry matter	Total amount of carbohydrates	The amount of fructose
1	Quince compote	34	32,2	27
2	Apple jam	66	65	59
3	Quince jam	58	57,2	48,7

SanPin indicators of toxic elements and organochlorine pesticides in cans were determined in accordance with GOST 30178-96, GOST 51429-99. The results obtained are presented in Table 6

Table 6: Toxic elements and organochlorine in canned food amount of pesticides

№	Canned type	The detected amount is mg / kg. not more than							
		Zn	Cd	Pb	Cu	As	Hg	GXTG	DDT
1	quince compote	6,8758	-	0,0536	1,5326	-	-	-	0,0026
2	Apple jam	5,1114	-	-	1,0856	-	-	-	0,0087
3	Quince jam	8,2740	-	-	1,8174	-	-	-	0,0052

PDK	10,0	0,03	0,4	5,0	0,2	0,02	0,05	0,1
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The results show that Cd, As, Hg and hexachlorocyclohexane were not detected in all types of canned food.

Pb is only 0.0536 mg / kg in bexi compote, which is 7.5 times lower than the allowable norm. Zn is 1.5 times lower than the permissible limit in quince compote, apple compote is 2 times lower and quince is 1.2 times lower. Cu metal was found in very small amounts in all canned goods. We can also see that dichlorodiphenyltrichloethane (DDT) is present in very small amounts. So we can say that this canned product meets the requirements of SanPin - №0283-10.

Conclusions. The growing number of people with diabetes in the world puts a burden on the food industry to provide people with diabetes and the population with safe food, expand the production of functional foods, the widespread use of sugar substitutes. In this regard, research work on the technology of functional products, including the search for sources of natural sugar substitutes, their pure extraction or extensive use of extracts and concentrates in the food industry is important.

Due to the high productivity of the Jerusalem artichoke plant, the possibility of high yields even in arid lands, as well as the ease of technological processing, it is possible to obtain fructose-rich juices and fructose syrups processed on an industrial scale.

Lemon and pomegranate juices, which are widely used in folk medicine, were used in the preparation of fructose-rich juices. As a result of the use of acid-rich fruit juices in the hydrolysis of inulin contained in Jerusalem artichoke juice, a juice with a very fragrant, delicious and sweet taste was obtained. This product can be easily consumed by people with diabetes. Due to the high content of fructose monosaccharide in the juice does not adversely affect blood sugar levels. The method of acid hydrolysis of inulin is also suitable for technological processes.

The results of the above research have been applied to industry, and now a technological line is being set up at Dalvarzinta'mirlash Zavodi LLC, located in Bekabad district, Tashkent region, to produce fructose syrup from Jerusalem artichokes.

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