Показана можливість виробництва гарячих маринадів з товстолобика. Особливістю м'язової тканини товстолобика є низька активність ферментативної системи і нездатність до дозрівання. Тому розроблена технологія гарячих маринадів з товстолобика з використанням гідроколоїдів рослинного походження для отримання драглеподібної заливки і поліпшення функціонально-технологічних властивостей готового продукту. Композиція прянощів і консервантів дає можливість збалансувати готовий продукт за органолептичними показниками і подовжити термін зберігання

Ключові слова: маринади з прісноводної риби, драглеутворення, низькоестерифіковані пектинові речовини, альгінові кислоти, бензойнокислий натрій, сорбат калію

Показана возможность производства горячих маринадов из толстолобика. Особенностью мышечной ткани толстолобика является низкая активность ферментативной системы и неспособность к созреванию. Поэтому разработана технология горячих маринадов из толстолобика с использованием гидроколоидов растительного происхождения для получения гелеобразной заливки и улучшения функционально-технологических свойств готового продукта. Композиция пряностей и консервантов дает возможность сбалансировать готовый продукт по органолептическим показателям и продлить срок хранения

Ключевые слова: маринады из пресноводной рыбы, рыбные маринады, гелеобразование, низкоэтерифицированные пектиновые вещества, альгиновые кислоты, бензойнокислый натрий, сорбат калия

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A TECHNOLOGY DEVELOPED TO PRODUCE HOT FISH MARINADES FOR A JELLYLIKE FILLING OF PROLONGED STORAGE

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1. Introduction

At present, the tendency to a gradual end of fishing for hydrobionts in the open waters of the seas and oceans is maintained. One of the important strategic measures aimed at restoring regional ecosystems is the development of aquaculture [1, 2]. Ukraine has the largest area of inland water bodies in Europe – about 1.3 million hectares. At the same time, 80 % of fish products consumed by Ukrainians are imported [3]. The unsatisfactory situation has arisen with the use of the inland waters of the country. In recent years, less than 30 % of potential production opportunities for freshwater fish have been used [1]. Meanwhile, on all continents, there has been a general tendency towards an increase in the share of aquaculture production in the overall production of fish [4, 5]. Aquaculture products should be of a more specific volume in achieving food security and nutrition in line with the global tendency.

The typical objects of aquaculture in Ukraine are common carp (Cyprinus carpio), silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella), white carp (Cirrhinus fulungee), black carp (Mylopharyngodon piceus), so-iuy mullet (Liza haematocheilus), sturgeon (Acipenseridae), rainbow trout (Oncorhynchus mykiss), and channel catfish (Ictalurus punctatus). However, among such a variety of aquaculture objects, the most promising are the white carp and the silver carp. The silver carp is commonly sold in Ukrainian retail chains in live and frozen forms, and the offer of this freshwater fish far exceeds the demand. In order to increase the interest of the population in purchasing the silver carp, it is necessary to develop new products from this fish that would be in high demand and would have certain organoleptic qualities and shelf life.

Due to the peculiarities of the enzyme system of the silver carp, associated with low maturation ability, a technology of producing hot marinades for a jellylike filling from this freshwater fish is highly essential.

2. Literature review and problem statement

The current development of world fisheries shows the growing role of aquaculture as a consequence of reducing

the volume of ocean catches. The development of aquaculture also contributes to the proximity of fisheries to markets, which makes it possible to process hydrobionts into high-quality finished products from fresh raw materials at local enterprises. Such objects of fishing for Ukraine may now be freshwater fish, the catch of which in 2015 amounted to 38,617 tons, of which about 44 % accounted for the proportion of silver carps [3, 6–8]. According to the taste qualities, the silver carp meat is tender and delicious; it may be a valuable object of dietary nutrition. Since ancient times, the silver carp has been valued as a source of valuable protein and vitamins in the diet of children [9, 10]. However, the range of food products from the silver carp is limited to a small amount of canned food and smoked baked goods. The low activity of the enzyme system makes it impossible to use the silver carp as a raw material for making salty fish products, the peculiarity of which is the formation of a "bouquet" during maturation. Therefore, it is promising to develop new types of culinary products from the silver carp in jellylike marinade fillings of prolonged shelf life.

Fish marinades can be divided into two groups: cold, or made from salty semi-finished products, and hot, or made from fish subjected to preliminary heat treatment (blanching, roasting, and hot smoking). The technology of producing hot marinades does not involve such a process as maturation and, accordingly, does not require the use of raw materials with high activity of the enzyme system. Cold marinades have a high degree of stability and can be stored for a long time; hot marinades in this respect can be referred to culinary products with a shelf life of 72 hours [11]. Hot marinades are fundamentally different from cold marinades as the only preservative in them is acetic acid, but the kitchen salt, the content of which is 2–3 %, plays only the role of a flavoring supplement. Taking into account the existing requirements of retail chains, long-term storage products should be developed through the use of a combination of preservatives (for long term and moderate positive storage temperatures).

The most attractive and convenient food element for the consumer can be a jellylike filling in the production of hot marinades with the preliminary heat treatment of the fish with hot smoking.

For the development of products in jellylike filling, it is becoming especially important to expand the range of specialized foods and to create new generation products with preventive properties. Recently, natural biopolymers of high molecular weight carbohydrates of vegetable origin often have started being used in recipes.

To obtain partially thixotropic texture of the preservative consistency, alginic acid, agar and agarose, cane gum, carrageenan, guarana, furcellaria, tragacanth, and gum can be used. The jelly-forming properties of these biopolymers do not depend on the mass fraction of sucrose and titrated acids [12–15].

A separate group of natural thickeners contains pectin substances (PSs) and alginic acid. The main advantages of alginates as gel formers include the ability to form thermostable gels, which can be made at room temperature. According to the recommendations of the FAO/WHO Expert Committee, the content of alginic acid and salts in food products, without risk to health, is 25 mg per 1.0 kg of the human body mass [15]. Among the modern hydrocolloids, the most promising from the point of view of solving technological problems and providing dietary prophylactic properties are low-esterified pectins (LEPs). Almost 80 % of all PSs are used in canning and confectionery production as a preservative to prevent the rapid drying and to increase the shelf life of baked bread [16]. LEPs are capable of forming sugar-free jelly, but it happens in the presence of ions of polyvalent metals, such as Ca^{2+}. It is the variation in the content of calcium that can affect the strength of the jelly, organoleptic parameters, and rheological properties [17]. The expressed therapeutic effect of PSs has predetermined their most active use as natural complexons and enterosorbents in treatments and preventive diets [18, 19].

Industrial preparations of PSs are characterized by a high degree of esterification (68–71 %). The jellification of such PSs requires at least 1 % of titrated acids and 70 % of sucrose, which makes it impossible to use them as preservatives in fish marinades.

LEPs can be obtained by means of biotechnological methods, including processing of high-esterified PS extracts derived from apple pomace with alfalfa pectin methyl esterase [19]. According to the research of the activity of alfalfa pectin methyl esterase at the variation of temperature and pH, the maximum activity of the enzyme was observed at a temperature of 25–50 °C and at a pH within the range of 4.5–8.0. The rate of action on the substrate is better at pH 4.8–5.2, which corresponds to the acidity of fish marinades.

Thus, the current state and prospects of developing the raw material base of Ukraine show that the most appropriate tendency is the focus of production on the processing of aquaculture objects. The most promising aquaculture objects are white and silver carps. It is advisable to develop the technology of hot marinades for a jellylike filling with the addition of a mixture of preservatives and substances that have a preservative effect, which will produce safe food for humans. LEPs and alginic acid are the most attractive components for the formation of preservative food fillings.

3. The aim and objectives of the study

The aim of the study is to develop a technology of producing hot marinades for a jellylike filling of the silver carp product of prolonged storage.

To achieve this aim, it is necessary to solve the following objectives:

– to substantiate the mass fraction of LEPs and alginic acid in the jellylike filling and to investigate the change of the rheological indicators of the jelly;

– to study the dynamics of changes in the physicochemical and organoleptic parameters of the product with the addition of LEPs and alginic acid;

– to research the effect of LEPs and alginic acid, the preservatives and their combination, on the safety indices and the shelf life of the finished product.

4. Materials and methods of research

The study is based on using organoleptic, physicochemical, structural-mechanical and microbiological methods.

The quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) is determined by using classical techniques and modern microbiological express analyzer of the Buck Trak 4300 series (SY-LAB Gerate GmbH (Austria)). The operation of Buck Trak 4300 is based

on controlling the impedance (electrical resistance) of the nutrient medium that changes in the process of vital activity of microorganisms.

Fig. 1. The express-analyzer of the Buck Trak 4300 series

More detailed materials and research methods are presented in [20].

5. Experimental data and development of a technology of producing hot marinades from smoked silver carp in a jellylike filling

Silver carps are large herbivorous freshwater fish. Depending on the age and mass, silver carps are conventionally classified into six groups: from the first group (fish weighing up to 500–600 g) to the sixth group (5,000–8,000 g). Basically, industrial processing deals with the fish of the first to third groups, which are characterized by the largest output of muscle tissue (about 39 %) [10].

The technological process of producing hot marinades contains the following operations: washing, sorting, removing scales, disassembling the fillet, flavoring and salting, draining, hot smoking, preparing gelatin filling on the basis of spiced acetic broth, and refrigerated storing.

One of the options for preliminary heat treatment of fish for hot marinades is hot smoking [11]. The use of such semi-finished product, combined with the aroma of spices contained in the marinade, allows getting a product with unique flavoring properties.

Preparation of fish for smoking involves such a technological operation as salting. Hot smoking entails flavor salting with the mass fraction of the salt in the muscle tissue not to exceed 1.5 %. Fish is prepared for salting in accordance with the requirements of normative documentation. For the production of hot marinades, silver carps are processed to extract the fillet that is then cut into pieces of 10×5×2 cm or 8×4×1.5 cm to ensure quick salting. The salted semi-finished product is obtained by wet salting at a temperature of 10 °C for 40–50 minutes in the brine density of 1.18–1.20 g/cm^3.

The consistency of the filling depends on the amount of the jellifier in the solution. For this purpose, the studied solutions contained the mass fractions of 0.5 %, 1.0 %, 1.5 %, 2.0 %, and 2.5 % of LEP and alginic acid in the spice broth. The latter was made by infusing the spices in boiled water for 30 minutes [21]. Then, after settling and cooling, it was filtered, salted, sugared, and acetified. The process of jellification was studied at a temperature of 20 °C, and the jelly strength was measured using a modified Valenta device, which determines the weight of the mass required to destroy the jelly. The results of the tests are given in Table 1.

Table 1

Changes in the jelly strength depending on the type and mass fraction of the jellifier

Samples	The mass fraction of the preservative in the solution				
	0.5 %	1.0 %	1.5 %	2.0 %	2.5 %
	Jelly strength, g				
LEP	24	89	97	104.7	108.5
alginic acid	25	94	102	109	112.4
LEP with alginic acid in the 1:1 ratio	38	108	112	157.2	210.7

The data in Table 1 show that the greatest strength of the jelly was recorded in a solution of LEP with alginic acid in the ratio of 1:1 with a mass fraction of 1.5–2.5 %. However, after a day in the samples with a mass fraction of 2 and 2.5 %, there happened synergetic processes. Therefore, the most rational option is the use of a 1.5 % solution of LEP with alginic acid in the ratio of 1:1.

The spicy broth was made for the preparation of the preservative spiced acetic filling with the following ingredients: cloves, cinnamon, bay leaf, peppercorn, black pepper, salt, sugar, and acetic acid. To extend the shelf life of the product, a combination of preservatives of sodium benzoate and potassium sorbate was added.

The process of mass transfer in hot marinades during refrigeration was studied on samples of smoked fish in a spiced acetic marinade with jelly-forming agents. One of the most important characteristics of hot marinades is the infiltration of the filling, which is characterized by an indicator of the relative gain of the mass (Fig. 2).

In the diagram, all values are close to the average (with a slight standard deviation), which is sufficient to make a decision.

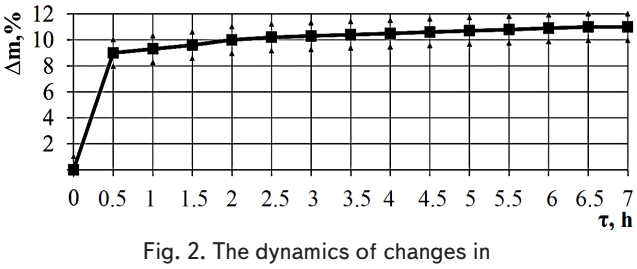

Fig. 2. The dynamics of changes in the relative gain of the mass

The data of Fig. 2 show that the main mass exchange occurred within 30 minutes of storage. After 7 hours of refrigeration, the relative gain of the smoked sample mass was 11 %.

Hot marinades from smoked silver carp are a new food product; therefore, changes of physical and chemical parameters of the product during storage were studied. It was especially important to specify the dynamics of accumulation of acetic acid (Fig. 3) and the change in the moisture holding capacity (MHC) (Fig. 4) of the muscle tissue of the fish.

The experimental data of Fig. 3 show that in 30 minutes the mass fraction of acetic acid increased to 0.6 %; in the

course of the next 7 hours, the increase was only 0.07 %. The small standard deviation was close to the average and made it possible to take the decision.

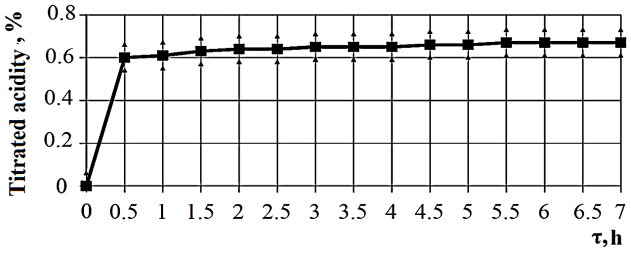

Fig. 3. The dynamics of changes in the titrated acidity of the smoked semi-finished silver carp product

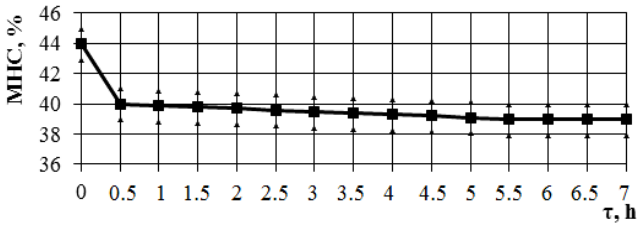

Fig. 4. The dynamics of changes in the moisture holding capacity of proteins of the muscle tissue of the smoked semi-finished silver carp product

The MHC of the muscle tissue protein after the hot smoking made up 44 %. After adding the filling, the MHC of the muscle tissue protein in 30 minutes decreased by 12 %, but with further storage, this figure did not change.

Taking into account the requirements of retail chains, further research was devoted to the development of a way to extend the shelf life of the culinary product by introducing preservatives and their combination. The recent studies [15] have made it possible to conclude that safety of culinary products is mainly ensured by the use of preservatives. In accordance with the requirements of the "Instructions for sanitary-microbiological control of the production of food products from fish and marine invertebrates" for fish culinary products made from disassembled fish in various sauces and marinades manufactured at Ukrainian enterprises, the amount of QMAFAnM is 1×10^4 CFU/g.

Currently, the most widely used preservatives are sorbic and benzoic acids and their salts. The joint application of sodium benzoate (SB) and potassium sorbate (PS) produces the effect of synergy (SB+PS) [15]. The results of the experiments are shown in Table 2.

Table 2

The effect of preservatives and their combination on the amount of QMAFAnM in the culinary products

Kind of preservative	Number of microorganisms (QMAFAnM), CFU/g			
	Storage time			
	24 hours	1 month	2 months	3 months
Control without preservatives	$4.1\cdot10^3$	$1.5\cdot10^{4*}$	spoiling	spoiling
SB	$3.3\cdot10^2$	$3.6\cdot10^2$	$4.6\cdot10^2$	$6.1\cdot10^3$
PS	$3.8\cdot10^2$	$4.1\cdot10^3$	$4.5\cdot10^3$	$9.2\cdot10^3$
SB+PS	$2.3\cdot10^2$	$2.5\cdot10^2$	$4.0\cdot10^2$	$4.6\cdot10^3$

*Note: * – experimental data for the 17th day of storage*

In the control group, stored for 2–3 months, the QMAFAnM was not determined due to complete spoiling of the culinary product. If the figures before 10 to varying degrees were translated into full numbers, after 1 month of control the value would be $1.5\cdot10^4$=15,000 CFUs, and the largest QMAFAnM for 3 months storage with the use of a preservative, PS in this example, would be $9.2\cdot10^3$=9,200 CFUs, which is much less than without the use of preservatives, and so was true for all indicators when the preservatives were introduced.

The use of various preservatives and their combinations allowed increasing the stability of the marinades at a moderate positive temperature of storage (4–6) °C and extending the shelf life to 90 days, against 17 days without the addition of proper preservatives.

During storage, marinades acquire the best organoleptic characteristics relative to the time of preparation. Pieces of fish are well saturated with the filling. The corresponding taste and aromatic properties appear as a result of the interaction of the flavor and aromatic components of the heat-treated muscle tissue protein spices that are part of the product recipe [11]. Fig. 5 represents profilograms of the complex of organoleptic indicators of the marinades.

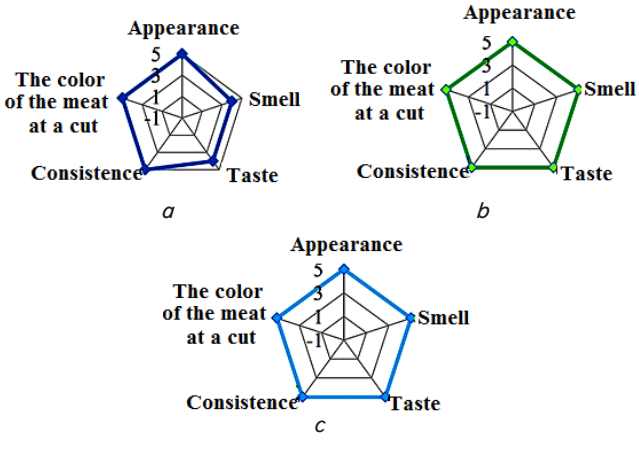

Fig. 5. The organoleptic evaluation of the finished product during storage: *a* – freshly made samples; *b* – after 30 minutes; *c* – in 3 months

The organoleptic evaluation was carried out during the whole period of storage at intervals of one month. Fig. 5 shows data that characterize the cooked products immediately after cooking (Fig. 5, *a*), after 30 minutes of storage (Fig. 5, *b*) and after 3 months (Fig. 5, *c*). The profilograms presented in Fig. 6 show that the organoleptic properties of the finished product after 30 minutes reached their maximum since the score of the main indicators is characterized by maximum values. For further storage, significant changes in the organoleptic characteristics did not occur during the entire period of storing.

Thus, the analysis of the experimental data testifies to the fundamental possibility and feasibility of producing hot marinades from the silver carp in a jellylike filling.

6. Discussion of the results of studying the importance of developing the technology of producing hot marinades from smoked silver carp in a jellylike filling

The proposed technology of producing hot marinades will contribute to some actualization of the development of

aquaculture in Ukraine, as demand for freshwater fish will increase at fish processing enterprises. The use of the silver carp to make an unconventional assortment of fish products – marinades in a jellylike filling with the use of LEP and alginic acid – can expand the range of products of high biological value and reduce the pressure in the consumption of bioresources by the population of Ukraine.

The undertaken tests are a continuation of research on the development of fish products of high biological value on the basis of natural biopolymers of plant origin, namely LEP, alginic acid, and agar [16–19].

An analogue of the proposed assortment is jellied fish. The filling was made using a gelling solution or linseed, which is usually prepared on the basis of gelatin and aromatic taste components. In recent years, interest in gelatin has declined significantly. This is due to the fact that spongiform encephalopathy (a disease of rabies) has manifested itself as such a serious problem that the use of collagen of animal origin has become dangerous.

In order to eliminate this disadvantage and taking into account the complex ecological situation in Ukraine associated with the Chernobyl disaster, it is proposed to use natural biopolymers based on vegetable raw materials that help obtain jellylike fillings.

The main drawbacks of this study are probably the use of acetic acid to create a certain organoleptic bouquet and the addition of preservatives to extend the shelf life. Therefore, this product has limitations for consumption by a group of people who have an exacerbation of diseases of the gastrointestinal tract.

In the future, it is planned to study the complex-forming ability of the components of the jellylike filling of the hot marinades with respect to radionuclides and heavy metal ions. Due to this property of vegetable biopolymers of carbohydrate nature, they are included in the diet of persons who are in a medium contaminated with radionuclides and who have contact with heavy metals.

It is known that certain categories of food products accumulate biogenic amines (BAs), especially fish products. Therefore, research related to the regulation of BA content is essential and will also be developed in the future.

7. Conclusion

1. To ensure the stable structural and mechanical properties of the jelly during refrigeration, the rational proportion of LEP and alginic acid in their combination was found to be 1:1 with a mass fraction of 1.5 %. In the filling, these parameters prevent synergetic changes, and the jelly strength formed is 112 g.

2. It was determined that during storage, there appears a change in the basic physical and chemical parameters of the fish marinades with the addition of LEP and alginic acid. This is accompanied by the saturation of the fish with flavoring fillings, characterized by an increase in the mass by 11 %, an increase in the titrated acidity of the muscle tissue to 0.67 %, and a slight change in the MHC from 44 % down to 39 %.

3. To ensure safety of the fish marinades and to increase the shelf life at moderate positive temperatures, a combination of sodium benzoate and potassium sorbate in a solution of LEP and alginic acid was used. The combination of the preservatives allowed obtaining the synergy effect; it increased the durability of the marinades at a moderate positive storage temperature (4–6) °C and extended the shelf life to 90 days against 17 days without adding the preservatives.

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Теоретично обґрунтовано та експериментально підтверджено доцільність використання рослинних добавок у технології пряничних виробів. Обґрунтовано вплив вмісту рослинних добавок на формостійкість пряників. Проведена сенсорна оцінка органолептичних показників готових виробів та побудовані профілі органолептичної оцінки пряників. Встановлено, що рослинні добавки сприяють поліпшенню якості пряничних виробів

Ключові слова: кедровий шрот, кунжутне борошно, фітопорошок з гірчака зміїного, пряничні вироби, органолептична оцінка

Теоретически обоснована и экспериментально подтверждена целесообразность использования растительных добавок в технологии пряничных изделий. Обосновано влияние содержания растительных добавок на формоустойчивость пряников. Проведена сенсорная оценка органолептических показателей готовых изделий и построены профили органолептической оценки пряников. Установлено, что растительные добавки способствуют улучшению качества пряничных изделий

Ключевые слова: кедровый шрот, кунжутная мука, фитопорошок с горца змеиного, пряничные изделия, органолептическая оценка

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STUDY INTO EFFECT OF PLANT SUPPLEMENTS ON THE QUALITY INDICATORS OF GINGERBREAD AND SIMILAR SPICE-CAKES

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1. Introduction

Nutrition is one of the most ancient factors that affects health of the nation. Proper nutrition contributes to the prevention of diseases, prolongation of life, creation of conditions to improve the body's resistance to adverse effects of the environment. An important task for the food industry is to provide the population with products with high consumer properties.

In accordance with "Global Strategy on Food, Physical Activity and Health" of the World Health Assembly, a gradual replacement of traditional assortment of food products with special ones that contribute to the maintenance of normal functioning of all organs and systems of a human body, to health and longevity, is the main direction in the development of the civilized market. The development of a strategy to create new scientifically based technologies for ecologically-friendly food products, including special purpose food products, is one of the main tasks of the world public policy related to food quality and safety [1].

Consumer demand for healthy foods, successes in the study of a physiological role of nutritional ingredients in a