Ministry of Education and Science of Ukraine
Black Sea Universities Network

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2022

PROCEEDINGS

ODESA, ONUT 2022

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Proceedings of International Competition of Student Scientific Works «Black Sea Science 2022» contain the works of winners of the competition.

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INTRODUCTION

International Competition of Student Scientific Works “Black Sea Science” has been held annually since 2018 at the initiative of Odesa National University of Technology (formerly Odesa National Academy of Food Technologies) with the support of the Ministry of Education and Science of Ukraine. It has been supported by Black Sea Universities Network (the Association of 110 higher education institutions from 12 countries of the Black Sea Region) since 2019, and by Iseki-FOOD Association (European Integrating Food Science and Engineering Knowledge into the Food Chain Association) since 2020.

The goal of the competition is to expand international relations and attract students to research activities. It is held in the following fields:

- Food science and technologies
- Economics and administration
- Information technologies, automation and robotics
- Power engineering and energy efficiency
- Ecology and environmental protection

The jury includes both Ukrainian and foreign scientists. In the 4 years that the competition has been held, the jury included scientists from universities of 24 countries: Angola, Azerbaijan, Benin, Bulgaria, China, Czech Republic, France, Georgia, Germany, Greece, Israel, Italy, Kazakhstan, Latvia, Lithuania, Moldova, Pakistan, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, USA.

At the same time, every year the geography has expanded and the number of foreign jury members has increased: from 46 jury members representing 25 universities from 12 countries in 2018, to 73 jury members of the 46 universities from 19 countries in 2022.

More than a thousand student research papers have been submitted to the competition from both Ukrainian and foreign institutions from 25 countries: China, Poland, Mexico, USA, France, Greece, Germany, Canada, Costa Rica, Brazil, India, Pakistan, Israel, Macedonia, Lithuania, Latvia, Slovakia, Romania, Kyrgyzstan, Kazakhstan, Bulgaria, Moldova, Georgia, Turkey, Serbia.

The interest of foreign students in the competition grew every year. In 2018, the students representing 15 institutions from 7 countries have submitted 33 works. In 2021 the number of submitted works increased to 73, authored by the students of 40 institutions from 18 countries.

The competition is held in two stages. In the first stage, student research papers are reviewed by members of the jury who are experts in the relevant fields. In the second stage of the competition, the winners of the first stage have the opportunity to present their work to a wide audience in person or online.

All participants of the competition and their scientific supervisors are awarded appropriate certificates, and the scientific works of the winners are included in the electronic proceedings of the competition. Every year the competition receives a large number of positive responses from Ukrainian and foreign colleagues with the desire to participate in the coming years.

1. FOOD SCIENCE AND TECHNOLOGIES

TECHNOLOGY OF MOUSSE PRODUCTS FROM HYDROBIONTS

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Abstract. *The expediency of improving the technology of shrimp mousses is substantiated in the work. Based on the analysis of literature sources, the priority areas of processing of fish raw materials and expanding the range of fish products have been identified. The analysis of existing technologies of mousse products from aquatic organisms has been carried out. The prospects of production of mousses from fish and shrimps have been established. The expediency of using shrimp to create food products with improved organoleptic characteristics and increased nutritional value has been theoretically substantiated. The effectiveness of combining crustaceans with fish, animal and plant raw materials has been experimentally confirmed. New mousse recipes based on shrimp meat with cream cheese, cream, olive oil, salmon fillet, avocado, apples, spices and condiments have been developed. A study of organoleptic, physico-chemical indicators of quality and nutritional value of finished products has been conducted. Based on the research results, the compliance of the indicators with the requirements of the standard has been established. Results of study on the chemical composition indicate the high nutritional value of the developed mousses. Based on theoretical and experimental researches the technological scheme of production of mousses on the basis of shrimps with use of animal and vegetable components has been developed. The main technological operations are preliminary preparation of raw materials, fine grinding of the mixture and packaging of the finished product.*

Keywords: *mousse, shrimps, technological scheme, recipe, nutritional value.*

I. INTRODUCTION

Pasty products from aquatic organisms are gaining popularity in the global market of fish products and are in great demand among consumers. This is due to their organoleptic characteristics, ease of consumption, high nutritional value and degree of assimilation, as well as the spread of low-waste industries. The technology of pasty products allows to obtain products enriched with various flavoring additives, functional ingredients, using raw materials with mechanical damage. The range of these products includes fish pates, pastes, oils, creams and mousses.

Despite the great popularity of pasty products from aquatic organisms abroad, in Ukraine their range is quite limited and is represented by fish pates and pastes from fresh or salted fish using a large number of synthetic flavors and aromatic additives [1].

One of the main conditions for the functioning of the human body is the mandatory presence of essential nutrients in the diet, which must be taken into account when choosing food ingredients. Therefore, the issue of expanding the range of pasty products based on valuable raw materials and natural ingredients that improve not only organoleptic properties, but also increase the nutritional, biological value and benefits

of the product for the body. A promising direction for solving this problem is to improve the technology of mousse products from shrimp and raw materials of animal and vegetable origin.

Shrimp, like all seafood, is a source of complete protein. The concentration of useful micro- and macronutrients in shrimp is ten times higher than in meat. Thus, shrimp contain sodium, potassium, phosphorus, sulfur, calcium, magnesium, iron, zinc, copper, manganese, iodine, fluorine, chromium, cobalt, nickel, molybdenum and others. Shrimp meat is also rich in vitamins: E, C, PP, B1, B2, B3, B6, B9, B12, A, H. Eating shrimp helps to reduce sensitization of the body and prevent allergic reactions [2]. Shrimp meat should be used in aquatic mousses in combination with various plant and animal components to create balanced nutritionally and biologically valuable products.

The purpose of the work is to improve the technology of multicomponent mousses based on aquatic organisms.

II. LITERATURE ANALYSIS

A significant part of the range of fish paste products is pate and paste, due to their nutritional properties and unique sensory characteristics. The attention of many scientists is focused on expanding the raw material base for the manufacture of pasty products, improving organoleptic and rheological parameters and replacing traditional raw materials [3-5]. Scientists have developed a functional pate based on freshwater fish with the addition of squid [4]. Known technology of fish pate from pike, bream, which additionally contains pumpkin, vegetable oil and algae [5]. According to the patent of the Russian Federation № 2512341 "Method of production of vegetable-fish pastes and pates from carp", known technology for the production of vegetable-fish pastes and pates from carp with the addition of pumpkin, onion and CO_2 extract of black pepper, CO_2 extract of garlic. In the patent of the Russian Federation № 2166873 "Pate" shows a method of obtaining vegetable and fish pâtés using chitosan, as a structurant, and the addition of CO_2 extracts of spices.

Fish pastes are made from herring, mackerel, salmon, culled for mechanical damage, as well as small fish species. Raw materials are used mainly in salt form [6, 7]. The technology of making such a paste from salted herring and salmon is given in the patent of the Russian Federation № 2537502 "Method of preparation of fish paste", which includes the preparation of fish raw materials (salting fish, filleting, washing) and auxiliary materials (butter, cheese, broccoli, bell pepper) carrots and laconus), chopping, packing. Also common are pasty products made from minced meat of fresh sea or ocean fish or minced fish [6, 7].

The most common pasty products are fish oils, creams, mousses. The peculiarity of these products is the combination of high nutritional value with a light, pleasant texture. Therefore, the selection of fat base (butter, oil, mayonnaise), available fish raw materials, their ratio to ensure the appropriate rheological and organoleptic characteristics are the subject of research of domestic and foreign scientists [6–8].

For the preparation of fish oils use fish species such as herring, mackerel, sardines (ivasi, sardinela, sardinops), food waste from salmon disassembly [6, 7]. The technology of cooking " Delikatesne " and " Novynka " oils, which include boiled and

frozen krill meat and salted pollock caviar [6, 7], has been developed. Good taste and delicate texture are inherent in shrimp oil, which is prepared from protein paste "Ocean" or krill meat and butter. Shrimp oils have a pink-cream or pink color, pleasant taste and aroma, delicate texture [6, 7].

Due to their attractive appearance, light, airy consistency, high nutritional value and unique taste and aroma properties, creams and mousses from aquatic organisms deserve the attention of discerning consumers. There are recipes for Scottish fish cream, which, in addition to skimmed haddock fillet, includes milk, butter, eggs, fresh wheat bread, salt, pepper, flavoring (with the taste of shrimp or parsley) and some other components [6, 7].

N. M. Kupina and M. V. Kudriashova developed a technology for preparing low-salt creamy product from aquatic organisms (fish, squid, octopus, bivalves and gastropods), which is given in the patent of the Russian Federation № 2040189 "Method of preparation of low-salt creamy product from hydro". Known technologies of fresh salmon mousse with shrimp, fresh haddock meat with shrimp and smoked haddock meat. Which include at least 40.0% of fish meat with mayonnaise and bechamel sauce [6, 7].

Despite the wide world range and experience in the production of pasty products, their production in our country remains problematic. Modern technologies for the production of these products are based on the use of fish raw materials and a large number of synthetic flavoring and stabilizing additives. Therefore, an important task is to expand the range of pasty products based on crustaceans.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The object of research – indicators of quality of finished products.

The subject of research – technology of making shrimp mousse.

Determination of organoleptic parameters has been carried out by the profile method using a 5-point scale, according to the recommendations of T.M. Safronova.

The ultimate shear stress was determined using a penetrometer Ulab 3-31 M, in accordance with GOST 30469 – 95. Water activity index was measured using a highly sensitive device Hygro Palm HP23-AW (UK), according to DSTU ISO 21807.

Studies of the chemical composition have been performed according to the following methods: mass fraction of moisture – by drying the product sample to a constant weight in an oven SNOL (Labimpex LTD, Ukraine) at a temperature of 100-105ºC according to DSTU 8029:2015; mass fraction of ash – by a weightning method, after the mineralization of a portion of the product in a muffle furnace SNOL (Labimpex LTD, Ukraine) at a temperature of 500–600°C according to DSTU 8718:2017; mass fraction of lipids – by the Soxhlet extraction-weight method according to DSTU 8718:2017 on the SOX 406 Fat Analyzer (Hanon Instruments, China); mass fraction of protein – by Kjeldahl method of the determination of a total nitrogen, which is based on the ability of organic matter of the product sample to be oxidized with concentrated sulfuric acid in the presence of a catalyst according to DSTU 8030:2015, while samples ashing has been performed on a DK6 digester (Velp Scientifica, Italy), with a vacuum pump JP, distillation has been carried out on a steam distillation apparatus UDK 129 (Velp Scientifica, Italy).

The acid number of lipids was determined according to DSTU 4350: 2004 (ISO 660: 1996, NEQ), DSTU 4560: 2006. Peroxide number of lipids, according to DSTU 4570: 2006, DSTU 4560: 2006. The total volatile basic nitrogen according to GOST 7636– 85.

The number of mesophilic aerobic and facultative anaerobic microorganisms was determined in accordance with DSTU 8446: 2015; bacteria of the Escherichia coli group, according to DSTU GOST 30726: 2002; Staphylococcus aureus, according to GOST 10444.2-94; pathogenic microorganisms, including genus Salmonella, according to DSTU ISO 11290-1, DSTU ISO 11290-2.

Shelf life was determined by the dynamics of changes in the complex of organoleptic, physicochemical and microbiological indicators.

IV. RESULTS

The objects of the study were shrimp-based mousses with the addition of animal (milk cream, cream cheese) and vegetable raw materials (olive oil, apples, avocados). The control was selected mousse based on minced cod without the addition of plant ingredients. Recipes for mousses are given in table 1.

Table 1. Comparative characteristics of the prescription composition of control and experimental samples of mousses

Name of ingredients	Ingredient content, %			
		Experimental samples		
	Control	№1	№2	№3
Shrimp meat	35	47	52	62
Minced cod fish	40	-	-	-
Minced trout is slightly salty	-	42	-	-
Cream cheese	15	-	-	24
Cream	-	-	-	12
Avocado	-	-	22	-
Apple	-	-	15	-
Stone salt	0,8	1,2	1,2	1
Garlic	-	0,6	-	0,8
Olive oil	-	8	9	-
Egg yolk	3,6	-	-	-
Water	3	-	-	-
Xanthan gum	0,25	-	-	-
Carob gum	0,15	-	-	-
Aroma of shrimp	0,05	-	-	-
Paprika	0,15	0,6	0,4	0,1
Ground black pepper	0,2	0,6	0,4	0,1

The prescription composition of mousses determines the appropriate organoleptic characteristics. In particular, the color of mousses depends on the use of vegetable raw materials. Avocado gave a green tint in sample №2.

Flavor and aroma indicators are improved by spices and vegetable cheese, which was added by us according to recipes. Adding black pepper, paprika and garlic adds spiciness and originality to the taste.

Differentiated organoleptic analysis of mousses allows to establish the assessment of the intensity of individual quality indicators and to present the results in the form of a profilogram.

Comparison of the obtained samples of mousses with the help of a quality polygon is shown in fig. 1. Organoleptic evaluation of shrimp-based mousses was performed on the following indicators: external appearance, color, consistence, taste, aroma.

It is clear that the developed samples of mousses differ in organoleptic evaluation. According to the results of organoleptic evaluation, sample №3 is the best, because its area is the largest, and control - the smallest.

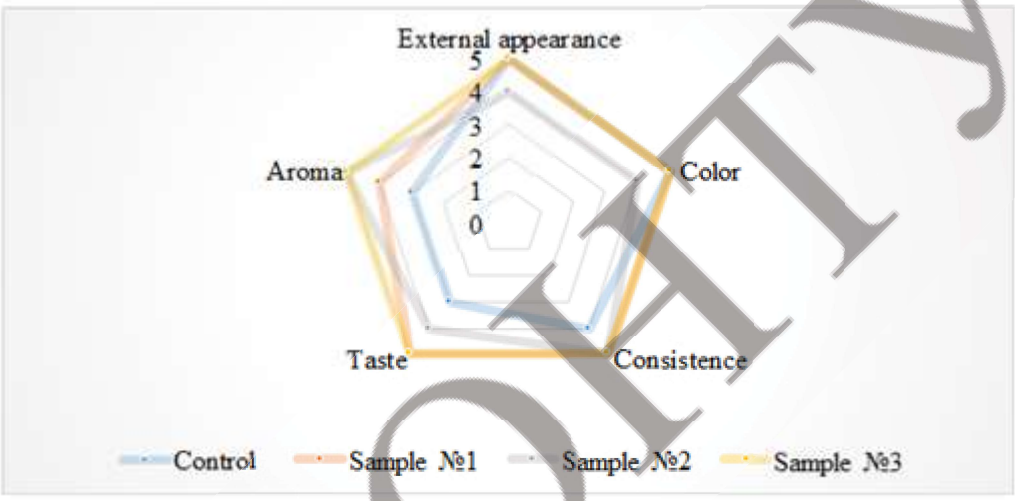

Fig. 1. Organoleptic evaluation of mousse samples

Relevant organoleptic characteristics were confirmed by the results of physicochemical parameters. Thus, the salt content in the control is 2.5%, and in test samples 1 and 2 is 2.3%, which corresponds to the norm of 1.5-2.5%, according to the requirements of the standard. To assess the consistency of the mousse, penetration measurements were performed and the shear stress was determined.

The measurement results are given in tabl. 2.

Table 2. Maximum shear stress of mousses (n = 3, p ≤0.05)

Name of samples	**Maximum shear stress, Pa**
Control sample	254,0
Sample №1	196,3
Sample №2	208,3
Sample №3	196,0

The results of the studies are shown in tabl. 2 show that the control sample is characterized by the highest value of the shear stress - 254 PA and, accordingly, has the densest structure compared to the developed samples. Sample №1 has a limit voltage of 196.3 Pa, sample №2 - 208.3 Pa, sample №3 - 196 Pa.

One of the important physical and chemical indicators is water activity. This indicator determines the resistance of the product to damage. The higher the activity of water, the more favorable conditions for the reproduction of microorganisms, the

higher the damage to the product by pathogenic microflora. According to this indicator, you can determine how perishable the product is, or vice versa. The activity of water in the finished product is shown in tabl. 3.

Table 3. Mousse water activity

Name of samples	Water activity	Microorganisms that can develop
Control sample	0,967	Bacteria, mold, yeast
Sample №1	0,989	
Sample №2	0,981	
Sample №3	0,979	

According to tabl. 3, we conclude that shrimp mousses are perishable products, as the rate of water activity in shrimp mousses is high. The range of such values suggests that the product is a favorable environment for the development of microorganisms (bacteria, mold, yeast).

The main indicator of nutritional value is the chemical composition. The results of studies of the general chemical composition of formulations are given in tabl. 4.

Table 4. General chemical composition of recipes

Name of samples	Chemical composition, %			
	moisture	fat	protein	carbohydrates
Control sample	50±2,0	44±0,2	5±0,7	0,5±0,1
Sample №1	64,5±1,5	7,5±0,2	18,7±0,7	0,4±0,1
Sample №2	67,25±2,25	9,95±0,2	15,7±0,7	3,63±0,1
Sample №3	66,89±2,1	12,3±0,2	16,6±0,7	1,48±0,1

From the tabl. 4 shows that the highest moisture content in the recipe of sample №2, and the lowest in the control sample, the highest fat content in the control sample, and the lowest in the recipe №1, the protein content is highest in sample №1, and the lowest in sample №2, the highest carbohydrates the content in the recipe №2, in the control and sample № 1 the carbohydrate content is minimal.

The chemical composition determines the caloric content of the product, which is presented in fig. 2.

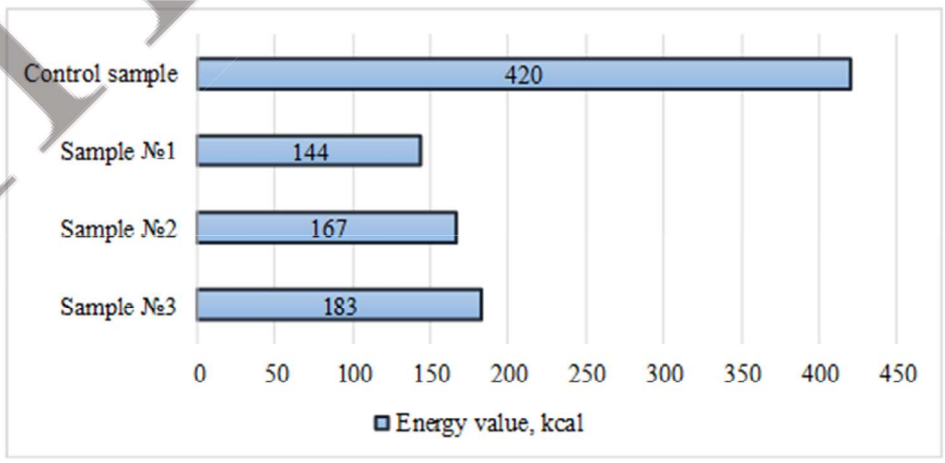

Fig. 2. Comparative characteristics of the energy value of mousse recipes

It is estimated that the energy value of the control sample exceeds the experimental ones, due to the fact that the bulk of the control formulation consists of butter and cream. Experimental samples have a much lower energy value, but the benefits are much greater, due to the high content of complete protein, the source of which is shrimp meat.

Based on the results of theoretical and experimental research, a technological scheme for the production of shrimp mousses has been developed, which is presented in fig. 3.

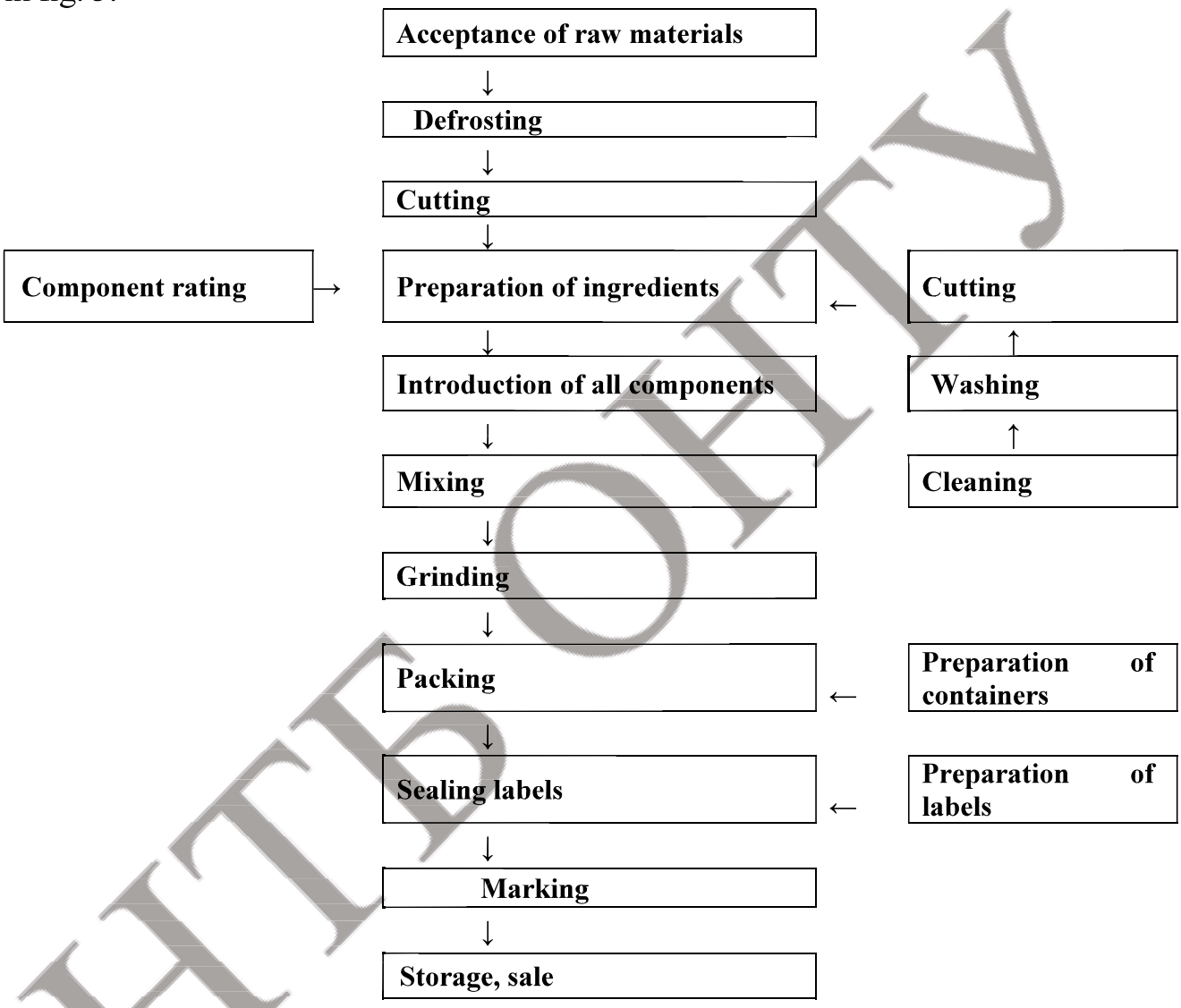

Fig. 3. Technological scheme of mousse production

The main technological operations are the preliminary preparation of fish and vegetable raw materials, which consists in washing, cleaning, grinding. The prepared ingredients are mixed in the appropriate recipe ratio, subjected to fine grinding and packing the mixture into molds. Store the finished product at temperatures from -2 to +2 °C for no more than 72 hours from the date of manufacture.

Food quality is a set of product properties that determine its suitability to meet certain needs in accordance with the purpose. The quality of any food product is determined by its characteristic properties, which are called quality indicators.

The results of studies of organoleptic characteristics of the product during storage for 72 hours are shown in fig. 4.

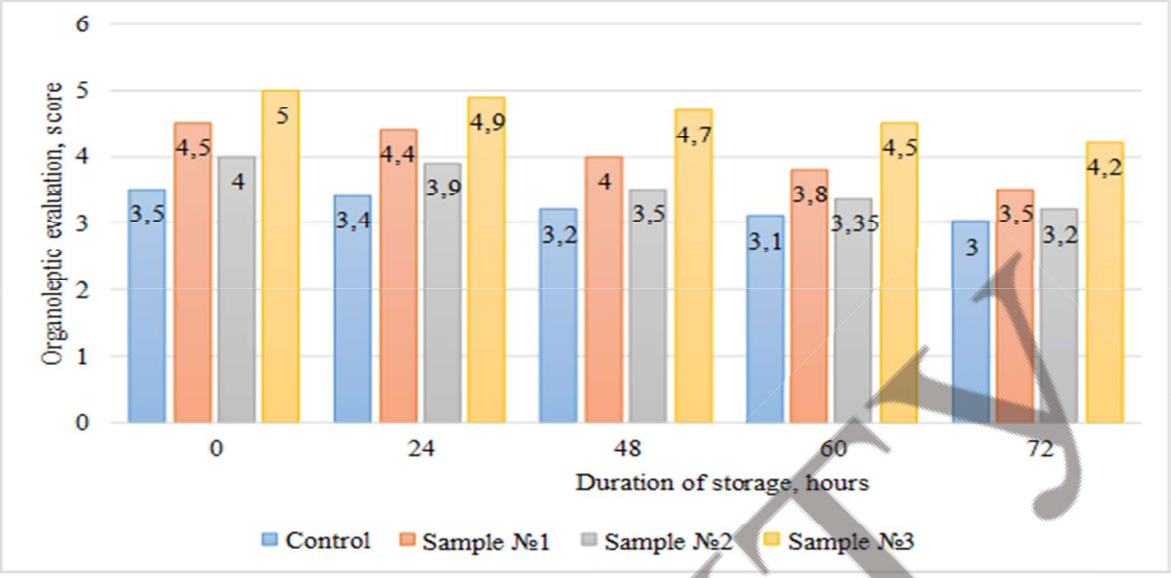

Fig. 4. Organoleptic evaluation of shrimp mousses during storage

Fig. 4 shows that gradually during storage mousse products reduce their organoleptic characteristics.

Acid and peroxide values are important indicators that must be determined during storage. Acid number is the amount of caustic potassium required in milligrams to neutralize free fatty acids. The acid number depends on the quality of raw materials used for production, methods and modes of its production, conditions and duration of storage of the product. The presence of lipid oxidation processes in the initial stages characterizes the peroxide value. Fig. 5 and 6 show the changes in peroxide and acid numbers during storage.

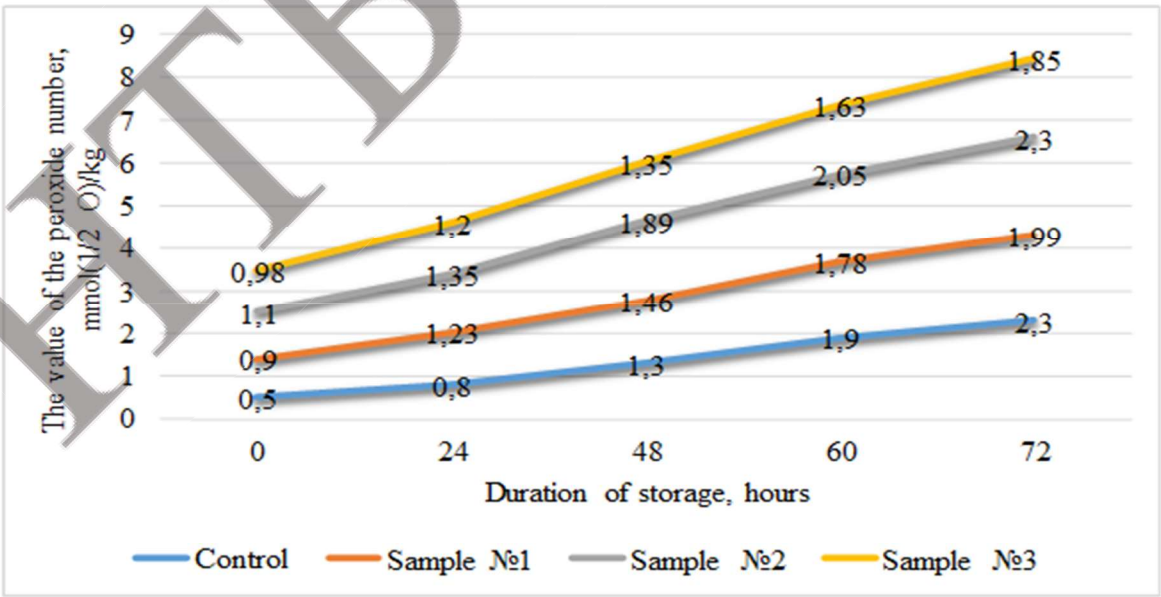

Fig. 5. Dynamics of lipid peroxide values in shrimp mousses

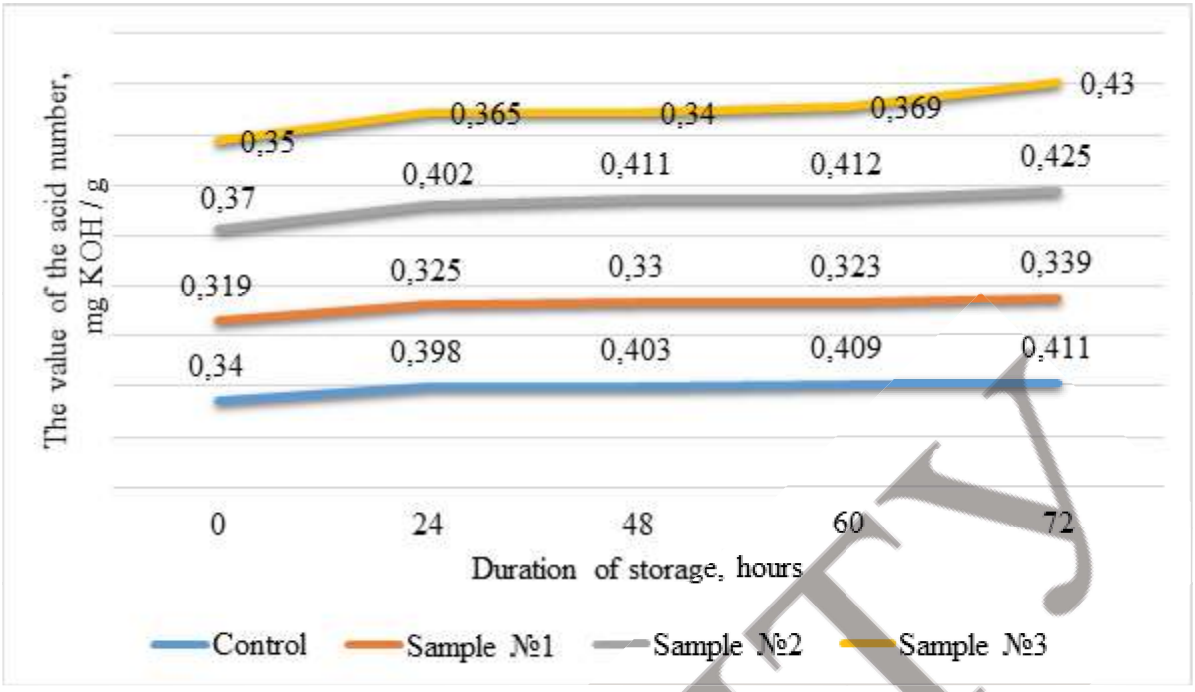

Fig. 6. Dynamics of lipid acid counts in shrimp mousses

In fig. 5 and 6 we can see that the indicators of acid and peroxide numbers during storage gradually increase, but these indicators, even at the end of the storage period are within acceptable limits.

The degree of microbiological processes and proteolysis was studied by changes in the total volatile basic nitrogen contents (TVBN). The total volatile basic nitrogen contents bases increases during storage under the action of enzymatic processes and the activity of microorganisms and is accompanied by the breakdown of amino acids to form ammonia, mono-, di- and trimethylamines.

The dynamics of TVBN content during storage is shown in fig. 7.

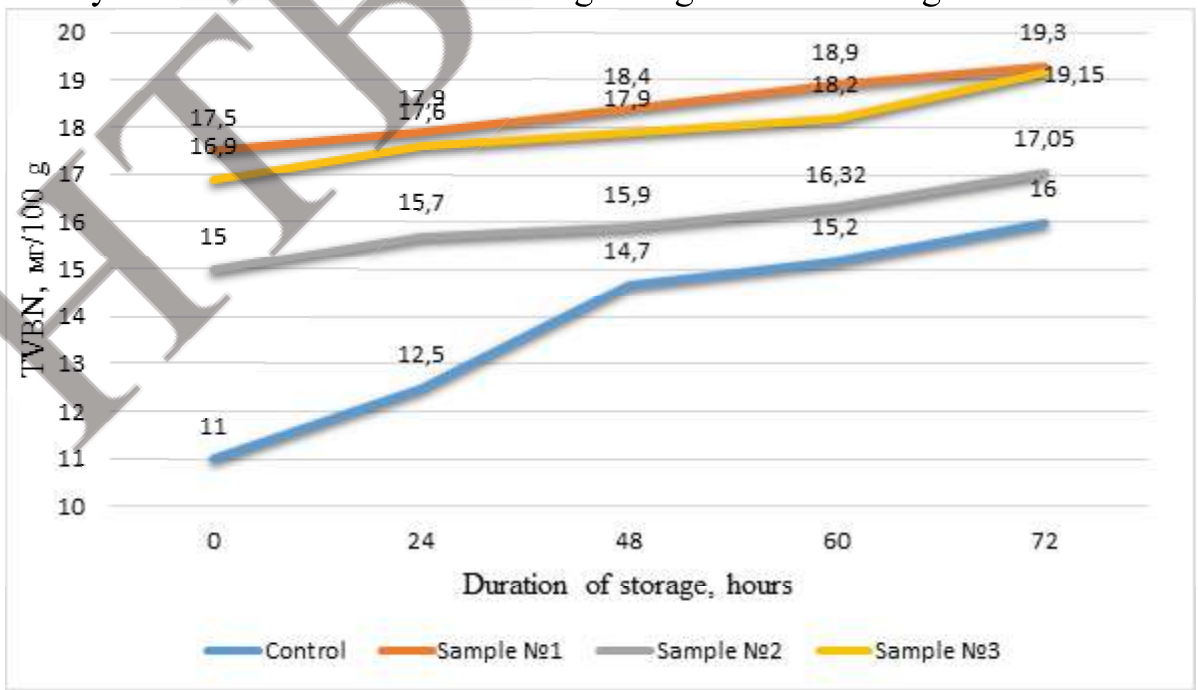

Fig. 7. Changes in TVBN indicators during mousse storage

Fig. 7 shows that at the expiration date of the product, ie after 72 hours, the content of TVBN in the control sample 16 mg %, in sample №1 − 19.3 mg %, in sample №2 − 17.05 mg %, in sample № 3 - 19.15 mg g % at the permissible level of 30 mg %.

The quality and safety of shrimp mousses were determined according to microbiological quality indicators. The state of the microbiological composition of shrimp mousses directly depends on the initial state of the microflora of raw materials, on the microbiological and sanitary condition of equipment and the enterprise as a whole, on compliance with sanitary norms of employees.

The results of research show that at the initial stage of storage, sample №2 is characterized by a higher degree of microbiological contamination compared to other samples, due to the addition of vegetable raw materials to the product. When storing mousses for 24 hours, the number of microorganisms increases in all samples. In sample №3 the amount of mesophilic aerobic and facultative anaerobic microorganisms (MAFAnM) is less than in other samples, due to the bactericidal properties of garlic. As of 72 hours of mousse storage, MAFAnM values are acceptable for product suitability, but close to the limit. Bacteria of the Escherichia coli group, Staphylococcus aureus and Proteus were not detected in 0.1 g of test samples. Pathogenic microorganisms, including Salmonella and L. monocytogenes, were absent in 25 g in all mousse samples.

Therefore, based on microbiological and organoleptic parameters, the allowable shelf life at a temperature of 0 to + 5◦C for mousses is not more than 72 hours.

V. CONCLUSIONS

Based on the results of theoretical and experimental research, the recipe and technology of shrimp-based mousses with the addition of animal (milk cream, cream cheese) and vegetable raw materials (olive oil, apples, avocados) have been improved.

A study of organoleptic, physicochemical, quality indicators and chemical composition of finished products. Based on the research results, the compliance of the indicators with the requirements of the standard has been established. According to organoleptic indicators, the highest score was obtained by sample №2. The salt content in the test samples and control corresponds to the norm - 1.5-2.5%. All samples have the appropriate mousse consistency, and the value of the shear limit stress of the control sample (254.0 Pa) exceeds this indicator of the experimental samples (196.0−206.3 Pa), which indicates a denser control structure compared to the developed samples. High values of water activity index (0.967-0.989) confirm that shrimp mousses are perishable products. Analysis of the results of research on the chemical composition shows that the experimental samples of mousse are characterized by high nutritional value due to the significant protein content.

The technological scheme of mousse production has been developed, which includes preliminary preparation of raw materials, fine grinding of the mixture and packing of the finished product.

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