

Marmalade with the use of plant materials for diabetic nutrition

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Abstract. In the Russian Federation, as well as in other countries of the world, the prevalence of diabetes continues to increase. Currently, the number of patients is more than 5 million people. The leading direction in the field of nutrition is the creation of a product range that help improve human health when consumed as part of the diet. Research related to the creation of products containing sweeteners is relevant. This development is aimed at expanding the range of diabetic products, namely the creation of a confectionery product (jelly marmalade) replacing sugar with a plant product - yacon powder, which contains fructooligosaccharides. The research made it possible to create a product with good organoleptic characteristics. According to physical and chemical indicators, the resulting sample meets the requirements of regulatory documentation. The use of yacon powder and pomegranate juice in the product formulation improved the biological value of the marmalade. The resulting confectionery product is highly important for increasing the range of diabetic products.

1 Introduction

Changes in a person's lifestyle at the present stage of social development are associated with insufficient physical activity. Poor nutrition and other factors lead to the development of diseases such as diabetes, and in different age groups of the population. Functional nutrition plays an important role in diabetes management, as proper selection of foods and diet can help control blood glucose levels and prevent complications of the disease. Studying the chemical composition of plant products helps to develop new food recipes that take into account the needs of a specific patient suffering from diabetes. A feature of this disease is the age of the patients, getting younger every year.

Confectionery products are part of the daily diet of Russians today. One of the urgent tasks of the confectionery industry is to improve the technological process for the production of confectionery products, to develop new recipes enriched with vitamins, macro- and microelements, and to reduce the calorie content of the product [1].

Marmalade is a sugary confectionery product with a gelatinous consistency, obtained by boiling gelling fruit or vegetable raw materials and a gelling agent solution with or without the addition of various additives.

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Marmalade, having the lowest calorie content in the group of sugary confectionery products, is in fairly high demand among the population. The starting materials for the production of this product are fruits and berries, which contain various sugars, organic acids, mineral salts and vitamins, which are partially transferred into the future product. Therefore, marmalade has high nutritional, taste and dietary properties. The composition of jelly marmalade must include gelling components - pectin, agar or gelatin [2].

The recipe for making marmalade is based on the use of large amounts of sugar, which can cause a number of serious health problems: obesity, cardiovascular diseases, diabetes of various forms.

This has led to an increased interest in creating marmalade without sugar or with a reduced amount of sugar. Jelly marmalade is traditionally made using synthetic colors and flavors, and artificial sweeteners are often used. In this area, we suggest to consider using yacon powder as a sugar substitute, which has a full range of essential amino acids and fructooligosaccharides, and pomegranate juice, known for its set of vitamins and macro- and microelements, will give the product a beautiful color. Yacon is a low-calorie product that is a healthy alternative to sugar. The main processed products are puree and powder [1,2,3].

It is known from literary sources that yacon processing products are widely used in bread baking and the production of flour confectionery products. The method of production of marmalade using yacon flour is known (patent RU2649987C1). The disadvantage of this formulation is the absence of vitamins and microelements in the product formulation [4,5,6].

The purpose of the study is to develop a recipe and technology for the production of jelly marmalade based on a gelling agent using a vitamin product - pomegranate juice and a sugar substitute - yacon powder.

To achieve this goal, the following tasks were formulated:

- to study the regulatory documentation for marmalade;
- based on existing technologies, to develop an alternative product without the use of sugar;
- to develop a recipe for a new product, develop prototypes using raw materials that meet regulatory requirements;
- to assess the quality of the samples.

2 Materials and methods

The research was carried out in 2023 on the basis of the department of commodity science, technology and examination of goods of South-West State University in Kursk.

The development of technology and recipes was carried out on the basis of GOST 6442 - 2014 "Marmalade. General technical conditions". According to this regulatory document, marmalade is a sugary confectionery product that has a certain specified shape, obtained by boiling gelling raw materials and a solution of a gelling agent with sugar, with or without the addition of molasses. The considered marmalade according to GOST refers to jelly marmalade on the basis of gelling agent.

The assessment of organoleptic quality indicators was carried out in accordance with GOST 5897-90 "Confectionery products. Methods for determining organoleptic quality indicators, sizes, net weight and components [6].

To create a product with a new recipe composition we used:

- "Yacon" powder produced by the company "Products of the 22nd Century", country of origin – Russia;
- first-press pomegranate juice corresponding to GOST 32101 – 2013 "Canned food. Juice products. First-pressed fruit juices. General technical conditions", country of

origin - Azerbaijan;

- food agar was used as a gelling element - a natural substance that is superior to gelatin in its properties. Food agar complies with GOST 16280-2002 – General technical conditions. Manufacturer – Russia.

Yacon powder contains the following minerals: calcium – 237 mg/100 g; phosphorus – 215 mg/100 g; magnesium – 116 mg/100 g; iron – 11.6 mg/100 g; zinc – 0.58 mg/100 g; manganese - 215 mg/100 g; copper – 82 mg/100 g [7, 8].

The nutritive value of yacon powder per 100 g is presented in Fig. 1. Energy value is 340 kcal.

Yacon Powder Contains:

- potassium – useful for maintaining metabolic reactions;
- selenium – important for protecting body cells from the action of free radicals;
- inulin – useful for strengthening the immune system;
- vitamins A, B and vitamin C [8].

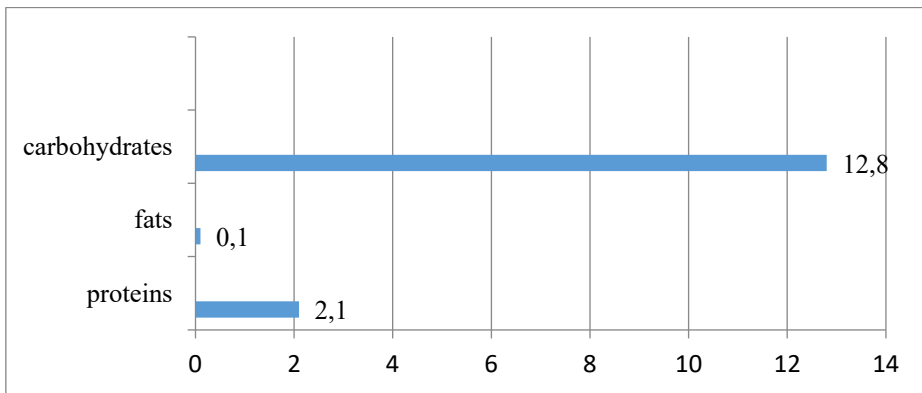


Fig. 1. Nutritive value of yacon powder.

Yacon powder is non-GMO and gluten-free. Inulin in the composition (60-70%), together with fiber, can delay the absorption of glucose from food. Thanks to this, the effect of slowing down the rise of sugar after eating is achieved. Inulin improves carbohydrate and lipid metabolism and normalizes blood sugar levels in patients with diabetes. The absorption of easily accessible carbohydrates and fats slows down, which is also very important for diabetics. Yacon is a low-calorie food that has become a healthy alternative to sugar [2,4,5].

The second very important element used in the marmalade recipe is pomegranate juice. Pomegranate juice is rich in vitamins E, PP, A, C, and some B vitamins; mineral elements - iron (18 mg), potassium (102 mg), calcium, phosphorus, sodium; organic acids, essential and nonessential amino acids, water-soluble polyphenols, tannins. Carbohydrates of pomegranate juice (14.2 g) are represented by mono- and disaccharides. Of the fat-soluble vitamins, pomegranate juice contains E and K. Of the water-soluble vitamins, there are vitamins C, B1, B2, B3 (PP), B4, B5, B6 and B9 [2].

Pomegranate juice retains all the vitamins and nutrients present in fresh pomegranate and is well absorbed by the body. Table 1 shows the composition and calorie content of pomegranate juice per 100 g of product.

Table 1. Composition and calorie content of pomegranate juice per 100 g.

Nutritive value	Amount
Proteins, g	0.23
Fats, g	0.01
Carbohydrates, g	12
Calorie content, kcal	55
Alimentary fiber, g	0.2
Water, g	83

The third main recipe component is agar. Agar is used in the food industry as a thickener and gelling agent. The ratio of proteins, fats and carbohydrates is presented in Table 2.

Table 2. Calorie content and nutritive value of agar per 100 g.

Nutritive value	Amount
Proteins, g	4
Carbohydrates, g	76
Calorie content, kcal	301

The energy value (calorie content) of agar is 301 kcal per 100 grams of product (edible part).

Agar contains the following elements: ash, starch, water, calcium, presented in Table 3.

Table 3. Micro- and macroelements contained in agar.

Micro- and macroelement	Amount
Ash, g	2
Starch, g	76
Water, g	18
Calcium, mg	1

The product satisfies hunger well with low calorie content and is suitable for dietary nutrition. Agar activates metabolism, stimulates intestinal function, and helps normalize blood sugar levels.

3 Results and discussion

To obtain a new product, a research algorithm was developed:

- review of scientific and regulatory documentation;
- development of a recipe for a marmalade product based on selected components;
- preparation of raw materials for the experiment;
- development of technology for the production of marmalade products;
- assessment and analysis of the quality of the resulting product.

The development of the recipe, production technology and assessment of the quality of the product was carried out in accordance with GOST 6442-2014 “Marmalade. General technical conditions”, focused on the production of jelly marmalades, molded by casting the mass into molds.

Three recipes have been developed related to the gradual replacement of sugar with Yacon powder. The goal of the development is to obtain a product with a complete replacement of sugar with a herbal supplement. Sample recipes are presented in Table 4.

Table 4. Recipe for tested marmalade samples per 1 kg of created product.

Ingredients, g	Sample No. 1 (control sample)	Sample No. 2	Sample No. 3	Sample No. 4
Pomegranate juice	784,0	784,0	784,0	784,0
Sugar	150,0	105,0	60,0	–
Agar	60,0	60,0	60,0	60,0
Yacon powder	–	45,0	90,0	150,0
Citric acid	6,0	6,0	6,0	6,0
Total	1000			

The production technology for jelly marmalade using yacon powder is presented in Fig. 2.

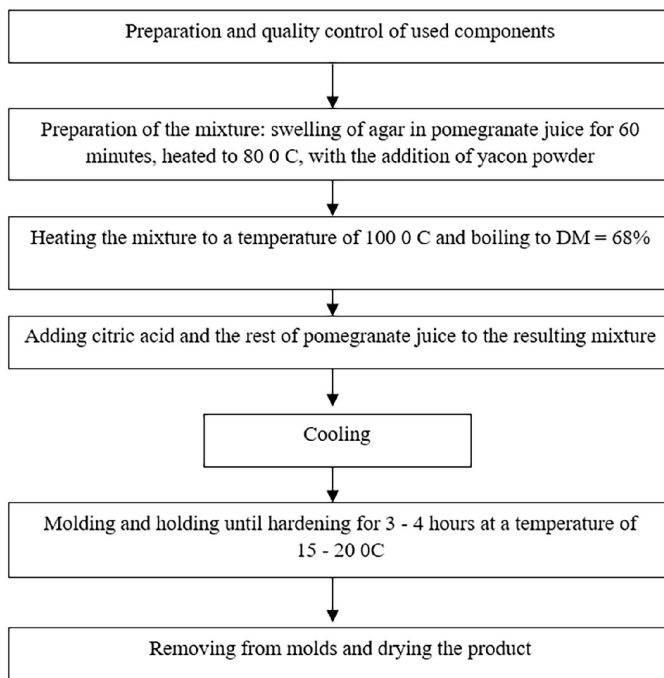


Fig. 2. Technological diagram for the production of jelly marmalade using yacon powder.

At the stage of preparation of raw materials, an organoleptic assessment of the raw materials used was carried out:

- pomegranate juice is a clear drink, with the characteristic taste and smell, without sediment in the container. The juice corresponds to GOST32101 - 2013 "Canned food. Juice products. First-pressed fruit juices. General technical conditions"
- agar is a powdery, free-flowing mixture without any foreign odor. The color of agar is light cream without any foreign odors or tastes. Meets the indicators and requirements of GOST 16280-2002 - "Food agar. General technical conditions".
- yacon powder is a beige powder, with a characteristic sweet taste and fruity smell (apple-watermelon), corresponds to the indicators declared by the manufacturer.

In laboratory conditions, samples of marmalade were obtained, presented in Fig. 3. Since the main goal of the study was aimed at obtaining jelly marmalade with a complete replacement of sugar according to the standard recipe with a sugar substitute - yacon powder,

then we consider the resulting sample of marmalade (No. 4) in comparison with the sample, made according to a standard recipe.

Quality indicators related to organoleptic ones were determined for the obtained marmalade samples.

Control sample (sample No. 1) – classic recipe.

- the control sample has the correct shape;
- the taste and smell are mild, without any foreign odor;
- the color of the product is bright, typical of pomegranate juice;
- the consistency is dense;
- the surface is glossy, without foreign inclusions.

Sample No. 4 - sugar is completely replaced with a sweetener - yacon powder.

- the shape of the product is correct, with clear contours, without deformation;
- the taste is characteristic of this type of product, without any foreign flavour;
- the smell corresponds to the fruity smell that is typical for yacon powder;
- the color is bright, characteristic of pomegranate juice;
- the consistency is correct, gelatinous;
- the surface is glossy, without foreign inclusions.

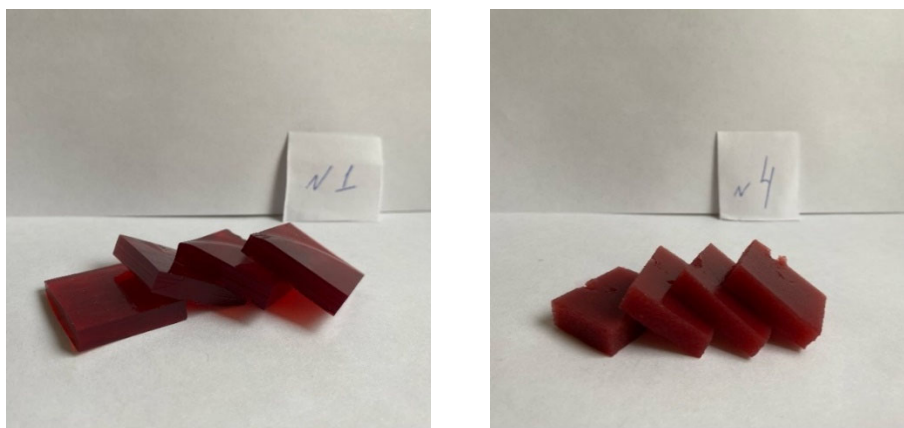


Fig. 3. Marmalade obtained in accordance with the research.

In laboratory conditions, physical and chemical quality indicators of the resulting marmalade were determined. The results of the study are presented in Table 5.

Table 5. Results of the study of physical and chemical quality indicators of sample No. 4 and the control sample of marmalade.

The name of indicators	Results	
	Sample No. 1	Sample No. 4
Mass fraction of total sugar	16.2	14.7
Mass fraction of ash undissolved in a 10% hydrochloric acid solution	0.036	0.042
Humidity, %	20.7	19.8

Table 6 shows the calorie content of the recipe components of the control sample (sample No. 1) and sample No. 4 with the complete replacement of sugar with yacon powder.

Table 6. Calorie content of the control sample (sample No. 1) and the enriched sample (sample No. 4) per 100 g of product.

Control sample		Final sample	
Ingredients	Kcal	Ingredients	Kcal
Pomegranate juice	55	Pomegranate juice	55
Agar	18.06	Agar	18.06
Sugar	50.85	Yacon powder	9.15
Citric acid	2.4	Citric acid	2.4
Total:	126.3	Total:	84.6

The saturation of the resulting product with nutrients and vitamins is shown in Fig. 4, 5.

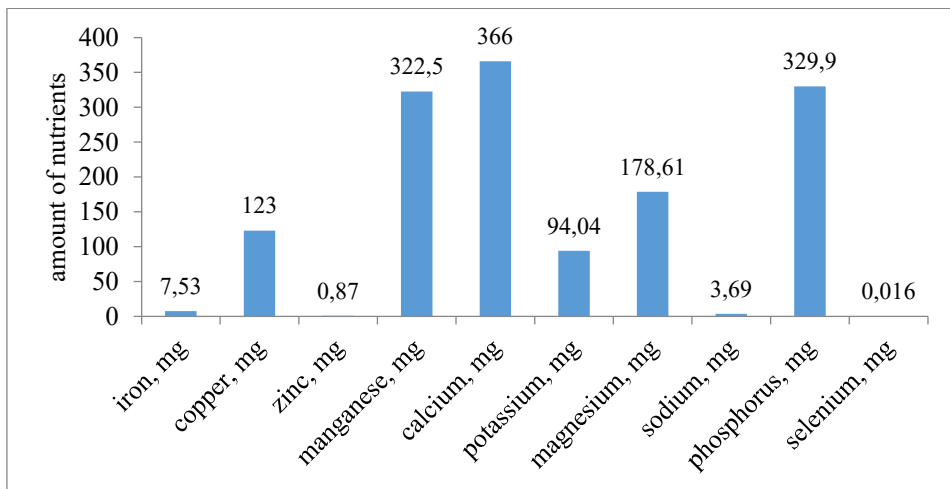


Fig. 4. Saturation of marmalade with macro- and microelements.

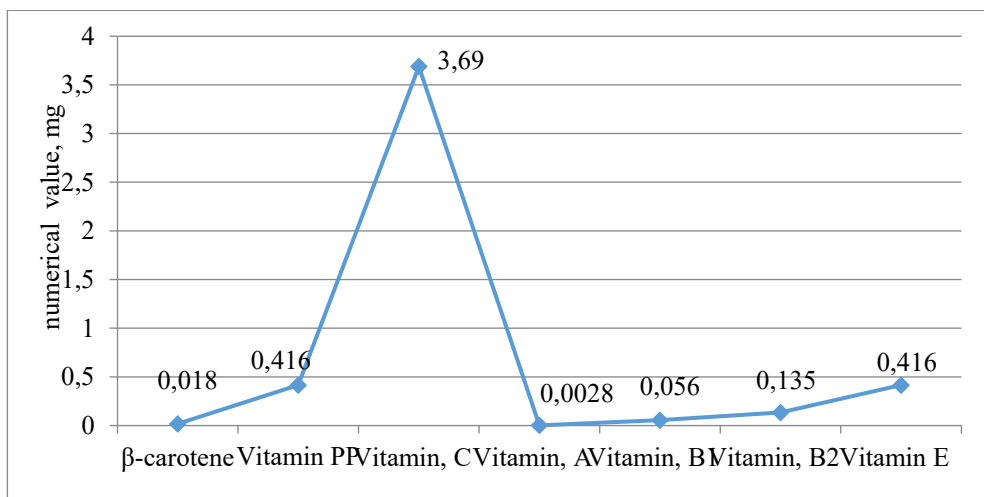


Fig. 5. Vitamin content in product.

As can be seen from the presented figures, as a result of the use of a herbal supplement and a vitamin product - pomegranate juice, there was a change in the chemical composition of the confectionery product.

4 Conclusion

The results of the study confirm the possibility of using yacon powder in the production of jelly marmalade with a complete replacement of sugar with a plant component. A new product recipe has been developed. The technology for producing marmalade with a herbal supplement has been determined, which is shown in Fig. 2.

The appearance of the resulting marmalade is shown in Fig. 3. An assessment of organoleptic indicators confirmed the possibility of obtaining a product with a complete replacement of sugar with yacon powder. The consistency of the samples is gelatinous, the shape is correct with clear contours, without deformation, the surface is glossy and shiny. The color is bright red, corresponding to the color of pomegranate juice. The taste and smell correspond to the added additive – yacon powder. The physical and chemical characteristics of the marmalade comply with the regulatory documentation. The resulting product reduces the calorie content of the confectionery product per 100 g of product: from 126.3 Kcal to 84.6 Kcal. The added additive based on pomegranate juice saturates the product with useful micro- and macroelements: calcium, magnesium, phosphorus, manganese, iron, vitamins.

The obtained product expands the range of diabetic products. It can be used in the diet of people suffering from diabetes.

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