UDC 641.1:641.8:641.52
DOI: 10.15587/1729-4061.2022.265201

TECHNOLOGY OF CRAFT CONFITURE FROM NON-TRADITIONAL LOCAL RAW MATERIALS

Oksana Dzyundzya
PhD, Associate Professor
Department of Food Engineering
Kherson State Agrarian and Economic University
Sretenskaya str., 23, Kherson, Ukraine, 73006
Artem Antonenko
Corresponding author
PhD, Associate Professor*
E-mail: artem.v.antonenko@gmail.com
Tetiana Brovenko
PhD, Associate Professor*
Galina Tolok
PhD, Associate Professor
Department of Technologies of Meat, Fish and Marine Products
National University of Life and Environmental Sciences of Ukraine
Heroyiv Oborony str., 15, Kyiv, Ukraine, 03041
Myroslav Kryvoruchko
PhD, Associate Professor
Department of Design and Engineering**
Tetiiana Bozhko
PhD, Associate Professor
Department of Commodity Science, Safety and Quality Management**
Dmytro Antiushko
PhD, Associate Professor
Department of Commodity Science, Safety and Quality Management**
Svitlana Vezhlivtseva
PhD, Associate Professor
Department of Commodity Science, Safety and Quality Management**
Tetiana Lebedenko
Doctor of Technical Sciences, Associate Professor, Head of Department***
Nataliia Kovalenko
PhD, Associate Professor***
*Depatment of Hotel and Restaurant and Tourist Business
Kyiv National University of Culture and Arts
Yevhena Konovaltsya str., 36, Kyiv, Ukraine, 01601
**State University of Trade and Economics
Kyoto str., 19, Kyiv, Ukraine, 02156
***Depatment of Hotel and Restaurant Business
Odessa National University of Technology
Kanatna str., 112, Odessa, Ukraine, 65039

Climate change and lower yields require maximum utilization of natural resources. In order to reduce the loss of valuable raw materials, it is relevant to substantiate craft innovative technologies involving local raw materials with maximum resource conservation. Taking into consideration global trends in the production of organic craft products, it has been established that there is a need to introduce resource-saving technologies.

The object of research for the preparation of craft confiture was quince and green tomatoes. We examined 5 samples of confiture with different ratios of quince puree to the green tomato puree. Sensory analysis revealed that compared to the score of the control sample (14.94 points), sample No. 3 (14.87 points) with a ratio of 2:1 quince puree to green tomato puree is rational.

It was found that the viscosity and shear stress indicators for control sample No. 1 and sample No. 3 are quite similar. The measurement results showed that the systems that were investigated have stable structure characteristics of viscous-plastic systems. The research results show that the introduction of green tomato puree into the composition of the model compositions has almost no effect on the viscosity of the masses (sample No. 3) compared to the control sample. The obtained data show that, regardless of the shear rate, the structure is actually the same.

It was established that in the prototype of confiture there are no significant changes in the chemical composition. However, there is a slight decrease in the content of carbohydrates, organic acids, and phenolic compounds, by 20 %, which is associated with a decrease in the quince content and the introduction of green tomatoes into the recipe. The energy value of the new product decreased by 5 %, which is insignificant. Microbiological studies indicate the hygienic safety of manufactured confitures from fruit and vegetable raw materials according to the specified indicators and fully comply with established standards

Keywords: fruit puree, quince puree, craft confiture, green tomato, model compositions

Received date 04.07.2022
Accepted date 14.09.2022
Published date 30.10.2022

***How to Cite**: Dzyundzya, O., Antonenko, A., Brovenko, T., Tolok, G., Kryvoruchko, M., Bozhko, T., Antiushko, D., Vezhlivtseva, S., Lebedenko, T., Kovalenko, N. (2022). Technology of craft confiture from non-traditional local raw materials. Eastern-European Journal of Enterprise Technologies, 5 (11 (119)), 48–54. doi: https://doi.org/10.15587/1729-4061.2022.265201*

1. Introduction

Changes in climatic conditions and a decrease in yields pose new challenging tasks for scientists in various industries every year, starting with the cultivation and ending with the sale of finished products. For the food industry, the latest trends are the production of organic and craft products, taking into consideration resource-saving technol-

ogies. In order to reduce the loss of valuable raw materials, it is relevant to devise non-standard innovative technologies involving local agricultural raw materials with maximum resource conservation. One of the promising areas is the production of craft products from raw materials that are almost not used for industrial processing, for example, green tomatoes and quince fruits.

Quince fruits contain pectin compounds, glucose, fructose, salts of potassium, iron, calcium, phosphorus, copper, and organic acids, as well as provitamin A, vitamins B1, B2, B6, B, C, PP, and E. Given the high content of pectin in fruits, quince is recommended for people who live in areas contaminated with radionuclides or work in hazardous industries. Pectins have the ability to normalize the microflora of the gut and remove radionuclides from the body.

Green tomatoes contain vitamins and minerals that help improve eye health and reduce the risk of disease. In addition to vitamins A, E, and C, green tomatoes also contain the antioxidants zeaxanthin, lutein, and lycopene, which protect the eyes from light damage. Lutein and zeaxanthin, according to experts, play a role in protecting against oxidative damage to the eye by free radicals. When lutein enters the body, the risk of developing cataracts is reduced.

The human body cannot fully produce and provide itself with essential nutrients. Therefore, devising innovative technologies for safe craft food products is an urgent task for the scientific community.

2. Literature review and problem statement

Tomatoes are the most cultivated vegetable crop in the world, the area of crops of which occupies about 24 % of the total area [1]. Ripe fruits are consumed both fresh and canned. The most common canned products are tomato paste, a variety of sauces, sun-dried tomatoes, and those canned whole. For industrial processing, only mature fruits are used. The climatic conditions of the temperate zone make it possible to grow tomatoes in the open field for a long period. However, significant volumes of tomatoes of green and technical maturity remain in the fields or are sent for recycling by processing enterprises because they do not meet the established requirements. Tomatoes are a source of carbohydrates, minerals, and vitamins, but green fruits contain a significant content of solanine, which is a toxic compound. Given the presence of a harmful element, most processing enterprises refuse to use this raw material. It is known that under the action of high temperatures, solanine is destroyed. Therefore, green tomatoes can be eaten only after heat treatment [2]. However, there are no data on the full chemical composition of green tomatoes after heat treatment.

Scientists have established that green tomatoes synthesize glycoalkaloids dehydrotomatin and -tomatine, which help protect against bacteria, fungi, and viruses [3]. It is proved that green tomatoes containing glycoalkaloids have an anticarcinogenic effect and can cause the death of human cancer cells. Taking into consideration these results, we can argue not only about the nutritional value of green tomatoes but also about the biological value, which requires more detailed research.

It was found that the use of green fruits has a positive effect on metabolism. Studies [4] have established that when using extracts from both red and green tomatoes in experimental groups of rats, normalization of blood cholesterol levels was observed, and the number of fat cells decreased, but the effect on other indicators is not given. According to the results of research, the expediency of using tomatoes in the treatment of obesity has been established. It is important to note that a comparison was made of tomatoes of different maturity, and it was found that useful properties are present in all samples.

Dried tomato extracts (*Solanum Lycopersicum* L.) have antioxidant activity, increase life expectancy, and neuroprotection. According to [5], Maillard reaction products suggest that dry processing of immature green tomatoes forms compounds that can protect against neurodegeneration. These studies are important, revealing the new properties of green tomatoes.

Analysis of studies of green tomatoes [3, 4] confirms that these fruits are quite valuable raw materials that are not sufficiently appreciated. Green tomatoes do not have a clearly expressed taste, therefore they can be the basis for the preparation of a variety of products.

There is a known technology for the production of the sauce "Greentomato" (LLC "Fruit and Vegetable Plant "Kherson", Ukraine) [6], which is characterized by high organoleptic and microbiological indicators, but this recipe needs to be improved in order to increase biological value.

In Latin American countries, dried green tomatoes, which are part of traditional meals, are popular [7]. Taking into consideration the data, we can observe that green tomatoes are eaten only after heat treatment, the effect on the human body has not been sufficiently investigated.

It can be argued that the nutritional value of green fruits is underestimated. Therefore, it is relevant to search for technologies for processing tomatoes in order to maximize the use of local raw materials and, in particular, the creation of special-purpose products.

Another valuable local plant is quince. Fruits contain a high content of polyphenols, vitamins, pectin, and minerals. Pectins that are contained in the fruits of quince have a number of technological and functional advantages, so it is usually used for making jam.

The technology of fruit and berry sauce made of quince and dogwood is known [8]. It has been established that it is necessary to blanch quince with water at a temperature of 95... 98 °C for (3...5)·60 s. Further grinding of quince to the consistency of puree reduces the content of cellulose, hemicellulose, and pectin substances in the insoluble residue, respectively, by 0.56 %, 1.2 %, and 1.7 %. In view of these data, it was found that the optimal is the moisture-heat treatment of quince with a hydraulic module of 1:0.8...1:0.9, at a temperature of 98...100 °C for (23...25)·60 s. A study of the chemical composition of the sauce revealed an increase in the content of biologically active substances, especially flavonoids. However, the disadvantage of this recipe is the presence in the composition of ginger, which is an allergen. Therefore, the use of this sauce is not suitable for people with allergic reactions.

After analyzing promising local raw materials, the question arises of determining the group of products that will be in demand among consumers.

Fruit and vegetable craft products include the production of jams, preserves, jams, and dessert sauces. It was revealed that most scientific developments are aimed at the production of sauce products. The range of sauces is varied and wide [9]. It has been established that production volumes using fruit and berry raw materials are inferior to

emulsion sauces [10, 11]. However, the issue of production of craft products such as confitures is not well understood.

Analyzing the sources revealed that considerable attention is paid to the production of jams [12, 13] and the study of their quality [14, 15]. Methods and procedures for checking the safety of these products do not always meet the quality requirements of the HACCP system. There is an increase in jam technologies with optimized nutritional value [16]. It is worth noting that there is a revision of the classic technologies for making jams and preserves, which makes it possible to minimize the technological process and reduce the loss of biologically active substances.

The properties of raw materials for the production of jams were studied in [17, 18]. The dependence of the degree of grinding of quince on the quality of the finished product has been established. It was found that the addition of quince in the volume of 10 % of the fruit base makes it possible to completely remove pectin from the technology [19]. These studies are promising for the creation of innovative technologies for structured products. There are known technologies for low-calorie jams using sweeteners and pectins [20, 21]. However, the introduction of an excessive amount of pectins in the composition of the recipe adversely affects the work of the gastrointestinal tract. Therefore, these developments will need to be improved.

Thus, the main share of research is based on the use of classical raw materials and their combinations. However, due to numerous developments, there is no clear data on structural, mechanical, and organoleptic studies, as well as the influence of formulation components on the values of the qualitative characteristics of confiture. These data could give an idea of the technological and organoleptic properties, and the ratio of green tomatoes and quince fruits in confiture technology. This makes it possible to assert the feasibility of research on craft food technologies involving unconventional local raw materials.

3. The aim and objectives of the study

The aim of this study is the technology of craft confiture from unconventional local raw materials. This will make it possible to obtain craft confiture with high organoleptic, structural-mechanical, and microbiological indicators that meet the requirements of the state standard.

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

– to determine the rational ratio of green tomatoes and quince fruits, taking into consideration the characteristics of the confiture behavior under the action of loads and the speed of their application;

– to investigate the physicochemical and microbiological parameters of confiture.

4. The study materials and methods

The object of this study was 4 model compositions of confiture, the main components of which are green tomatoes and quince:

– sample number 1 (control) – quince confiture;

– sample number 2 – confiture ratio of mashed quince to green tomatoes is 5:1;

– sample number 3 – confiture ratio of mashed quince to green tomatoes is 2:1;

– sample number 4 – confiture ratio of mashed quince to green tomatoes is 1:1;

– sample number 5 – confiture ratio of mashed quince to green tomatoes is 1:2.

The hypothesis of the study assumes the possibility of ensuring high quality and safety of craft confiture by determining the rational ratio of the main components (green tomatoes, quince) of the model composition.

The main raw materials chosen were local raw materials, namely, green tomatoes (variety "Slivka")) and quince fruits (variety "Dessert"). Tomatoes were grown in open ground (Village Muzykivka, Kherson oblast) and were harvested on October 10, 2020. Quince fruits were collected at the Research Farm "Novokakhovske" (Village Plodove, Kherson oblast) and were collected on October 9, 2020. They were delivered to the laboratory and selected in terms of shape, size, color, and shine, the presence of the stem, the absence of mechanical damage, as well as the absence of pests on or in tomatoes and quince. The collected samples were washed with biodegradable detergent and tap water and allowed to air dry for further research.

The research was carried out during 2020–2021 at the laboratories of Kherson State Agrarian and Economic University, Kyiv National University of Culture and Arts, the National University of Life and Environmental Sciences, State University of Trade and Economics, Odesa National Technological University (Ukraine).

5. Results of investigating the craft confiture from local raw materials

5. 1. Determining the rational ratio of ingredients

Confiture is a jelly-like product containing evenly distributed whole or crushed fruits or berries, prepared by boiling with the addition of sugar and structure-forming substances.

The local crops, characteristic of the south of Ukraine, are tomatoes and a wide range of fruit crops among which is quince. Tomatoes are a low-calorie product with a high content of nutrients, in particular, B vitamins, and minerals (iodine, iron, chlorine, phosphorus, fluorine), which satisfy the functional needs of the body in essential substances [2]. Usually, ripe fruits are used for industrial processing, and green fruits are usually rejected and disposed of. Quince is a source of carbohydrates, especially pectin substances, essential oils, organic acids (tartaric, malic, and citric), and tannins. Desserts and sweet meals are characterized by excellent taste and gelling properties. Therefore, taking into account the technological properties of quince, it is advisable to use the fruit as a basis for the preparation of craft jams with green tomatoes.

Variants of recipes for model compositions are given in Table 1.

Table 1

Recipe of model compositions of craft confiture, kg

The name of the raw material	Raw material consumption, kg				
	Sample 1 (control)	Sample 2	Sample 3	Sample 4	Sample 5
Quince puree	60	50	40	30	20
Mashed green tomatoes	–	10	20	30	40
Sugar	40	40	40	40	40
Output, kg	100	100	100	100	100

In order to determine the rational ratio of formulation ingredients, it was important to create a product with high organoleptic parameters (Table 2).

Table 2

Requirements for organoleptic characteristics of craft confiture

Indicators	Organoleptic characteristics of experimental samples
Appearance and consistency	A homogeneous, jelly-like mass with evenly distributed pieces of tomatoes and quince. Without extraneous plant inclusions. No signs of sugar.
Color	The color is from amber to greenish yellow
Taste and smell	The taste and smell are pronounced quince, without extraneous flavors and odors

In the developed craft confitures, the organoleptic assessment was carried out by a tasting board. The results of the sensory evaluation are given in Table 3 and shown in Fig. 1. According to the sensory assessment of the main organoleptic parameters (Table 3), the optimal formulation ratio of ingredients was established.

Table 3

Organoleptic evaluation of craft confiture, points

Confiture	Physical appearance and consistency	Color	Taste and smell	Overall score
Sample No. 1	4.98	5.0	4.96	14.94
Sample No. 2	4.94	4.98	4.95	14.87
Sample No. 3	4.94	4.98	4.95	14.87
Sample No. 4	4.84	4.86	4.86	14.56
Sample No. 5	4.54	4.73	4.84	14.11

In accordance with Table 3, Sample No. 1 is a control (100 % of quince) and a standard; when replacing quince with green tomatoes, the mass is boiled down to the content of dry soluble substances in the finished product to 68 %. In the process, changes are observed, with an increase in tomatoes, organoleptic indicators decrease, and the maximum allowable is to replace quince with green tomatoes in a ratio of 2:1 (sample number 3).

Sensory evaluation (Table 2, Fig. 1) confirmed the high organoleptic characteristics of confitures, which indicates that the combination of the proposed ingredients improves the characteristics of the finished product in compliance with the indicators at a high level. The graphic image (Fig. 1) shows the dynamics and clearly shows that the recipe of sample No. 3 is rational.

Changes in viscosity and shear stress by measurement time depending on the rate of displacement of confiture samples (Fig. 2), which are obtained from the experimental data are correlated with the data of organoleptic indicators.

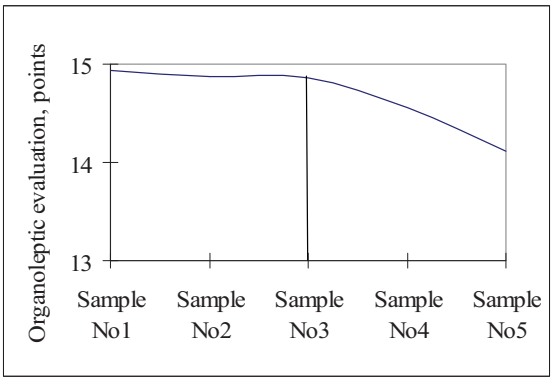
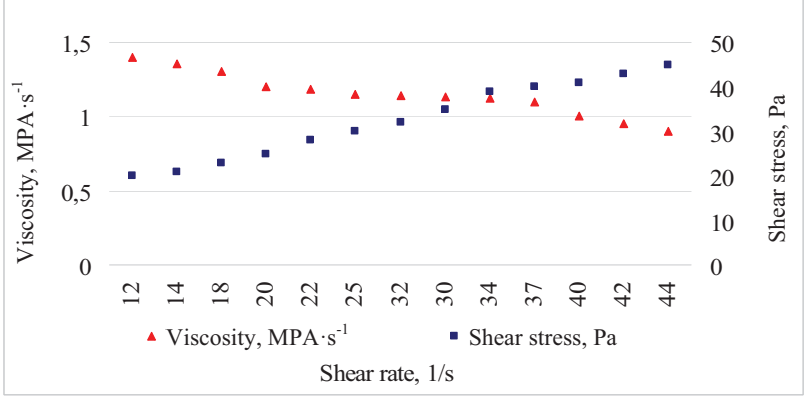
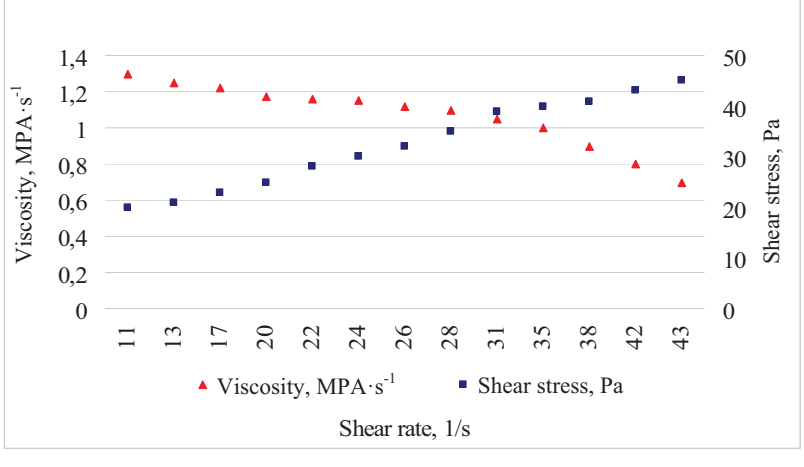


Fig. 1. Organoleptic evaluation of confiture prototypes



a



b

Fig. 2. Dependence plots of shear stress on viscosity: *a* — confiture sample No. 1 (control); *b* — confiture sample No. 3 (experiment, ratio of quince puree to green tomatoes 2:1)

The viscosity and shear stress have a similar appearance for control sample No. 1 and sample No. 3. That is, as the velocity gradient increases, the viscosity decreases and stabilizes before moving to the region of the destroyed structure, and the shear stress values increase.

The obtained data (Fig. 2) make it possible to analyze the effect of mashed green tomatoes on the rheological characteristics of confitures, the curves of viscosity and shear stresses, constructed according to the experiment.

The measurement results showed that the systems that were investigated have a stable structure and are characteristic of viscous-plastic systems. The destruction of the structure begins only after reaching the specified stress (Fig. 2). Obtaining the dependence of the shear stress on viscosity makes it possible to analyze the effect of the introduced tomatoes on the rheological properties of confiture. The research results show that the introduction of green tomato puree (sample no. 3) into the composition of the viscosity of the masses, compared with the control sample, almost does not change. The obtained data (Fig. 2, Table 3) indicate that regardless of the shear rate, the structure is actually the same.

The technological scheme of the production of craft confiture is schematically shown in Fig. 3.

The proposed confiture technology (Fig. 3) does not imply significant differences in the stages of production compared to the classical ones.

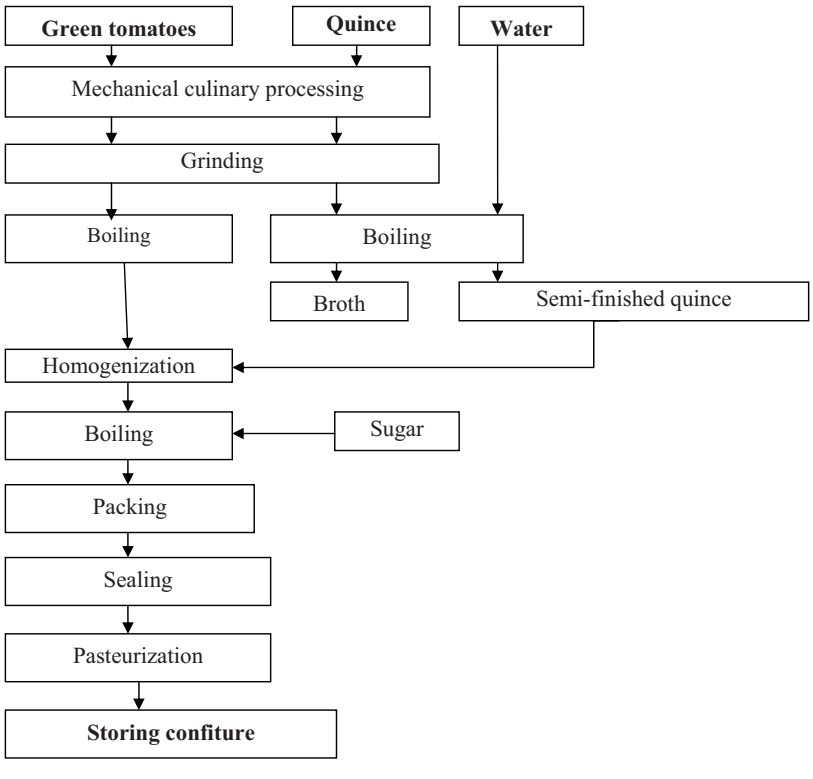


Fig. 3. Basic technological diagram of production of craft confiture from green tomatoes and quince

5. 2. Results of investigating the nutritional value and microbiological safety of craft confiture

To obtain objective data on the nutritional and energy value of the developed craft confiture, physicochemical studies were conducted, which are crucial for the storage of confiture. The results are given in Table 4.

Comparing confiture samples, we observe the absence of significant changes in the chemical composition. However, there is a slight decrease in the content of carbohydrates, organic acids, and phenolic compounds, which is associated with a decrease in the quince content and the introduction of green tomatoes into the recipe. Thus, the ingredient ratio of formulation components makes it possible to develop a new product without a significant impact on the nutritional value of confiture with high organoleptic parameters.

Table 4

Comparative physical and chemical indicators of craft confiture

Indicator name	Quince confiture (control)	Confiture «Khersons'kyy»
Chemical composition and energy value (g/100 g, kcal/100 g)		
Proteins	0.4	0.5
Fats	0.3	0.2
Carbohydrates	46.3	44.8
Energy value	190.5	184.0
Physical-chemical indicators, %		
Dry matter content	68	68
Content of titrated acids	0.45	0.36
The content of pectin substances	0.90	0.76
pH, units	3.5	3.5
Phenolic compounds	470	380

No less important is the establishment of the level of safety of the new product, characterized by microbiological indicators (Table 5).

Table 5

Microbiological indicators of craft confiture

Indicator	Permissible value	Actual level
The number of mesophilic aerobic and facultatively anaerobic microorganisms, CFU per 1.0 g, no more	5.0×10^3	1.1×10^2
Bacteria of the group of coliforms (coliforms), in 0.1 g of the product	Not allowed	Not detected
Lactic acid microorganisms, CFU in 1.0 g	Not allowed	Not detected
Fungi, CFU in 1.0 g	Not exceeding 5,0	Not detected
Yeast, CFU in 1.0 g	Not allowed	Not detected

The results of research (Table 5) testify to the hygienic safety of manufactured confitures from fruit raw materials according to microbiological indicators and fully comply with the requirements of DSTU 4900: 2007. Jams. General specifications.

6. Discussion of results of investigating the confiture from local raw materials

New food products are modeled in accordance with the recipes (Table 1) in compliance with all technological parameters to obtain the optimal result. According to the results of the sensory assessment of the set of indicators, it was established that the most rational is the ratio of green tomatoes to quince, which is 1:2. With an increase in the proportion of green tomatoes, there is a deterioration in organoleptic indicators (Table 3, Fig. 1). The developed

confiture recipe, based on the results of quality properties, has established itself as a competitive product with high organoleptic indicators.

It has been established that the use of quince to create a confiture structure of green tomatoes is appropriate (Table 2, Fig. 2). However, it is known that the viscoelastic properties of products are decisive in technology during the production, storage, and consumption process. For confiture, one of the important indicators is consistency. Therefore, it is important to study the effect of green tomato puree introduced into quince confiture on rheological behavior. Rheological properties were evaluated and experimental rheograms of shear stress and shear velocity were constructed in Fig. 2. The shear rate varied from 3.4 to 68 s^{-1}. It was found that the samples exhibited a non-Newtonian pseudoplastic behavior. If it is linear and passes through the origin, it is called Newtonian. When the flow curve does not pass through the origin or is nonlinear, the material is called non-Newtonian. It is known that when the shear rate increases, the apparent viscosity decreases, which confirms the non-Newtonian behavior of jam samples. It was found that the apparent viscosity decreased with increasing shear rate in Fig. 2. The apparent viscosity of confitures decreased with an increase in the concentration of puree from green tomatoes. That is, there is a decrease in visible viscosity with an increase in the shear rate, which demonstrated the non-Newtonian behavior. It is worth noting that study [22] explained the situation why the shear stress rheogram starts far from the starting point of the shift/shear stress plot and is concave downwards. This is due to the yield strength during the flow of material, which provides a cross structure or other interactive structure that must be damaged before the flow begins at a convenient speed. In view of the results obtained, the rheological properties of confiture are influenced by time, temperature, and shear rate. In addition, linear viscoelastic properties and viscosity depend on the concentration of pectin.

A feature of our result, in comparison with the existing ones, is the combination of quince, which acts as a structure-forming agent with green tomatoes. Modern nutritional trends are aimed at maximizing the saving of food resources [9, 23].

The study of the nutritional value and microbiological safety of craft confiture indicates the absence of abrupt changes in the chemical composition. Puree from green tomatoes does not have a clearly expressed taste but contains vital nutrients (Table 4). The combination with quince fruits makes it possible to create confiture with an insignificantly reduced content of fats and carbohydrates and increased protein content. Thus, the ratio of quince puree to tomatoes of 2:1 makes it possible to develop a new product without a significant impact on the nutritional value of confiture with high organoleptic characteristics. Studies of microbiological indicators (Table 5) indicate compliance with the requirements (DSTU 4900:2007. Jams. General specifications.)

The possibility of creating new resource-saving technologies not only with high organoleptic and structural-mechanical parameters but also with improved nutritional value has been confirmed. In the context of a global growing shortage of resources, the development of food technologies is aimed at the optimal use of existing non-traditional agricultural raw materials.

The proposed solutions and recommendations could expand the ways of effective use of green tomatoes and quince in food technologies.

The results reported in this paper have limitations related to the properties of green tomatoes used to produce confiture. To obtain identical results in production, it is necessary to use green tomatoes (variety "Slivka")) and quince fruits (variety "Dessert").

Further research will be aimed at studying the biological value of quince and green tomato confiture and the use of other pectin-containing raw materials (apples, dogwood, ziziphus) in this technology.

7. Conclusions

1. The rational ratio of puree from green tomatoes and quince fruits has been determined, taking into consideration the characteristics of the confiture behavior under the action of loads and the speed of their application. Changes in viscosity and shear stress by measurement time depending on the shear rate of confiture samples have been investigated. It has been established that the rational puree ratio is 1:2 (tomato:quince). This proportion provides appropriate structural and mechanical properties and high organoleptic characteristics.

2. It was established that according to the main physical and chemical indicators, the developed confiture almost does not differ from the control sample. The energy value of the new product decreased by 5 %, which is insignificant. Given that mashed green tomatoes are a mass with neutral taste properties, there is a decrease in the volume of phenolic compounds by 20 %. However, a balanced ingredient content makes it possible to get a product with high taste characteristics.

The study of microbiological indicators of confiture indicated compliance with the established standards and indicates the safety of the product.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

References

1. Ushkarenko, V. O., Munkin, M. V., Berdnikova, O. G. (2018). Formation of productivity of hybrids of tomato СХД-277 depending on mineral nutrition in conditions of irrigation of the south of Ukraine. Tavriyskyi naukovyi visnyk, 2 (100), 105–111. Available at: http://www.tnv-agro.ksauniv.ks.ua/archives/100_2018/part_2/17.pdf
2. Zhu, C., Wu, S., Sun, T., Zhou, Z., Hu, Z., Yu, J. (2021). Rosmarinic Acid Delays Tomato Fruit Ripening by Regulating Ripening-Associated Traits. Antioxidants, 10 (11), 1821. doi: https://doi.org/10.3390/antiox10111821

3. Friedman, M., Levin, C. E., Lee, S.-U., Kim, H.-J., Lee, I.-S., Byun, J.-O., Kozukue, N. (2009). Tomatine-Containing Green Tomato Extracts Inhibit Growth of Human Breast, Colon, Liver, and Stomach Cancer Cells. Journal of Agricultural and Food Chemistry, 57 (13), 5727–5733. doi: https://doi.org/10.1021/jf900364j
4. Choi, K.-M., Lee, Y.-S., Shin, D.-M., Lee, S., Yoo, K.-S., Lee, M. K. et. al. (2013). Green tomato extract attenuates high-fat-diet-induced obesity through activation of the AMPK pathway in C57BL/6 mice. The Journal of Nutritional Biochemistry, 24 (1), 335–342. doi: https://doi.org/10.1016/j.jnutbio.2012.06.018
5. Bagoudou, A. F., Matsumoto, K., Chawalitpong, S., Park, H. Y., Vattem, D. A., Nakamura, S., Katayama, S. (2021). Maillard reaction products derived from heat-dried green tomato increase longevity and neuroprotection in Caenorhabditis elegans. Food Science and Technology Research, 27 (5), 747–757. doi: https://doi.org/10.3136/fstr.27.747
6. Ryapolova, I. O., Honcharuk, D. V. (2020). Development of recipes and examination of sawn products from non-condensed raw materials. Scientific notes of Taurida National V.I. Vernadsky University. Series: Technical Sciences, 31 (6), 89–94. doi: https://doi.org/10.32838/TNU-2663-5941/2020.6-2/16
7. Recio Colmenares, R. B., Recio Colmenares, C. L., Pilatowsky Figueroa, I. (2020). Estudio experimental de la deshidratación de tomate verde (Pysalis ixocarpa brot) utilizando un secador solar de tipo directo. Bistua revista de la facultad de ciencias basicas, 17 (1), 76–86. doi: https://doi.org/10.24054/01204211.v1.n1.2019.3136
8. Vasylieva, O. O. (2021). Technology of sweet sauce quince fruit and dogwood. Obladnannia ta tekhnolohiyi kharchovykh vyrobnytstv, 1 (42), 13–19. Available at: https://oblad.donnuet.edu.ua/index.php/tehnolog/issue/view/12/29
9. Lozova, T. P. (2019). Trends and problems of logistic development of the fruit and fruit products market. Economic Innovations, 21 (2 (71)), 70–82. doi: https://doi.org/10.31520/ei.2019.21.2(71).70-82
10. Deynichenko, G., Lystopad, T., Novik, A., Chernushenko, L., Farisieiev, A., Matsuk, Y., Kolisnychenko, T. (2020). Determining the content of macronutrients in berry sauces using a method of IR-spectroscopy. Eastern-European Journal of Enterprise Technologies, 5 (11 (107)), 32–42. doi: https://doi.org/10.15587/1729-4061.2020.213365
11. Lystopad, T., Deinychenko, G., Pasichnyi, V., Shevchenko, A., Zhukov, Y. (2020). Rheological studies of berry sauces with iodine-containing additives. Ukrainian Food Journal, 9 (3), 651–663. doi: https://doi.org/10.24263/2304-974x-2020-9-3-13
12. Liu, Z. (20189). Optimization of the processing technology of low sugar jujube jam by response surface methodology. China Condiment, 44 (10), 77–80.
13. Abduraimova, M., Alibekov, R., Orymbetova, G., Nurseitova, Z., Gabrilyants, E. (2020). Food safety and HACCP system in the apple jam production. Industrial Technology and Engineering, 3 (36), 38–44. Available at: https://sjau.auezov.edu.kz/index.php/engineering/article/view/78/70
14. Juan, C., Mañes, J., Font, G., Juan-García, A. (2017). Determination of mycotoxins in fruit berry by-products using QuEChERS extraction method. LWT, 86, 344–351. doi: https://doi.org/10.1016/j.lwt.2017.08.020
15. Rodriguez Bernal, J. M., Herrera-Ardila, Y. M., Olivares-Tenorio, M. L., Leyva-Reyes, M. F., Klotz-Ceberio, B. F. (2020). Determination of antioxidant capacity in blackberry (Rubus glaucus) jam processed by hydrotermodynamic cavitation compared with traditional technology. DYNA, 87 (215), 118–125. doi: https://doi.org/10.15446/dyna.v87n215.84521
16. Awulachew, M. T. (2021). A Current Perspective to Jam Production. Advances in Nutrition & Food Science, 6 (1). doi: https://doi.org/10.33140/anfs.06.01.01
17. Cascales, E. V., García, J. M. R. (2020). Characteristics of the raw fruit, industrial pulp, and commercial jam elaborated with Spanish quince (Cydonia oblonga Miller). Emirates Journal of Food and Agriculture, 32 (8), 623–633. doi: https://doi.org/10.9755/ejfa.2020.v32.i8.2140
18. Baroni, M. V., Gastaminza, J., Podio, N. S., Lingua, M. S., Wunderlin, D. A., Rovasio, J. L. et. al. (2018). Changes in the Antioxidant Properties of Quince Fruit (Cydonia oblonga Miller) during Jam Production at Industrial Scale. Journal of Food Quality, 2018, 1–9. doi: https://doi.org/10.1155/2018/1460758
19. Ergün, A. R., Tekgül, Y. (2021). Production of quince jam with ginkgo biloba extract as a pectin substitute: effects on physicochemical, microbiological, rheological and sensory qualities. GIDA / The Journal of FOOD, 46 (5), 1301–1312. doi: https://doi.org/10.15237/gida.gd21095
20. Yousefi, M., Hossein Goli, S. A., Kadivar, M. (2018). Physicochemical and Nutritional Stability of Optimized Low-calorie Quince (Cydonia oblonga) Jam Containing Stevioside During Storage. Current Nutrition & Food Science, 14 (1), 79–87. doi: https://doi.org/10.2174/1573401313666170912164941
21. Vaseghi, F., Jouki, M., Rabbani, M. (2020). Investigation of physicochemical and organoleptic properties of low-calorie functional quince jam using pectin, quince seed gum and enzymatic invert sugar. Food Science and Technology, 17 (106), 157–171. doi: https://doi.org/10.52547/fsct.17.106.157
22. Barbieri, S. F., de Oliveira Petkowicz, C. L., de Godoy, R. C. B., de Azeredo, H. C. M., Franco, C. R. C., Silveira, J. L. M. (2018). Pulp and Jam of Gabiroba (Campomanesia xanthocarpa Berg): Characterization and Rheological Properties. Food Chemistry, 263, 292–299. doi: https://doi.org/10.1016/j.foodchem.2018.05.004
23. Zokirova, M., Saribaeva, D., Xojieva, S. (2020). Research technology of production of herbal and natural preserves. European Journal of Molecular and Clinical Medicine, 7 (2), 325–333.