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DEVELOPMENT OF FUNCTIONAL MARMELOD TECHNOLOGY BASED ON PUMPKIN MASH AND LIGHTENED CURRENT WHEY

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РОЗРОБКА ТЕХНОЛОГІЇ ФУНКЦІОНАЛЬНОГО МАРМЕЛАДУ НА ОСНОВІ ПЮРЕ З ГАРБУЗА ТА ОСВІТЛЕНОЇ ПІДСИРНОЇ СИРОВАТКИ

Objective. *Objective of the article is to develop the technology and recipe of marmalade based on pumpkin puree and clarified whey and the study of organoleptic characteristics at a certain shelf life.*

Methods. *The paper uses standard generally accepted and special research methods that ensure the implementation of the tasks. Sampling was carried out in accordance with the requirements of DSTU ISO 874-2002, preparation of samples for laboratory analysis — in accordance with DSTU 7040: 2009. Practical testing of recipes and technology was carried out in the technological laboratory of DonNUET.*

Results. *The improvement of the recipe composition and quality of marmalade with the use of natural raw materials — pumpkin puree has been studied. The inclusion of pumpkin puree in the recipe will help to obtain functional marmalade. The article highlights the results of the study of organoleptic parameters. The positive effect of marmalade is due to the mutual complex influence of all components and their quantity. The main task of improving the quality of marmalade is the use of natural raw materials, reducing sugar content and increasing the biological value of finished products.*

We researched fruit marmalade, which is based on pumpkin puree and clarified whey. The literature available to us does not establish the use of pumpkin as the main raw material in the production of marmalade. Given the yield, availability, widespread distribution of this vegetable in Ukraine, as well as information about the nutritional and biological value of pumpkin, we consider it appropriate to use pumpkin for marmalade production. Based on research, it can be argued that the use of pumpkin puree for marmalade production will expand the range of marmalade and increase the biological value of finished products. The inclusion of pumpkin puree in the recipe will help to obtain functional marmalade. The positive effect of marmalade is due to the mutual complex influence of all components and their quantity.

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Formulation of the problem. The concept of healthy eating involves the development and implementation of products containing natural ingredients. Not the least role in the human diet belongs to confectionery, they help improve mood, increase mental activity and saturate the body with carbohydrates.

Jelly marmalade is in great demand among the population, especially among children, due to its pleasant taste and appearance. Usually, the bright color and pleasant taste of the products indicates the presence in their composition of synthetic dyes and flavors, the use of which leads only to negative consequences [1].

According to the UK Food Standards Agency, “Marmalade is a mixture, brought to a suitable gel-like consistency, of water, sugar and fruit pulp, fruit puree, fruit juice, fruit peel or aqueous fruit extract, or any combination of these, used for every 1000 g of finished product, at least 200 g of fruit and berry raw materials, of which at least 75 g is obtained from the endocarp” [2].

In Germany, historically, marmalade is a sweet smooth product made from sugar and boiled fruit, regardless of the origin of the fruit, was commonly known as “Konfitüre” [3].

The composition of marmalade in Europe is controlled by a European Union directive, which prescribes the minimum amount of hard fruit and sugar required for various categories. Production consists of mixing the ingredients, raising the temperature and evaporating to the correct soluble solids content either at 100 °C at atmospheric pressure or up to 60 °C under vacuum. Vacuum boiling prevents heat damage, caramelization and loss of fruit volatiles, but provides additional pasteurization [4]. In Ukraine, marmalade is a solid jelly-like product made from fruit juices or decoctions and sugar with the addition of gelling agents [5].

The market for functional products today is a dynamic and specific segment of production activity that requires active and qualified personnel capable of effectively and quickly bringing a fundamentally new and useful product to the market [6, 7]. The segment of sugary confectionery products in Ukraine is the most traditional and therefore more oriented to the domestic market. But it is in it that new niches and segments appear and develop, formed under the influence of new trends.

Today, more and more “healthy” confectionery products are becoming more and more popular, which take into account the needs of consumers seeking to lead a healthy lifestyle, including for children and adolescents [8].

Therefore, the urgent problem today is the development of new types of these products using natural plant ingredients in order to expand the range, increase biological value and create competitive products in the market.

Analysis of recent research and publications. Currently, the domestic market offers a wide range of herbal supplements from fruit and non-traditional medicinal raw materials (purees, pastes, concentrated juices, powders), which can be used as dyes and to increase the biological value of jelly marmalade. However, it should be noted that the production of most of these additives involves complex technological processing of raw materials, which leads to the loss of dyes and nutrients: vitamins, dietary fiber, organic acids, glycosides and more.

A significant advantage among herbal supplements are those that have a high coloring ability. Studies have shown that the priority of such plant additives is cryogenic grinding of raw materials. Herbal supplements obtained by low-temperature technologies, due to fine grinding are a concentrate of biologically active substances (anthocyanins, carotenoids, chlorophylls), contain a significant amount of low- and high-molecular phenolic compounds, dietary fiber, vitamins, glycosides, organic acids and macro-acids. antioxidant, immunomodulatory properties, as well as high coloring ability, good taste and aromatic characteristics.

The above indicates the relevance of studying the possibility of using plant powders with high content of natural dyes of anthocyanin, carotenoid and chlorophyll nature in the production of jelly marmalade to improve its quality and biological value, natural color products, and exclusion from the recipe of synthetic dyes and flavors.

Kuprina O. V., Tyurina A. K., Medvedeva E. N. developed a recipe for functional marmalade products based on sea buckthorn puree and arabinogalactan isolated from Siberian larch wood [9].

Yamchenko T. V., Zemlyakova E. S. developed a recipe and technology for the production of marmalade from non-standard raw materials, namely oat flakes, from which an oat drink was obtained, which acts as the basis for this product [10].

Sanzharovskoy N. S., Khrapko O. P. substantiated and developed recipes and technologies for the production of jelly marmalade «Yagodny», «Phyto», «Spring» based on pectin extracts from hawthorn, wild rose and sea buckthorn fruits and phyto-infusions — chamomile, dioica nettle, peppermint, allowing to obtain products mass consumption with increased nutritional value, intended for functional nutrition [11].

Sagdic O., Toker O. S., Polat B., Arici M. and Yilmaz M. T. studied the bioactive and rheological properties of rosehip marmalade, which is widely consumed for breakfast in Turkey. This marmalade is prepared by boiling fruit pulp with sugar and acid until the desired Brix value is reached [12].

Skobelskaya Z. G., Butin S. A., Lyubenina I. A., Kolpakova V. V. a recipe and technology for the production of functional marmalade enriched with polyunsaturated fatty acids has been developed.

Domestic linseed oil containing more than 60% omega-3 and omega-6 fatty acids served as an additive that imparts functional properties to marmalade [13].

Savenkova T. V., Krylova E. N., Mavrina E. N. a method for the production of functional jelly marmalade has been developed. As a functional additive, an inulin preparation with a mass fraction of dietary fiber of 90% is used [14].

Figueroa L. E., Genovese D. B. developed a new functional product — marmalade enriched with dietary fiber. For this purpose, 3 g of fiber from apples, bamboo, plantain, and wheat were added [15].

Ajala S., Ajao I. A. developed a banana marmalade with the addition of ginger to the recipe. This was done to increase the nutritional value and improve the taste of banana marmalade. Marmalade was prepared with different amounts of ginger (1; 2; 3 and 0%). According to the results of the study, marmalade with 1% ginger received the highest rating [16].

Tugba Ozbek, Neshe Shahin-Yoshilchubuk and Birsen Demirel developed and characterized strawberry marmalade containing functional food ingredients such as omega-3 fatty acids, dietary fiber, protein and antioxidants, with the addition of chia seeds [17].

Pavlovich S. R., Tepich A. N., Vuychich B. L. studied low-calorie marmalade, which is produced at the Srbijanka factory (Serbia). This low-sugar marmalade is made from apricot, peach, strawberry, apple and orange [18].

Egbekun M. K., Nda-Suleiman E. O., Akinie O. developed a recipe and technology for making marmalade from corrugated pumpkin (*Telfairia Occidentalis*), which grows in Africa [19].

Zhilinskaya N. V., Sarkisyan V. A., Vorobieva V. M., Vorobieva I. S., Kochetkova A. A., Smirnova E. A., Glazkova I. V. developed marmalade for patients with type 2 diabetes. This marmalade was made on the basis of agar-agar, gelatin and pectin with maltitol, dried fruits and berries to control glycemia [20].

Lobosova L. A., Magomedov M. G., Zhurakhova S. N. a technology has been developed for producing jelly-fruit marmalade on pectin with the replacement of granulated sugar with fructose and 30% applesauce with pureed chokeberry fruits, molded by the “syringing” method using a continuous vacuum syringe into a metallized film of the “flow-pack” type [21].

Kamiloglu S., Pasli A. A., Ozcelik B., Camp D. V., Kapanoglu E. investigated the stability of total phenolic compounds and phenolic acids, as well as the antioxidant capacity in black carrot marmalade after processing, storage and in vitro gastrointestinal digestion. — intestinal tract. It was concluded that black carrot marmalade is a good source of polyphenols with a high level of bioavailability [22].

Frolova N. A. and Reznichenko I. Yu. a method has been developed for obtaining functional jelly marmalade, where stevioside is used as a sweet agent in syrup, pectin from viburnum and lemongrass berries is used as a gelling agent, and pulp from viburnum and lemongrass berries, Lavitol-V premix, is used as functional components [23]. Arslaner A., Salyk M. A. investigated the physicochemical and microbiological characteristics and mineral compositions of marmalade

obtained by the traditional method using *Berberis integerrima* Bunge (purple barberry), *Berberis vulgaris* L. (pink barberry), *Rosa pimpinellifolia* L. (black rosehip), *Rosa canina* L. (pink rosehip), *Malus sylvestris* Miller (sour apple) and *Vaccinium corymbosum* L. (blueberry), grown in natural conditions in the provinces of Bayburt and Trabzon. Based on research, it was concluded that these fruits, which are not usually eaten as table fruits, but have a rich mineral composition, characteristic taste and pleasant aroma, can be used in the production of marmalade [24].

Emaldi U., Nassar D. M., Semprum K. studied the possibility of obtaining marmalade from the pulp of the fruits of the red and white varieties of the cactus Cardon Dato (*Stenocereus griseus*). Marmalade recipes were developed and their stability was evaluated during three months of storage at room temperature [25].

Emelike N. D.T., Akusyu O.M. developed marmalade from tropical fruits and nuts such as mango, cashew, pineapple, guava, lemon. Their pectin strength was evaluated. The results of the study showed that all samples were understandable and suitable for consumers. But the highest acceptability scores are for mango, pineapple, and cashew marmalade. Consequently, it was concluded that some Nigerian tropical fruits and nuts can and should be used in the production of marmalade, which will also have a positive effect on reducing their annual losses [26].

Thus, the conducted studies confirm the relevance of developing and saturating the market with sugary confectionery products, namely marmalade, which lead to increased competition, develop a scientifically based formation of specialized diets with the inclusion of functional marmalade, for feeding organized groups living in environmentally unfavourable regions. The constant addition of marmalade to the human diet will ensure mass prevention of the population from aggressive environmental agents.

Objective of the article is to develop the technology and recipe of marmalade based on pumpkin puree and clarified whey and the study of organoleptic characteristics at a certain shelf life.

Presentation of the main study material. It is known that the benefits of pumpkin puree is the presence of a large number of minerals and vitamins. It contains vitamin A, which is important for eyesight, and together with vitamin E, it improves the condition of the skin. The puree contains B vitamins, which are important for the nervous system, which, in turn, helps to cope with insomnia, fatigue and stress. Ascorbic acid, which is also present in this product, increases the body's defenses. Pumpkin puree also contains vitamins D, F and PP. As for minerals, for example, it contains magnesium and potassium, which are important for the cardiovascular system, as well as iron, which is involved in the process of hematopoiesis. Pumpkin puree contains a lot of fiber, which cleanses the intestines and improves the digestive system. Contains pumpkin puree folic acid, which is needed for children and adults. Pumpkin has the ability to improve kidney function and cleanse the body of toxins. Due to the high content of pectin, pumpkin has high gem-forming properties, which allows you to avoid the use of additional substances. The main source of pectin in the human body are fruits and products made from them, in particular, marmalade.

In order to enrich marmalade with biologically active substances, various types of non-traditional raw materials are used: we have proposed pumpkin puree, which allows to give the product certain functional properties and at the same time has a positive effect on its safety due to available natural bactericidal substances.

We have proposed a method of obtaining marmalade, which includes the preparation of pumpkin puree, preparation of syrup from sugar, molasses and pectin, using clarified whey (75–80 ° Turner), fermented with bacterial leaven, adding additives, cooking, separating marmalade mass with laminated, developing, forming, drying and packing. Clarified whey is fermented with bacterial yeast, which consists of a consortium of lactic acid bacteria — culture of Bulgarian (*Lactobacillus bulgaricus*) and acidophilic (*Lactobacillus acidophilus*) rods in a ratio of 3:2 at a temperature of 37–38 °C with the addition of ascorbic acid.

The problem is solved by the fact that the composition of marmalade in the following ratio of components (parts by weight):

clarified curd whey	18.0–20.0
bacterial leaven	0.9–1.0
granulated sugar	30.0–36.0

sirup	4.5–5.0
citrus pectin	3.0–3.2
pumpkin puree.....	32.5–40.0
ascorbic acid	2.2–2.4
sodium lactate.....	0.5–0.6

The use of the proposed method will allow to obtain marmalade with a harmonious combination of organoleptic, high therapeutic and prophylactic and consumer properties. The positive effect of marmalade is due to the mutual complex influence of all components and their quantity. The ratio of the components of the composition is selected experimentally to ensure in the finished marmalade a high content of biologically active compounds inherent in this composition of raw materials. The composition has a vitamin, tonic effect and thus increases the human body's resistance to adverse environmental factors.

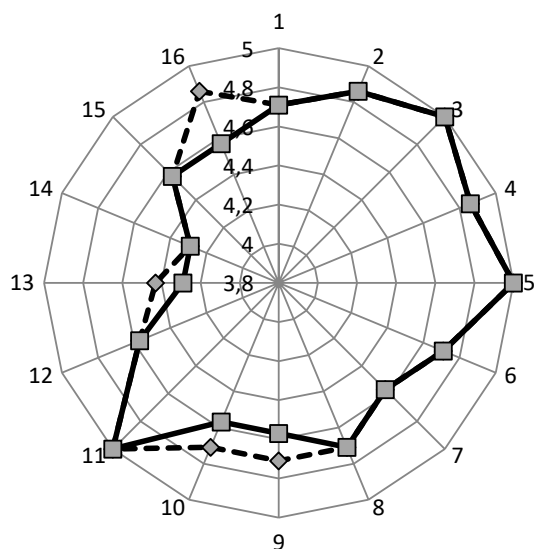
These components of the composition in certain quantities harmoniously complement the organoleptic properties of each other, creating marmalade with original taste and pleasant aroma. The complex of compounds that are part of plant raw materials, allows you to include marmalade to dietary products.

We conducted research on the recipe composition of different ratios of ingredients on different examples. Examples of marmalade formulations and their organoleptic properties are given in Table 1. The quality of the product was determined by organoleptic method.

Table 1 — Organoleptic evaluation of fruit and berry marmalade

Indicator	Fruit and berry marmalade according to traditional recipes	“Amber” marmalade (from pumpkin puree with clarified whey)
Taste, smell and color	Clear taste and smell, with a slight sourness, deep orange color, characteristic of this type of product	The outer layers have a distinct taste and smell of pumpkin marmalade, bright orange color, slightly pronounced milky taste
Consistence	Gemstone	Gemstone
Form	Slightly irregular in shape, without deformation	Slightly irregular in shape, without deformation
Surface	A thin crystalline layer	A thin crystalline layer

According to the regulatory documentation for the period of storage (up to 30 days) in the product should not be processes that affect the quality of marmalade. To establish changes in the quality of amber marmalade, studies of organoleptic parameters were conducted. Quality indicators were determined before and after storage for 30 days. To determine the changes in the organoleptic characteristics of the strip during storage, a scale of sensory evaluation was developed, which is presented graphically in the form of separate descriptors on circular organoleptic profiles,



where the value of each component of organoleptic evaluation is marked on a 5-point scale. After determining the organoleptic characteristics, organoleptic profiles were constructed (Fig. 1).

According to the results of the study (Fig. 1), after 30 days of storage in marmalade «Amber»

Figure 1 — Organoleptic profiles of marmalade «Amber»: - - - freshly made; — after 30 days of storage. Descriptors: appearance (1 — homogeneity; 2 — fluidity); consistency (3 — density; 4 — viscosity); color (5 — intensity; 6 — purity; 7 — homogeneity; 8 — naturalness); smell (9 — purity; 10 — expressiveness; 11 — balance); taste (12 — sweetness; 13 — intensity; 14 — homogeneity; 15 — texture; 16 — naturalness).

there was a slight decrease in the severity of odor, as well as the intensity and naturalness of the taste of pumpkin.

Conclusions. Based on research, it can be argued that the use of pumpkin products for marmalade production will expand the range of fruit marmalade and increase the biological value of finished products. Inclusion in the recipe of pumpkin will help to obtain functional marmalade. The positive effect of marmalade is due to the mutual complex influence of all components and their quantity. In further research, we will investigate the chemical composition of fruit marmalade. Justification of the content of significant amounts of ascorbic acid, pectins and β -carotenes. Due to this, fruit marmalade has not only high nutritional, but also therapeutic and prophylactic properties.

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Мета. Метою статті є розробка технології та рецептури мармеладу на основі гарбузового пюре і освітленої підсирної сироватки та дослідження органолептичних показників при певному терміні зберігання.

Методи. У роботі використано стандартні загальноприйняті та спеціальні методи дослідження, що забезпечують виконання поставлених завдань. Відбір проб здійснювався згідно з вимогами ДСТУ ISO 874-2002, підготовка проб до лабораторного аналізу — згідно з ДСТУ 7040: 2009. Практичну апробацію рецептур та технології проводили в технологічній лабораторії ДонНУЕТ.

Результати. Досліджено покращення рецептурного складу та якості мармеладу з використанням натуральної сировини — гарбузового пюре. Включення в рецепт гарбузового пюре допоможе отримати функціональний мармелад. У статті висвітлено результати дослідження органолептичних показників. Позитивний ефект мармеладу обумовлений взаємним комплексним впливом усіх компонентів та їх кількості. Основним завданням підвищення якості мармеладу є використання натуральної сировини, зниження цукристості та підвищення біологічної цінності готової продукції.

Досліджено фруктовий мармелад, основу якого складає гарбузове пюре та освітлена сироватка. Доступна нам література не встановлює використання гарбуза як основної сировини у виробництві мармеладу. Враховуючи врожайність, доступність, широке поширення цього овоча в Україні, а також відомості про харчову та біологічну цінність гарбуза, вважаємо за доцільне використання гарбуза для виробництва мармеладу. На основі досліджень можна стверджувати, що використання гарбузового пюре для виробництва мармеладу дозволить розширити асортимент мармеладу та підвищити біологічну цінність готової продукції. Включення в рецепт гарбузового пюре допоможе отримати функціональний мармелад. Позитивний ефект мармеладу обумовлений взаємним комплексним впливом усіх компонентів та їх кількості.

Ключові слова: гарбуз, освітлена підсирна сироватка, мармелад, рецептура, технологія, органолептичні показники, вітаміни, пектин.