The reason for the current work is the lack of technology to produce food from the fruits of melon crops, namely oriental sweets like soft sweets, based on processed overripe fruits of melon crops of domestic growth.

The rationale for the need for this research work was the demand for the creation of technology for the manufacture of food, a high percentage of unsold substandard melons and watermelons. As well as the lack of the possibility of processing melon crops near the areas of cultivation and manufacturing sweet products at small and medium-sized enterprises. The development of technology to produce sweet meals will have a positive impact on the expansion of the scope of use of the fruits of melon crops.

The absence of an established mechanism for processing and marketing overripe fruits brings great losses. In this regard, the issue of finding solutions to new ways of selling melon crops is relevant.

The study revealed the possibility of producing Turkish delight from the fruits of watermelon and melon. At the same time, Turkish delight from the pulp of watermelon was more stable than that from melon. The developed oriental sweet product based on the pulp of watermelon outperforms the control sample in all the studied indicators. The mass fraction of fat in the developed product is 0.26 %, which is 0.13 % more than that in raw materials. The mass fraction of protein increased by 0.53 %. In Turkish delight based on watermelon, the carbohydrate content increased by 3.7 times, by 15.1 %. The content of ascorbic acid in watermelon Turkish delight is slightly less, by 7.22 mg/100 g, than that in melon. The developed Turkish delight was stored both under room and refrigeration conditions, the shelf life was 5 days and 21 days, respectively

Keywords: Turkish delight, fruits of watermelons and melons, organoleptic analysis, quality indicators, nutritional value

UDC 664.858.8
DOI: 10.15587/1729-4061.2022.258534

DEVELOPMENT OF TECHNOLOGY FOR THE PRODUCTION OF TURKISH DELIGHT FROM MELON CROPS ON A NATURAL BASE

Yelena Petrenko*
Dinara Tlevlessova
Corresponding author
PhD, Associate Professor*
E-mail: tlevlessova@gmail.com, dinusina@mail.ru
Laila Syzdykova
PhD, Associate Professor*
Gaukhar Kuzembayeva
PhD*
Karlygash Abdiyeva
PhD*
*Department of Food Technology
Almaty Technological University
Tole bi str., 100, Almaty, Republic of Kazakhstan, 050012

Received date 20.04.2022
Accepted date 02.06.2022
Published date 30.06.2022

***How to Cite**: Petrenko, Y., Tlevlessova, D., Syzdykova, L., Kuzembayeva, G., Abdiyeva, K. (2022). Development of technology for the production of turkish delight from gourds on a natural basis. Eastern-European Journal of Enterprise Technologies, 3 (11 (117)), 6–18. doi: https://doi.org/10.15587/1729-4061.2022.258534*

1. Introduction

In the world production of watermelons, Republic of Kazakhstan ranks 11th. Worldwide, 117,204,081 tons of watermelon are produced per year with China being the largest producer of watermelons with a production volume of 79,244,271 tons per year. Turkey ranks second with 3,928,892 tons of annual production. Republic of Kazakhstan ranks sixth in the world in terms of melons [1].

World production of melon is about 14 million tons, with an average yield of 15.0 tons/ha. China ranks first in gross harvest (2.5 million tons). Iran, Egypt, and Romania produce 0.5 million tons per year and export the surplus to Western Europe. In the CIS, the annual production of melon is about 0.5 million tons, and in the USA – 0.8 million. Under modern conditions, melon is grown in the southern regions of Ukraine, in Transnistria, Uzbekistan, Turkmenistan, Kazakhstan, etc. [2].

In Republic of Kazakhstan, the gross harvest in 2020 exceeded the value of 2019 by 43 thousand tons. This indicator indicates that despite a slight reduction in the area under melon crops, the yield of watermelons and melons has increased.

In addition to the difficulties in the field of agriculture with the sale of the received volume of melon crops, there is a disappointing picture in the processing industry. In the official register of enterprises in Republic of Kazakhstan, there are no data on organizations whose activities are aimed at processing substandard fruits of melon crops and producing a quality product based on them [3].

Given the fact that watermelons and melons are a rare type of plant raw material, practically not subjected to processing, the actual area of research is the development of technologies for processing the fruits of melon crops and the creation of recipes for confectionery products on a natural basis, which have no analogs in the modern market.

2. Literature review and problem statement

During the exploratory study, scientific works on the use of the fruits of melons in the food industry, and works in which the issue of optimizing the production technology of Turkish sweets were considered, were examined.

Studies into the physicochemical properties, composition, and structure of the pulp of watermelon, variations in the calibration of fruits by size are reported in [4–6].

Thus, in work [4], the composition and properties of the pulp of watermelon were investigated in order to develop a modification of the fruit calibration process. While solving the task of expanding the range of healthy food products made on the basis of melon crops [5], a technology for preparing pickled melon was developed. As a result, a high-quality product with a sufficiently long shelf life was created. The manufacturing of that product requires high-quality unripe fruits. A given technology is not applicable to overripe or substandard melon fruits. Paper [6] studied the profitability and ways to increase the efficiency of using watermelon and melon fruits from the fields as raw materials to produce concentrates. Work [7] describes organoleptic, chemical, and microbiological indicators of the quality of earlier developed jelly sweets. The devised technology of making a sweet meal involves the addition of rowan juice, in connection with which there is some dilution of the melon base.

The development of a functional product based on melon crops is presented in work [8], which describes in detail the composition and properties of ripe fruits, the profitability of creating products based on them. According to the cited study, it was found that watermelon contains the greatest amount of lycopene and citrulline in comparison with other fruits. However, the study did not pay attention to factors affecting the quality of the fruit, such as maturity and processing technique.

Among the papers under consideration, studies aimed at creating and optimizing the recipes of natural juices based on melon crops stand out. Work [9] provides information on studying the physical and mechanical properties of melon fruits and various products based on them. In addition to juice, the cited work describes the production technologies of the following meals and products: stewed fruit, marinade, confiture, frozen foods. Technologies and formulations are given but there is no mathematical confirmation of reproducibility and proof of product quality.

Methods of extraction, composition features, quality indicators, and ways to preserve the beneficial properties of juices, including melon and watermelon, are described in [10]. However, there is no information about the stabilization of watermelon juice.

Watermelon juice is a perishable product and, therefore, there are difficulties with its sale. The development of techniques for preserving the product while maintaining useful properties based on the results of studies of the effect of yeast strains on the process of fermentation of juice is reported in work [11].

The possibility of using watermelon fruits, which were not eaten for various reasons, in food production [12], has been established. As a product, the cited work considered the creation of fermented juice. According to the results of the cited study, it was found that freshly squeezed watermelon juice is a favorable environment for the development of lactic acid bacteria. However, negative fermentation processes occur in that product, which have a great impact on the resulting quality. Given this, it is impossible to use pure watermelon juice to prepare a fermented drink. To improve the functional properties, scientists proposed to combine watermelon with other fruits but further research in this area has not been conducted.

The development of the technology for a probiotic drink on milk whey and pure watermelon juice is reported in [13]. In particular, it presents an optimized recipe for a fermented drink of proper quality. The created product has a short shelf life – 21 days (at a temperature of 4±1 °C) or 2 days (at a temperature of 30±1 °C). The short shelf life complicates the possibility of selling the product throughout the country.

The issues of organizing waste-free production through the creation of a technology for environmentally friendly hydrothermal processing of melon peel for the extraction of biologically active pectin oligosaccharides were studied in work [14].

A new type of composite flour has been created with the addition of the pulp of date fruits and toasted watermelon seeds. During the study, it was found that the enrichment of flour with toasted watermelon seeds significantly improved the nutritional value and functional properties of the product. The added ingredients, due to the peculiarities of their composition, act as natural substitutes for sugar and fat in composite flour [15].

From the above-described literature sources [4–15], it follows that most developed technologies are based on the creation of products based on purified juices of watermelons and melons. In the manufacture of products, puree of fruit pulp is not used, and, therefore, the percentage of food waste increases. In addition, among modern technological advancements, there are practically no technologies to produce confectionery products. Based on this, the issue of the possibility of creating an oriental sweet product based on puree from the fruits of melon crops was considered.

In the recipes of oriental meals such as soft sweets, the use of fruit syrups, juices, and concentrates is common. In this connection, Turkish delight was chosen as the ultimate product for the development of production technology based on the fruits of melon crops.

The possibility and profitability of using various food additives to give the necessary properties and extend the shelf life of Turkish sweets have been studied [16]. The most important food additives investigated in the cited work are acids, extracts, flavors, dyes. The described additives are approved for use in the food industry in the manufacture of Turkish sweets. Their application is strictly regulated by the relevant documents. However, excessive use of chemical additives can lead to risks to the health of the consumer. People are interested in eating products without the addition of chemical food additives. In this regard, the most beneficial option is the development of a recipe for meals with their minimal use.

Another work describes the possibility of enriching Turkish sweet product with berry syrups, in particular syrups of sour cherries and black grapes. Biochemical and sensory analysis of the studied samples confirmed an improvement in the quality of products due to fortification with syrups [17]. The cited study suggests the effectiveness of enrichment of Turkish delight with new plant components to improve biochemical parameters, chemical composition, and taste characteristics.

Paper [18] reports the results of experiments involving packaging with a modified gas atmosphere in order to extend the shelf life of Turkish delight. The cited paper established positive dynamics of quality preservation when modifying the gaseous medium but the study was conducted on one sample of Turkish delight, as a result of which there is a possibility of changing the results when trying to preserve other types of Turkish delight.

Work [19] reports a study into the production technology and problems in the manufacture of Turkish sweet prod-

ucts. However, it does not specify clear requirements for the structure of Turkish delight; the authors refer to the lack of clear regulations on this characteristic. During the study, the main cause of product spoilage was established – the formation of mold.

Other scientists drew the same conclusion during research. They attributed Turkish delight to the group of products most susceptible to microbiological contamination. The primary sources of product contamination are manufacturing equipment (knives, trays), the secondary source is personnel. In this regard, strict control over compliance with sanitary standards is necessary. Raw materials are not recognized as a source of pollution since products undergo long-term heat treatment [20].

According to the results of research [21], optimal storage conditions were established – low relative humidity (50 %) and a temperature of 15 °C. With an increase in humidity or temperature in the room, the oriental sweet product becomes unsuitable for consumption after 20 days. The tests were carried out on a sample made according to the following ratio of ingredients – water:sugar:starch 47 %:47 %:6 %. The cited study does not take into consideration the factor of the influence of plant supplements on the shelf life of the product.

Study [22] considered the possibility of using different varieties of pomegranate in the production of Turkish delight and the effect of vacuum packaging on the shelf life of the finished product. The history of Turkish sweet product and its place in the culture of the country were tackled in [23].

Changes in the recipe concern not only fillers but also the main ingredients. According to [24], the purpose was to establish the effect of replacing ordinary sugar with isomaltose: this compound is an isomer of sucrose but with a lower glycemic index and non-caries property. The results of studying the physicochemical indicators of the quality of control and experimental samples show the possibility of using isomaltose as a sugar substitute in Turkish sweets [25]. However, in the cited work, the terms and conditions of storage of products were poorly studied, and, therefore, the issue of using a substitute is not completed.

Our review of the scientific literature [16–25] revealed the following: studies of Turkish delight are mainly aimed at studying quality indicators and ways to improve them by introducing additives or changing the cooking technology. There were no studies conducted on the creation of oriental desserts from the fruits of melon crops.

The possibility of creating a Turkish sweet product from the pulp of fruits and watermelons was determined on the basis of an analysis of scientific works addressing the quality indicators of the raw materials used and the selected product for the subsequent development of production technology.

Watermelon pulp is consumed fresh and is practically not used for cooking. An exception is the manufacture of watermelon juices and pickled pieces of watermelon, but this type of processing is also of little use.

Watermelon contains a large volume of vitamins and minerals. Thus, in its composition there are vitamin B1 – 0.04 mg, vitamin B2 – 0.04 mg, vitamin B6 – 0.08 mg, vitamin B9 – 8 mg, vitamin C – 9 mg, vitamin E – 0.1 mg, potassium – 110 mg, calcium – 14 mg, magnesium – 12 mg, sodium – 16 mg, selenium – 1 μg, sulfur – 2 mg, phosphorus – 36 mg, iron – 500 μg, manganese – 110 μg, copper – 82 μg, fluorine – 16 μg, zinc – 220 μg [26].

The fruits of watermelon contain in sufficiently large quantities a carotenoid pigment – lycopene. Its amount ranges from 23 to 72 mg/kg. This pigment is resistant to high temperatures, and, therefore, during heat treatment its content in the product almost does not decrease. Nutritional value is associated with the presence of sugars, vitamins, organic acids, and mineral compounds.

The structure of the pulp of melon is quite watery, which is due to the high water content – 90 %. The caloric content of melon is mainly due to a large percentage of carbohydrate content – 7.42 %, of which monosaccharides account for 1.3 %, disaccharides – 5.9 %, polysaccharides – 0.22 %. In the pulp, there is fiber – 0.1–0.65 % and a small volume of pectin substances (0.01–0.1 %), which affect the density of the pulp. The content of proteins and fats is much less: 0.6 % and 0.3 %, respectively. The rich chemical composition is determined by the content of such useful substances as vitamins, macro- and microelements. 100 grams of edible part contain: vitamin E – 0.1 mg, vitamin C – 21 mg, vitamin B6 – 0.06 mg, vitamin B5 – 0.24 mg, vitamin B2 – 0.04 mg, vitamin B1 – 0.04 mg, vitamin B9 – 6 mg, potassium – 118 mg, calcium – 16 mg, magnesium – 13 mg, sodium – 32 mg, sulfur – 10 mg, phosphorus – 12 mg, iron – 1000 μg, manganese – 37 μg, copper – 47 μg, fluorine – 20 μg, zinc – 92 μg. The high content of enzymes increases the digestibility of melon [27].

Citric and tartaric acids in the production of Turkish delight are used to prevent the crystallization process of sugars. In addition, acids give the sugary dessert a pleasant sour note.

The choice of an ingredient for the manufactured product was carried out on the basis of research reported in [16–27]. Based on the results of this study, several conclusions were drawn about the quality of the manufactured Turkish delight:

– samples with a content of 5 grams of tartaric acid or 3 grams of citric acid demonstrated the best quality indicators;

– tartaric acid gives the product a softer consistency;

– citric acid has a beneficial effect on the durability and texture of sweet product;

– no significant differences were found between the samples in terms of chemical indicators.

In addition, it is recommended to use tartaric acid in other areas for external use, for the manufacture of desserts, it is preferable to use citric acid.

In this case, the need to add citric acid is due not only to the recipe but also to the need to adjust the acidity of the product to reduce heat treatment regimes. Without the addition of citric acid, prolonged heat treatment will be required to suppress the growth of harmful microorganisms.

3. The aim and objectives of the study

The purpose of this study is to create the possibility of processing unsold watermelons and melons by developing a technology for the production of sweet products on a natural base.

To accomplish the aim, the following tasks have been set:

– to determine the optimal mass of starch and the duration of heat treatment when cooking Turkish delight based on melon and watermelon puree;

– to devise recipes and technological schemes for the manufacture of Turkish delight based on the pulp of melon and watermelon fruits;

– to analyze microbiological indicators of the quality of Turkish delight based on melon crops.

4. The study materials and methods

The raw materials used in the production of Turkish sweets must meet the quality requirements of food raw materials and food and sanitary standards approved by the Ministry of Health.

The raw materials for the manufacture of Turkish delight are the following products: watermelon fruits, melon fruits, granulated sugar, corn starch, citric acid.

When developing the recipe, pre-frozen and stored at a temperature of –18 °C, the pulp of the fruits of melon crops, namely watermelon of the Zhetygen variety and melons of the Mirzachulskaya variety, was used. The choice of these varieties is justified by high rates of organoleptic evaluation, wide prevalence, and affordability.

We studied the quality of raw materials and finished products in certified laboratories at Almaty Technological University. The key quality indicators studied at the laboratories are the mass fraction of solids, protein content, fat content, carbohydrate content, acidity, vitamin C. All tests were carried out under the following conditions: temperature, 21 °C; humidity, 81 %.

Exploratory experiments were performed on the basis of a complete factor experiment with possible combinations of determining factors. In establishing the optimal composition for Turkish delight based on melon, the following factors varied: cooking time and the volume of starch used. The number of experiments to implement possible combinations of factors was determined from the formula:

$$N=p^k, \quad (1)$$

where N is the number of experiments;

k is the number of factors;

p is the number of levels; in this case, 2.

Since two factors vary in this study, a value of 4 was obtained. Based on this, 4 variants of the technology to produce Turkish delight were devised. Based on the previously studied recipes of oriental sweet product, the following variations of recipes were planned, according to which samples of products were subsequently made:

1) melon puree – 67.4 %, corn starch – 4.8 %, granulated sugar – 3.3 %, citric acid – 0.5 %, water – 24.1 %. The heat treatment time with a mass of the main ingredient of 400 grams was 40 minutes;

2) melon puree – 67.4 %, corn starch – 4.8 %, granulated sugar – 3.3 %, citric acid – 0.5 %, water – 24.1 %. The heat treatment time with a mass of the main ingredient of 400 grams was 70 minutes;

3) melon puree – 53.1 %, corn starch – 8 %, granulated sugar – 2.6 %, citric acid – 0.4 %, water – 36 %. The heat treatment time with a mass of the main ingredient of 400 grams was 40 minutes;

4) melon puree – 53.1 %, corn starch – 8 %, granulated sugar – 2.6 %, citric acid – 0.4 %, water – 36 %. The heat treatment time with a mass of the main ingredient of 400 grams was 70 minutes.

Mass fractions of physicochemical parameters, vitamin C content, and titrated acidity were determined by standard methods.

5. Results of studying the possibility of producing high-quality Turkish delight from watermelons and melons

5. 1. Determining the optimal starch mass and temperature regime for making Turkish delight based on melon and watermelon puree

We determined the best sample based on organoleptic analysis. During the analysis, seven experts evaluated oriental sweets according to the following criteria: appearance (shape and surface), color, taste, smell, consistency. Each criterion was assessed on a five-point scale.

For sensory analysis, each sample was prepared as follows: it was cut into different parts of a cubic shape and rolled in a mixture of corn starch and powdered sugar.

The organoleptic assessment of the quality of samples of melon-based Turkish delight is visualized in Fig. 1.

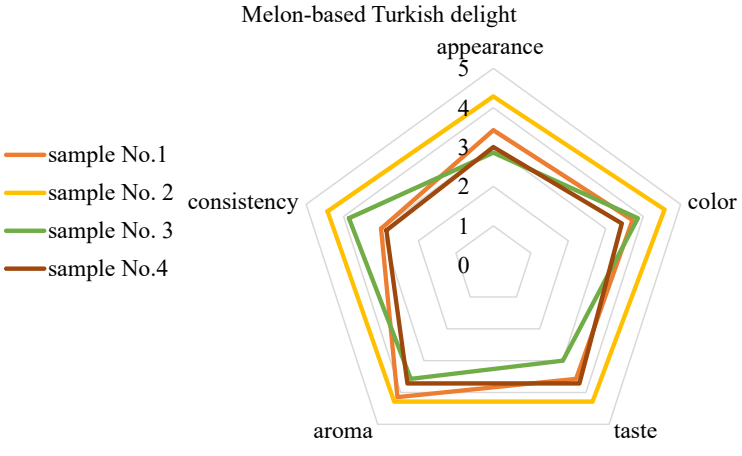

Fig. 1. Profilogram of organoleptic parameters of Turkish delight based on melon puree

Sample No. 1 has a slightly uneven, sticky surface due to an insufficiently elastic and slightly liquid consistency, when pressed, it disintegrates. A pleasant melon color and a specific aroma of melon crops have been preserved. The taste is moderately sweet, one can feel the notes characteristic of melon. A short period of heat treatment made it possible to keep the color, aroma, and taste of melon puree almost unchanged. However, the same factor negatively affected the consistency of the sample. The finished mass was not sufficiently boiled, as a result of which the portion pieces did not retain the required shape. The resulting sample does not meet the requirements of the current state standard GOST 30058-95 "Oriental sweets such as soft sweets. General specifications" as a result of which it cannot be attributed to the studied category of products.

Sample No. 2 has a regular viscous, gelatinous consistency and a pleasant appearance. The product retained a rich yellow color and sweetish aroma of melon. There is a delicate taste of pulp and a pleasant sweet aftertaste with a slight sourness. A long period of boiling slightly weakened the intensity of the taste and aroma of the raw materials but the presence of melon puree is clearly traced in the product. Due to longer boiling, the properties of corn starch were fully revealed, which created the required consistency. At the same time, adding it in small quantities did not affect the taste of the product. The sample does not stick to the hands. In this case, the manufactured product fully complies with

the requirements of regulatory documentation and can be recognized as a new type of oriental sweet product, specifically Turkish delight.

Sample No. 3 has a lighter color, compared to previous samples, the aroma of melon is felt weakly. There was a slight melon taste in the dessert, however, in addition, notes of raw corn starch were clearly traced. The consistency is soft but not elastic enough, the surface is sticky. A short period of heat treatment with a high starch content had a negative impact on the organoleptic qualities of the product. The time spent on heat treatment was not enough, as a result of which the starch was not fully boiled, retained its specific taste in the product, interrupting the taste and aroma of melon, and did not have the desired binding effect. The high concentration of thickener made the color of the resulting product pale, little similar to the color of the pulp of melon. Sensory analysis established the inconsistency of the sample under study with the requirements of the state standard GOST 30058-95 "Oriental sweets such as soft sweets. General specifications". As a result, this sample is not Turkish delight.

Sample No. 4 has a fairly dense texture and a light yellow tint in appearance. The product practically does not reveal the aroma and taste of melon puree.

Due to the long period of heat treatment, corn starch is well boiled, there is no raw taste of this ingredient in the product. However, the high starch content interrupts the taste of melon, making the product bland and almost tasteless. The same situation can be seen with the flavor of the sample. The lack of a rich yellow color is also associated with a high starch content. The synergy of the two regulated factors gave the product an elastic but absolutely non-viscous consistency. When pressed, a piece of the Turkish delight instantly restores its shape and springs. This property is not typical for the product under study. In a given sample, the main qualities of the raw materials used have not been preserved, the consistency does not correspond to the original product. In this regard, this sample is also not a qualitative variation of oriental sweet product.

According to the data shown in Fig. 1 and the results of our sensory analysis, the overall tasting evaluation of the samples is as follows:

– sample No. 1 – 3,6;
– sample No. 2 – 4,4;
– sample No. 3 – 3,4;
– sample No. 4 – 3,3.

Based on these data, it is concluded that sample No. 2 has optimal taste, aromatic and textural indicators with a minimum content of corn starch and longer heat treatment. In organoleptic evaluation, sample 1 is second only to sample 2. The least satisfying taste qualities were demonstrated by sample No. 4 with the maximum starch content and a long boiling period.

The degree of influence of variable factors on the quality of finished products was assessed using a statistical analysis of the results of the experiment.

The dependence of product quality on the studied parameters is quite fully characterized by the regression equation. The following data serve the parameters affecting the process of obtaining a quality product: duration x_1–t, min; the volume of starch x_2–m, g. The experimental data were treated in the software Microsoft Office Excel (USA) and Statistica 12.0 (USA).

The quality of the regression equation was established using the coefficient of multiple correlation R, determination coefficient R^2. In the case of melon Turkish delight, R=0.84 and R^2=0.71. These values are close to the limit value ($R^2 \leq 1$), which indicates a fairly strong influence of the studied parameters on the organoleptic indicators of product quality.

According to the results of the regression analysis, a direct relationship was established between the quality of the product and the duration of heat treatment, and the inverse relationship between the quality of the product and the mass of the starch used.

The results of our statistical analysis show the independence of our observations and a 71 % credibility of the data obtained.

Profilograms of optimum, mean values, and response surface analyses were also constructed for organoleptic indicators of product quality depending on the variable parameters of product manufacturing (Fig. 2, 3).

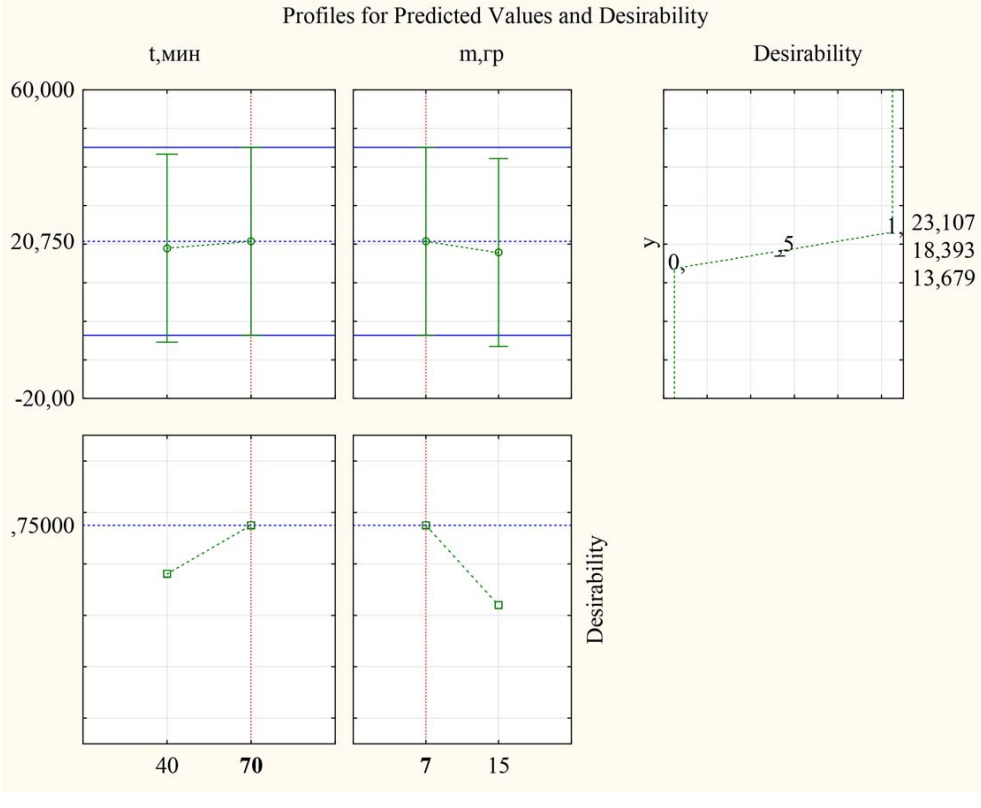

Fig. 2. Profilogram of optimum analysis

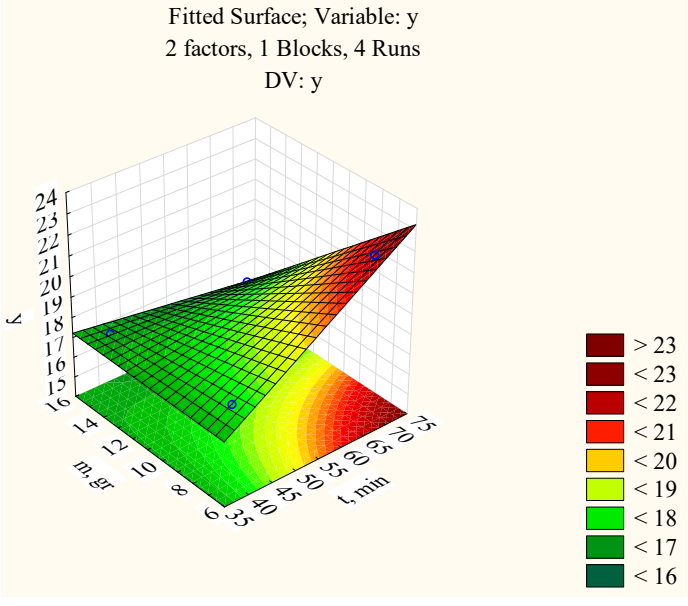

Fig. 3. Established response surface according to the desirability function of organoleptic melon-based quality indicators of Turkish delight depending on the amount of starch and the duration of heat treatment

In the lower right corner in Fig. 3, there are color labels that determine the area of value of the controlled factors where the product quality indicators are most important.

5. 2. Development of recipes, technological schemes for the manufacture of Turkish delight based on the pulp of melon and watermelon fruits

Based on the results of our study of statistical diagrams, the optimal formulation of the experimental sample was developed. Samples under the numbers of 1, 3, and 4 do not have high enough organoleptic ratings and do not meet the requirements of GOST 30058-95 "Oriental sweets such as soft sweets. General specifications". Given this, they are not subject to further research. The most optimal sample of the Turkish delight is chosen to be a product with the following ratio of ingredients: melon puree – 89 %, corn starch – 6.2 %, granulated sugar – 4.4 %, citric acid – 0.4 %. This experimental sample was subject to further quality studies.

A thorough and complete statistical analysis eliminates the possibility of error. Similarly, a complete factor experiment was conducted for the Turkish delight based on watermelon. The variable factors and the number of experiments remained unchanged.

During the study, four variations of Turkish sweets based on watermelon puree were made with the following ratio of ingredients:

1) watermelon puree – 61.3 %, corn starch – 6.2 %, granulated sugar – 3 %, citric acid – 0.3 %, water – 29.3 %. The heat treatment time with a mass of the main ingredient of 400 grams was 60 minutes. Overall tasting score – 3.4;

2) watermelon puree – 61.3 %, corn starch – 6.2 %, granulated sugar – 3 %, citric acid – 0.3 %, water – 29.3 %. The heat treatment time with a mass of the main ingredient of 400 grams was 80 minutes. Total tasting score – 4.5;

3) watermelon puree – 53.2 %, corn starch – 8 %, granulated sugar – 2.6 %, citric acid – 0.2 %, water – 35.9 %. The heat treatment time with a mass of the main ingredient of 400 grams was 60 minutes. General tasting evaluation – 4;

4) watermelon puree – 53.2 %, corn starch – 8 %, granulated sugar – 2.6 %, citric acid – 0.2 %, water – 35.9 %. The heat treatment time with a mass of the main ingredient of 400 grams was 80 minutes. The overall tasting score is 3.8.

We determined a high-quality sample among the recipes of the Turkish delight from watermelon similarly. The findings are based on an organoleptic assessment of the quality of sample No. 5.

The organoleptic indicators of the quality of the studied samples are shown in Fig. 4.

Sample No. 1. The pieces of the Turkish delight of regular shape have a dark rich pink color. The taste and aroma of the product is unexpressed, the taste of the main ingredient is not revealed. The consistency of the Turkish delight is not viscous enough, the total mass is covered with a sticky layer of unbound liquid. There is a destruction of the texture when pressed. During a short period of heat treatment, the binding properties of starch added in small quantities were not sufficiently revealed in the manufactured sample, as a result of which the consistency of the product does not correspond to the description provided in the regulatory and technological documentation. The unexpressed taste and aromatic properties give grounds for recognizing this sample as of poor quality.

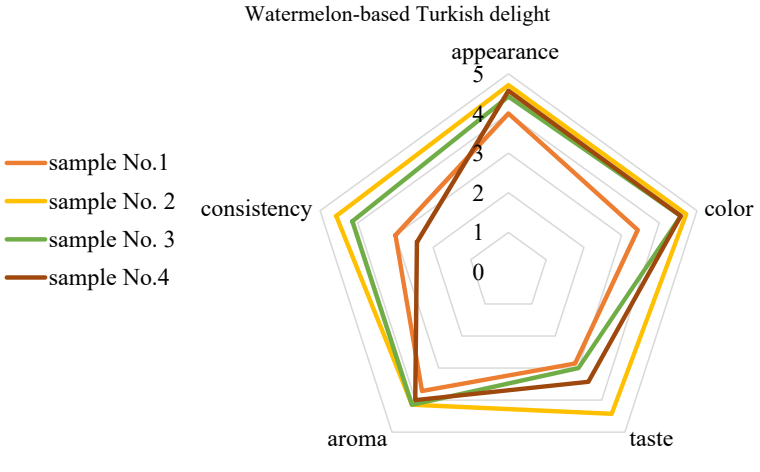

Fig. 4. Profilogram of the organoleptic parameters of Turkish delight based on watermelon

Sample No. 2 has a delicate but rather elastic consistency. The color is pink-red, characteristic of the pulp of watermelon. The product has a delicate aroma of a melon crop, a sugary taste with a slight sourness, and a pleasant aftertaste without foreign odors and tastes. The cubes of the Turkish delight melt in the oral cavity when consumed. With prolonged boiling of the mass, a small amount of corn starch gave the product the necessary texture while not affecting the taste and aromatic properties of

the sample. According to all the studied characteristics, sample No. 2 meets the requirements of the state standard GOST 30058-95 "Oriental sweets such as soft sweets. General technical conditions", in connection with which it can be attributed to the group of oriental desserts, specifically Turkish delight.

Sample No. 3 has a uniform, soft, elastic texture. The color is pink, quite delicate, pleasant. The product has a pleasant watermelon aroma and taste but, in addition, there is a taste of raw corn starch. During the heat treatment, the high starch content did not have time to fully open, not all the starch bound the watermelon puree, and, therefore, the remaining starch gave a specific taste to this sample. The color of the thickener also had an impact on the resulting product, compared to the pulp, the product has a pale pink tint.

Sample No. 4. Its appearance represents even cubes, of pale pink color. The surface is flat, a little dry. The product has an excessively elastic texture, absolutely does not stretch. When breaking a piece, there is some heterogeneity of the texture. The product has the aroma and taste of watermelon puree, not as pronounced as in previous samples. The high concentration of starch together with prolonged heat treatment negatively affected the consistency of the dessert. In this case, the product in texture is similar to jelly sweets, rather than to Turkish delight. Due to this factor, the sample cannot be classified within a group of oriental sweets such as soft sweets.

Based on the selected optimal recipes for the oriental sweet product from the fruits of melon crops, technological schemes were drawn up describing the production process of the Turkish delight based on melon (Fig. 5) and the Turkish delight based on watermelon (Fig. 6).

After working out the optimal recipe and technological modes for the manufacture of Turkish delight based on melon fruits, studies were conducted to determine their nutritional and biological value. The data are shown in Fig. 7–10.

Vitamin C is one of the most important micronutrients for the human body. It is involved in many biochemical processes, such as the synthesis of collagen, serotonin from tryptophan. Vitamin C is not produced by the body on its own, so it is important to ensure its intake through food. Under the influence of high temperatures, ascorbic acid is quickly destroyed, and, therefore, in the framework of this study it was decided to check the content of this vitamin in the product. In comparison with the control sample, the content of vitamin C in the finished product decreased by 0.24 mg/100 g. In this case, the decrease in the content of ascorbic acid is insignificant, and, therefore, the developed dessert can be attributed to the group of products-sources of vitamin C.

During the analysis, the acidity of raw materials and experimental samples of desserts was determined. The data are shown in Fig. 11.

According to GOST 30058-95 "Oriental sweets such as soft sweets. General technical conditions", one of the important physicochemical indicators for oriental sweets such as soft sweets is acidity. As can be seen from Fig. 11, the total acidity is higher, hence the shelf life will be longer.

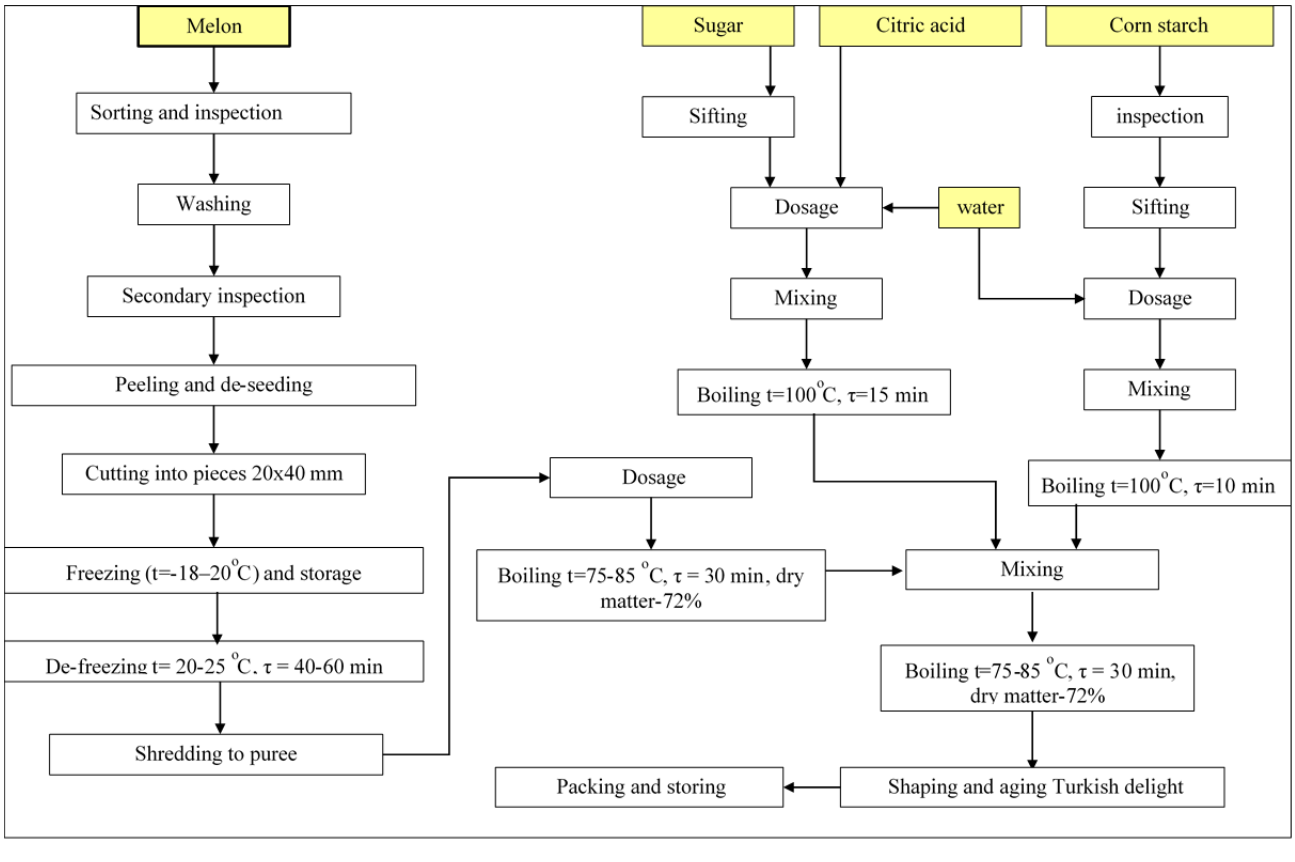

Fig. 5. Technological scheme to produce Turkish delight based on melon fruits

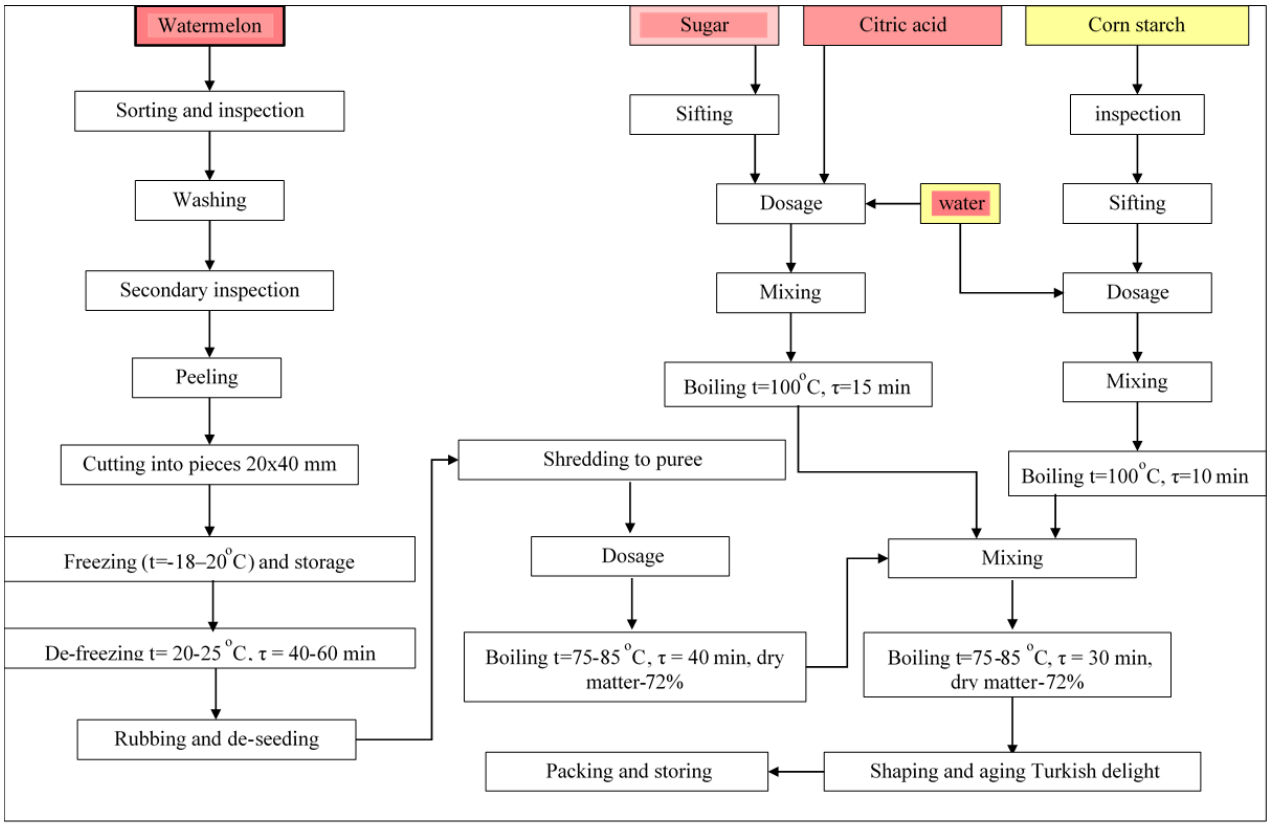

Fig. 6. Technological scheme to produce Turkish delight based on watermelon fruits

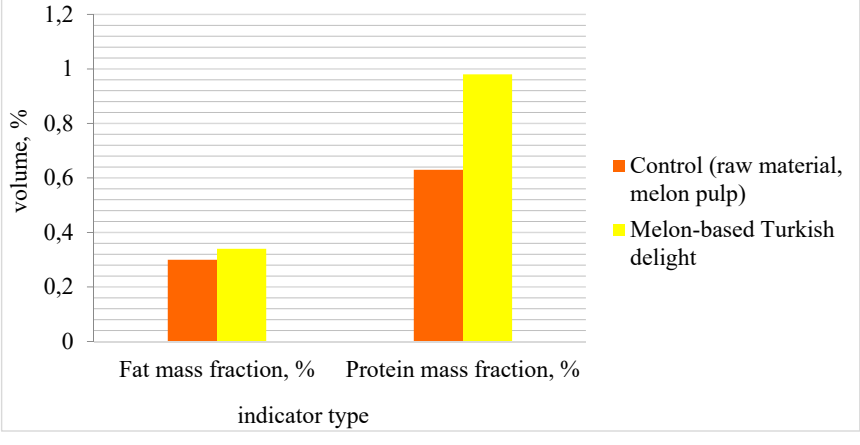

Fig. 7. The mass fraction of fat and protein in melon pulp and the Turkish delight based on it

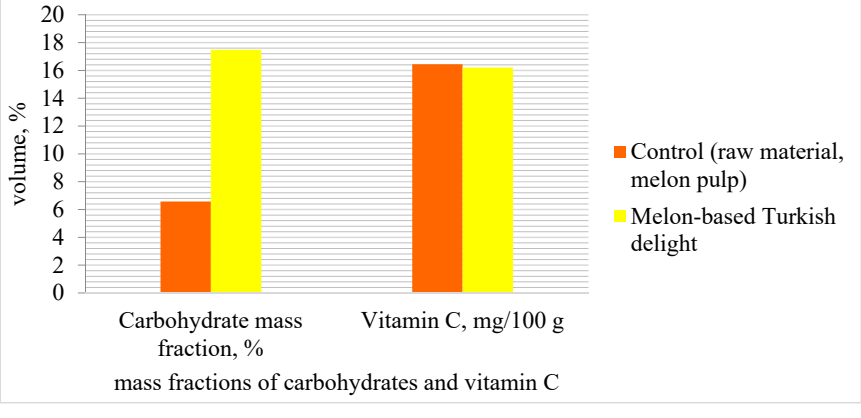

Fig. 8. The mass fraction of carbohydrates and the content of vitamin C in the pulp of melon and the Turkish delight based on it

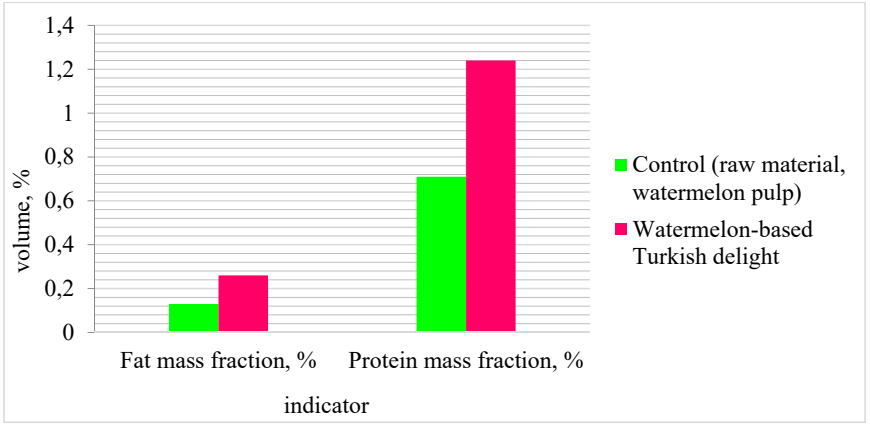

Fig. 9. Mass fraction of fat and protein in the pulp of watermelon and the Turkish delight based on it

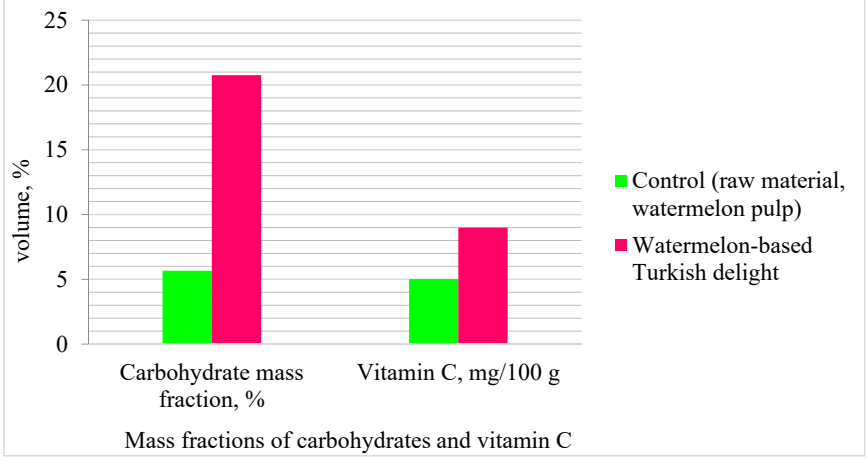

Fig. 10. Mass fraction of carbohydrates and content of vitamin C in the pulp of watermelon and the Turkish delight based on it

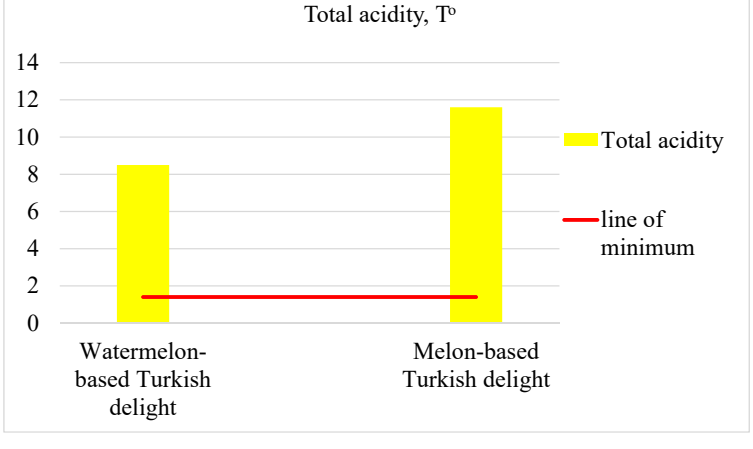

Fig. 11. Results of the analysis of the total acidity of experimental samples

5. 3. The microbiological indicators of quality of the Turkish delight based on melon crops

In addition to determining the organoleptic properties of manufactured products and assessing their nutritional and biological value, the samples of Turkish delight based on melon and watermelon were subjected to microbiological analysis to assess the sanitary condition of the product and establish its safety.

According to GOST 30058-95 "Oriental sweets such as soft sweets. General technical conditions", the main microbiological indicators of the quality of oriental sweets are:

– the content of mesophilic aerobic and facultative-anaerobic microorganisms;

– yeast content;

– the content of mold fungi.

To more accurately determine the quality and safety of products, microbiological analysis was used not only for the samples of manufactured products but also for samples of the raw materials. Quality control was carried out by comparing experimental data with medical and biological requirements and sanitary quality standards of food raw materials and

food products for plant raw materials and sweets. The results of this analysis are shown in Fig. 12, 13.

According to Fig. 12, 13, it was established that the content of microorganisms in the raw materials and finished products on the first day does not exceed the permissible values specified in the Technical Regulations of the Customs Union TR TC 021/2011 "On the safety of food products". In the samples of the experimental Turkish dessert based on melons, in comparison with the raw materials, the content of mesophilic aerobic and facultatively anaerobic microorganisms is reduced.

Repeated microbiological analysis was carried out on day 25 from the date of manufacture of the sample. The results of the analysis are shown in Fig. 14, 15.

When comparing the results of analyses on the first and twenty-fifth days, it was found that the content of yeast, mesophilic aerobic and facultatively anaerobic microorganisms increased in the experimental samples.

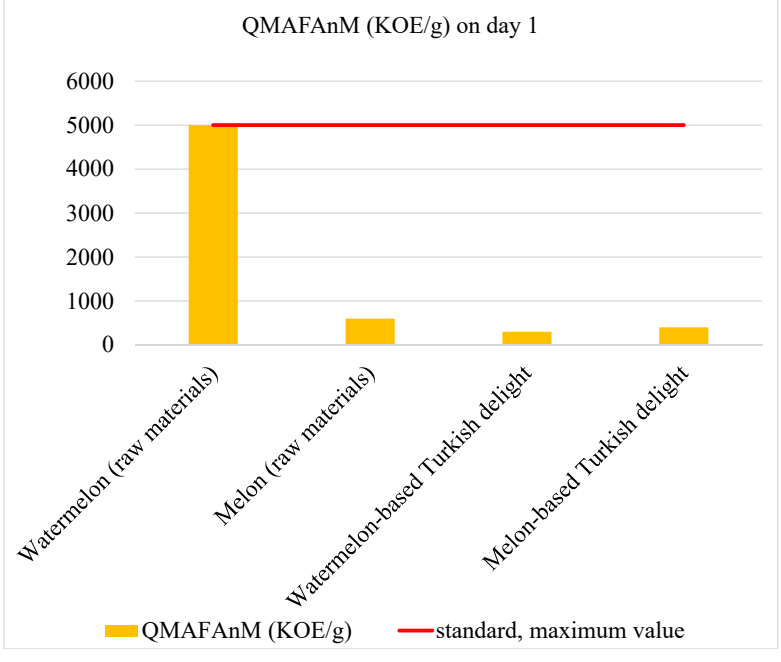

Fig. 12. Content of mesophilic aerobic and facultative-anaerobic microorganisms in raw materials and finished products on day one

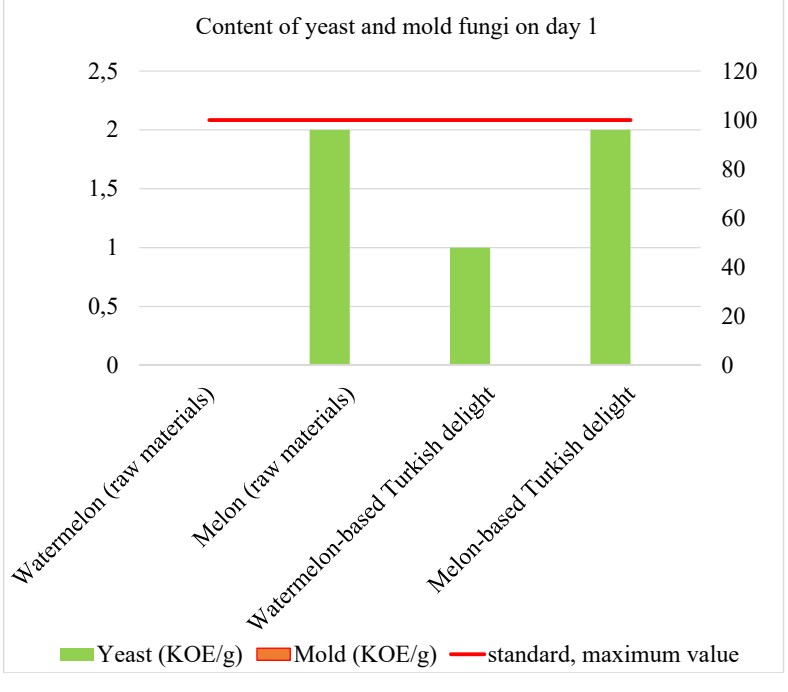

Fig. 13. The content of yeast and mold fungi in raw materials and finished products on day one

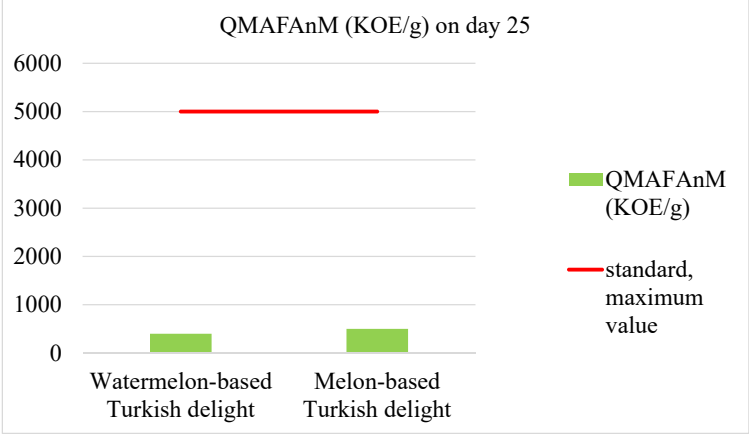

Fig. 14. Content of mesophilic aerobic and facultative-anaerobic microorganisms in raw materials and finished products on day 25

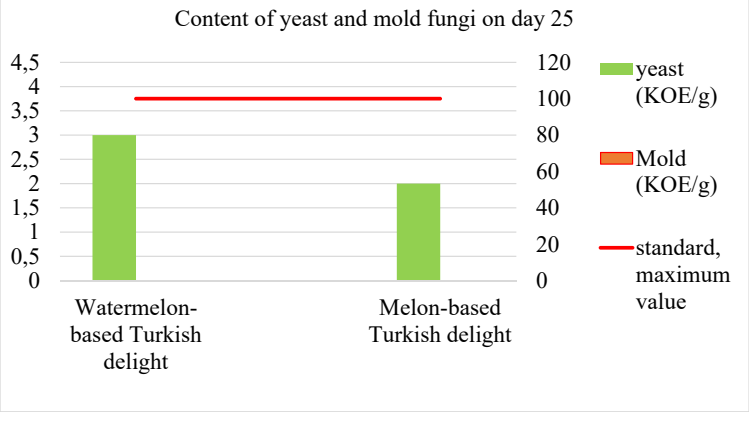

Fig. 15. The content of yeast and mold fungi in raw materials and finished products on day 25

6. Discussion of results of studying the technology of production of Turkish delight from overripe fruits of melons and watermelons

Our results prove the possibility of using overripe fruits of watermelons and melons in the production of Turkish delight, both fresh and from frozen semi-finished products. The condition is to control the contamination and acidity of the mixture. According to our analysis, the organoleptic parameters are affected by the duration of heat treatment and the mass of the starch introduced. Based on the results shown in Fig. 2 and Fig. 3, it can be concluded that 70 minutes of heat treatment with the introduction of 7 % corn starch are optimal.

As can be seen from the data in Fig. 9 and the results of our sensory analysis, the overall tasting evaluation of the samples is as follows:

– sample No. 1 – 3, 4;
– sample No. 2 – 4, 5;
– sample No. 3 – 4;
– sample No. 4 – 3, 8.

The resulting data on the organoleptic analysis of the Turkish delight based on watermelon were similarly subject to statistical analysis.

The technological schemes for the Turkish delight from watermelons and melons are shown in Fig. 5, 6. According to the diagrams in Fig. 8, 9, compared with the control sample, which is the pulp of a melon, the amount of nutrients in the developed oriental sweet product has increased. Thus, the amount of fat increased by 0.04 %, protein by 0.35 %, carbohydrates by 10.9 %. In this regard, the caloric content of the product has also increased. When comparing the data shown in Fig. 10, 11, the following conclusion is made: the developed oriental sweet product based on watermelon pulp exceeds the control sample in all studied indicators. The mass fraction of fat in the developed product is 0.26 %, which is 0.13 % more than that in the raw materials.

The mass fraction of protein increased by 0.53 %. In the Turkish delight based on watermelon, the carbohydrate content increased by 3.7 times, by 15.1 %.

In comparison with the control sample, the content of vitamin C in the developed product increased by 3.96 mg/100 g. An increase in this indicator was achieved due to the addition of citric acid to the product.

When comparing the test results for the first and twenty-fifth days, Fig. 12–15, it was found that in experimental samples during storage, there was an increase in the content of yeast, mesophilic aerobic and facultatively anaerobic microorganisms.

In existing methods, the pulp of watermelons and melons was not used, moreover, mainly the classic Turkish delight is the ratio of water, starch and sugar, when boiling – tartaric acid and juices are added. We took overripe fruits from the fields and froze the pulp and produced Turkish delight from the frozen pulp of watermelons and melons. The contamination of the product is investigated as it is a disadvantage of this product in the classic recipe. The proposed method differs in that the recipe reduces the amount of sugar by 5 times. In the classic recipe of Turkish delight, sugar syrup is 50 %, in the developed version – 9 %.

The limitations of our study are the seasonality of the product and the rise in price of the Turkish delight because of the storage of semi-finished products in the freezer.

The disadvantage of this study is the lack of coverage by species and varieties of watermelons and melons. In this study, we confined ourselves to late-ripening varieties, in terms of studying early-ripe varieties of watermelons and melons for suitability for production of Turkish delight since the nitrate content in them is greater. The content of nitrates is regulated for early-ripe varieties, the permissible norm of nitrate content in watermelons is 60 mg/kg, melons – 90 mg/kg. The use of products with a high content of nitrates can lead to food poisoning. Additionally, the content of nitrates leads to the rapid growth of yeast and bacteria, which leads to rapid spoilage of products.

The development of this study is to explore the possibility of using early-ripe fruits of watermelons and melons in the production of sweets and long-term storage products. Ensuring the high quality of the product from melon crops with a long shelf life and the impact of storage and packaging conditions on the quality of the finished product. Lack of funding and laboratory equipment to determine the quality of the product in storage conditions can be a difficulty.

7. Conclusions

1. Based on the experiments conducted, it was concluded that sample No. 2 has optimal taste, aromatic and textural indicators with a minimum content of corn starch and a longer heat treatment. In organoleptic evaluation, sample 1 is second only to sample 2. According to the results of the regression analysis, a direct relationship was established between the quality of the product and the duration of heat treatment, and the inverse relationship between the quality of the product and the mass of the starch used. The results of our statistical analysis show the adequacy of the obtained equations and the coefficient of determination is 0.71, which proves the significance of the obtained coefficients of the regression equation.

2. Of the highest quality and pleasant in terms of organoleptic indicators is sample No. 2. The ratio of components in this version is as follows: watermelon puree – 86.6 %, corn starch – 8.7 %, granulated sugar – 4.3 %, citric acid – 0.4 %. The sample, made according to the developed recipe, was sent for further quality studies. Of the two products created, watermelon Turkish delight has a higher calorie content. In the melon Turkish delight, there is a higher fat content, 0.08 % higher than that in watermelon. However, the values of the mass fraction of proteins and carbohydrates acquire a higher value in the Turkish delight based on watermelon pulp, by 0.26 % and 3.28 %, respectively.

Initially, the carbohydrate content in the pulp of melon is higher than that in the pulp of watermelon. However, in the manufacture of desserts, a larger amount of starch was added to the watermelon puree, which served as a factor in increasing the carbohydrate content in the finished product.

The content of ascorbic acid in the watermelon Turkish delight is slightly less, by 7.22 mg/100 g, than that in melon. However, given the fact that the very pulp of watermelon initially contains a smaller amount of this vitamin, watermelon Turkish delight can also be recommended for use as a source of vitamin C.

3. Microbiological analysis of the samples showed that the product can stored at a refrigerated temperature longer than 25 days and is suitable for consumption. Despite the increase in the content of yeast, mesophilic aerobic and facultatively anaerobic microorganisms, on day 25 the level does not exceed the permissible norm of quality products. Consequently, this recipe and the proposed technology are suitable for introduction into the production of sweets from melon crops. The developed products comply with regulatory documents and demonstrate not only qualitative indicators but also good organoleptic estimates.

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