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Improvement of technology of fish semi-finished products with addition of non-conventional raw materials

Nataliia Holembovska*, Nataliia Slobodianiuk, Valentyna Israelian

National University of Life and Environmental Sciences of Ukraine
03041, 15 Colonel Potehin Str., Kyiv, Ukraine

Abstract. Considering the results of studies of the scientific literature on the nutritional value and biological effectiveness of cranberries and goji berries, it was established that the development of technology of semi-finished products with their use is relevant and has practical significance in the technology of fish product production. The technology for the production of moulded fish semi-finished products opens up new opportunities in the field of rational use of secondary fish raw materials, making it possible to expand the range of functional fish products based on natural components, which will to some extent expand the current problem of processing raw materials of inland waters of Ukraine. The purpose of the research is to determine the biological value of new fish semi-finished products based on a combination of freshwater fish and non-conventional raw materials. The research presents the results of studies of the chemical composition, organoleptic evaluation and physicochemical changes of semi-finished products with the addition of non-conventional raw materials and the establishment of their shelf life. It was established that the control sample after 90 days of storage undergoes hydrolytic deterioration, which indicates intensive hydrolysis of lipids and accumulation of free fatty acids in this sample. In experimental samples, hydrolytic deterioration gradually increases and reaches a critical point only by the end of the shelf life. Oxidation processes in lipids of semi-finished products were explored by changes in the accumulation of primary oxidation products – peroxides and secondary products – carbonyl compounds. According to the dynamics of changes in the peroxide number of lipids of semi-finished products, it was established that the control sample during 60-135 days is not subject to storage, and in the experimental samples after 135 days the quality of fat deteriorates and is described as not subject to storage. The authors have established that the developed technology

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**Corresponding author*

of fish semi-finished products will significantly expand the range of functional products based on natural components, which will allow expanding the current problem of processing raw materials in inland waters of Ukraine to some extent

Keywords: fish sticks, non-conventional raw materials, cranberries, goji berries, semi-finished products, organoleptic evaluation

Introduction

In the fishing industry, the rational use of raw materials plays an important role, as the fish comes to production with mechanical damage, different sizes, with defects. The technology for the production of moulded fish semi-finished products offers new opportunities in the field of rational use of secondary fish raw materials and allows expanding the range of fish products (Ivaniuta *et al*., 2021).

Biologically active food substances belong to the natural components of food and have a pronounced physiological and pharmacological effect on the main regulatory and metabolic processes of the body. Therewith, they are an effective way to combat vitamin deficiency (Holembovska *et al*., 2021; Kondratiuk et al., 2021). Biologically active food substances are contained in modern technology of food production of plant raw materials: wild and cultivated berries, which are widespread in the country. In general, wild raw materials should be considered as a source of dietary fibre in the human body.

Nowadays, the enrichment of the daily diet with biologically active substances is a relevant subject. They effectively eliminate the deficiency of vitamins, organic acids and minerals. Eating foods that have adverse effects on our bodies requires reconsideration of the rules of modern nutrition (Manoli *et al*., 2021).

Using non-conventional plant raw materials, such as cranberries, and goji berries and their introduction into the recipe allows for enriching the diet with biologically active substances, obtaining high-quality products with good organoleptic characteristics, and expanding the range of existing dishes (Golembovskaya, 2019).

Quick-frozen convenience foods such as fish cutlets, cakes, meatballs, and others, most often made from minced fish, and a variety of ready meals, hot and cold snacks, are becoming increasingly popular with consumers.

The preparation of conventional minced fish products (cutlets, meatballs, cakes) is almost identical, the main differences are in the recipes of minced mixtures, shape and weight of the products.

Natural cut products include steaks, fillets, schnitzels, kupati, kebabs and others. The range of cutlet mass products includes various types of cutlets and cakes (homemade, moskovskie, beef, etc.), meatballs, zrazy, rolls and others. In the last twenty years, many scientists have proposed a large number of bread substitutes in the cutlet mass, such as grains, vegetables, fruits and their processed products (da Silva *et al*., 2019; Lansing *et al*., 2018).

The problem of finding supplements for chopped masses with specific technological properties and, therewith, high biological value is still relevant. Scientists continue research on improving minced meat production

technologies, finding ways to increase the duration of their storage, improving quality through the introduction of supplements and expanding the range (Fernandez *et al.*, 2019; Cherednichenko & Bal-Prylypko, 2019).

The problem of antioxidant deficiency in nutrition can be solved, through the establishment, of new combined products containing natural mineral and vitamin supplements in the form of vegetables and fruits, and non-conventional plant raw materials (Nikolaienko, M., Bal-Prylypko, L., 2020; Menchynska *et al.*, 2019).

In recent years, after the discovery of the antioxidant properties of some substances (vitamins, bioflavonoids, etc.), some researchers have proved the feasibility of using plant raw materials as the main source of antioxidants in minced products, which allows for extending their shelf life and enriching them with biologically active substances.

The introduction of blanched Menchynska carrots and onions into quick-frozen chopped semi-finished products packed in polymeric materials allows them to be stored at a temperature of -18°C for three months. Scientists explain this fact by the content of antioxidants (carotenoids) in carrots and phytoncides (quercetin, myricetin, kaempferol) in onions (Eveleva & Cherpalova, 2019).

Thus, the introduction of herbal supplements, as a rule, reduces the shelf life of semi-finished products (frozen – up to 1 month), except for those with antioxidant properties.

The purpose of the research is to determine the biological value of new fish semi-finished products (fish sticks) based on a combination of freshwater fish (carp) and non-conventional raw materials (cranberries and goji berries).

By the set purpose, were defined the following *tasks*: development of the recipe composition and technology of semi-finished products from freshwater fish using non-conventional raw materials; investigation of changes in the quality of semi-finished products during storage by organoleptic indicators; conducting a comprehensive assessment of the quality of finished products during storage.

Materials and Methods

The research was conducted in the laboratory of the Department of Meat, Fish and Seafood Technology of the National University of Life and Environmental Sciences of Ukraine.

As the main raw materials in the experimental research were used carp of spring and autumn catch according to DSTU 2284 (2010), which were grown in the reservoirs of PJSC "Cherkasy fish farm", cranberries according to DSTU 5035:2008 and goji berries according to TU U 15.8-00481181-018:2016.

The preparation of samples for organoleptic, physicochemical and microbiological studies was performed according to GOST 7636-85 (1985), and sampling was performed by GOST 7631-85 (1985).

The characterization of the chemical composition of fish semi-finished products was performed by the following methods: the mass fraction of moisture by drying the product sample to a constant mass at a temperature of 100-105°C; the mass fraction of ash – by weight method, after mineralisation of the product sample in a muffle furnace at a temperature of 500-600°C; the mass fraction of lipids by the Soxhlet method; the mass fraction of protein by determining the total nitrogen by the Kjeldahl method. Samples were ashing on Velp Scientifica DK6 series (Italy) and distilled on a Velp Scientifica UDK 129 steam distillation apparatus (Italy).

Results

In the first stages of work, studies of plant raw materials were performed. The results of studies of organoleptic characteristics of cranberries and goji berries are presented in Table 1. The physicochemical parameters of cranberries are presented in Table 2.

Table 1. *Organoleptic characteristics of cranberries and goji berries*

Indicators	Biologically active supplements	
	Cranberry	Goji
Appearance and consistency	the berry is dark red, spherical or ellipsoidal up to 12 mm in diameter, without visible inclusions and impurities.	
Flavour and odour	Juicy, sour	Pleasant juicy, sour flavour with a slightly bitter aftertaste
Colour	From light to dark red colour, homogeneous throughout the mass	Dark red, homogeneous throughout the mass.

Table 2. *Physicochemical parameters of cranberries*

Name of raw material	Dry substances, %	Vitamin C, mg/100 g	Pectini, g	Titrated acidity, %
Cranberry	24.2	7.04	0.84	2.75

The main component of dry substances – sugar. Monosaccharides presented in fruit and berry raw materials are always contained with mineral salts. The content of glucose and fructose in berries is approximately the same, sucrose is practically absent. The chemical composition of cranberries and goji berries is presented in Table 3.

Table 3. *Chemical composition of cranberries and goji*

Indicators name	Cranberry	Goji
Mass fraction of moisture, %	80.9	12
Sugar, %	6.2	-
Pectin substances, %	0.6-3.3	2.4
Fibre, %	1.4-1.6	3.1

Analysing the data presented, it can be concluded that the chemical composition of berries is diverse, depending on the species, variety, germination conditions and harvesting time. In developing the recipes, requirements standards recommended by the WHO FAO have been considered. A sample of semi-finished products made without vegetable supplements was used as a control. The recipe of the control and experimental samples is presented in Table 4.

Table 4. *Recipes of fish sticks with supplements*

Components name	Recipe composition, kg per 100 kg of products		
	Control	Sample 1	Sample 2
Minced fish	78.92	76.92	76.92

Table 4. Continued

Components name	Recipe composition, kg per 100 kg of products		
	Control	Sample 1	Sample 2
Salt	1	1	1
Eggs in minced meat	5	5	5
Bread	8	8	8
Water	5	5	5
Starch	2	2	2
Black pepper	0.06	0.06	0.06
Allspice pepper	0.02	0.02	0.02
Cranberry	-	2	-
Goji	-	-	2

In the production of moulded semi-finished products, the liquid dough was used, the recipe of which is presented in Table 5. Combining freshwater fish raw materials with vegetable raw materials allows for optimising the taste properties of the finished product, biological value and extending the shelf life. To assess the quality of finished products, their chemical composition was explored. The results are presented in Table 6.

Table 5. *Recipe of liquid dough*

Components name	Recipe composition of liquid dough, kg per 100 kg
Flour wheat	32
Starch	5
Salt	1.5
Chicken eggs	3
Water	60

Table 6. *General chemical composition of semi-finished products, % (n=5, p≤0.05)*

Name of indicators	Samples of semi-finished products		
	Control	Sample 1	Sample 2
Humidity content	83.81±2.4	75.04±2.3	69.64±2.7
Protein content	11.9±0.7	18.1±0.9	21.6±0.8
Fat content	3.21±0.22	3.27±0.21	3.24±0,23
Content of mineral substances	1.08±0.14	3.58±0.16	5.51±0.16

According to the analysis of the chemical composition, the humidity content in the samples ranges from 75.04 to 83.81%. The protein content ranges from 11.9 to 21.6%, the lowest content in the control sample. It can be explained by the ratio of raw materials and herbal supplements.

The fat content in the finished preserves ranged from 3.21 to 3.27%, which indicates a positive effect on the taste properties of the product.

The mineral content of the control contains 1.08%. In the experimental samples, their content varies from 3.58 to 5.51%. The test samples differ from the control in mineral content as herbal supplements contain a large number of minerals that enrich the finished product.

To determine the taste properties of semi-finished products, an organoleptic evaluation of the quality of the prototypes was performed during all stages of production before storage. The evaluation was performed on their developed 5-point scale.

The investigation of organoleptic quality parameters of the experimental samples of semi-finished products during the shelf life is presented in Table 7.

Table 7. *Organoleptic evaluation of fish semi-finished products based on vegetable raw materials, points (n=5, p⩽0.05)*

Name of the sample recipes	Shelf life, days	Evaluation of indicators, points				Overall score
		appearance	odour	consistency	flavour	
control	30	4.8±0.4	3.6±0.3	4.6±0.3	4.4±0.4	17.4
	60	4.8±0.4	3.6±0.3	4.6±0.4	3.8±0.3	16.8
	90	4.8±0.4	3.4±0.3	4.4±0.4	3.2±0.3	15.8
	135	4.6±0.4	3.0±0.3	4.0±0.3	2.6±0.3	14.2
	180	4.4±0.3	2.6±0.2	3.8±0.3	1.6±0.3	12.4
Sample 1	30	4.2±0.3	4.8±0.4	3.8±0.3	5.0±0.4	17.8
	60	4.4±0.4	4.8±0.4	3.8±0.3	4.8±0.3	17.8
	90	4.6±0.4	4.8±0.3	3.8±0.3	4.6±0.4	17.8
	135	4.4±0.3	4.6±0.3	3.8±0.3	4.4±0.4	17.2
	180	4.2±0.3	4.6±0.4	3.6±0.3	3.8±0.3	16.2
Sample 2	30	4.8±0.4	4.8±0.3	4.4±0.4	4.6±0.3	18.6
	60	4.6±0.4	4.8±0.4	4.2±0.3	4.6±0.4	18.2
	90	4.2±0.3	4.8±0.4	4.2±0.3	4.6±0.3	17.8
	135	4.4±0.3	4.4±0.3	4.0±0.3	4.4±0.4	17.2
	180	4.2±0.3	4.0±0.3	4.0±0.3	3.8±0.3	16.0

The data of Table 7 demonstrate that according to organoleptic indicators during 180 days of storage, all products had a uniform ruddy crust on the surface, and retained their shape. The odour of samples 1 and 2 were rated significantly higher than the prototype, in particular, sample 2 due to the presence of spices in its recipe. The odour of the prototype after storage for 90 days is characterised as specific, and fishy. The degree of accumulation of fatty acids as a result of hydrolytic decomposition of lipids of semi-finished products was explored by changing the acid number of lipids. The results of the research are presented in Fig. 1.

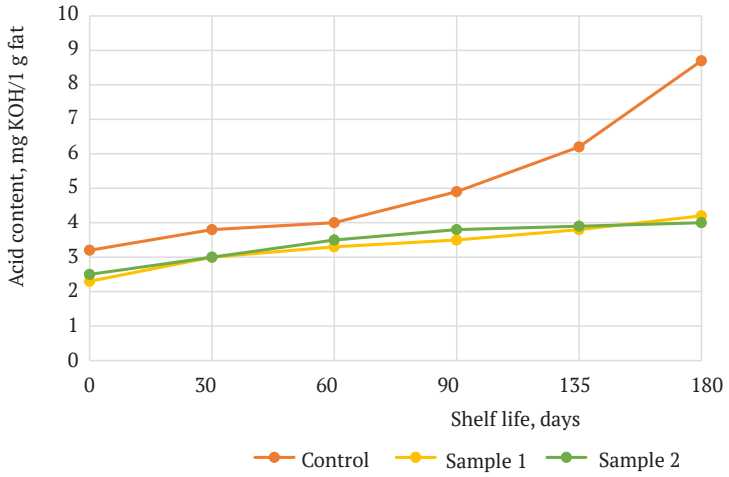

Figure 1. Dynamics of the acid number of lipids of semi-finished products

The data of Fig. 1 demonstrate that changes in the acid number of lipids of semi-finished products during storage for 180 days at a temperature of minus 18°C have a linear upward trend.

Acid numbers of lipids in the control sample after 90 days of storage reach 4.0 mg KOH/1 g of fat and continue to increase, indicating intensive lipid hydrolysis and accumulation of free fatty acids in these samples. The acid number of the lipids of samples 1, and 2 gradually increases during the 180 days of storage and only reaches 4 mg KOH/1 g fat at the end of the storage period (180 days).

Oxidative processes in lipids of semi-finished products were explored by changes in the accumulation of primary oxidation products – peroxides and secondary products – carbonyl compounds. The results of studies of changes in the lipid peroxide number of semi-finished products during storage are presented in Fig. 2.

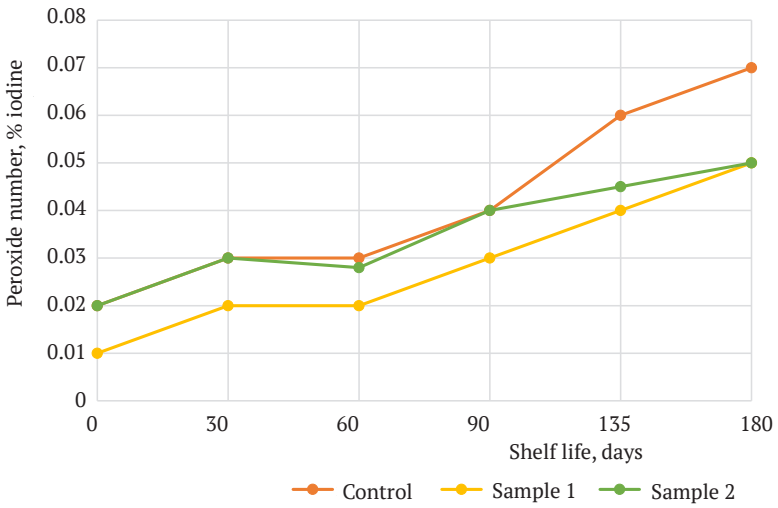

Figure 2. Dynamics of lipid peroxide number of semi-finished products

In the experimental samples, the accumulation of primary oxidation products was the slowest compared to the control. It is explained by the fact that the control samples of fish sticks contain more fat than the experimental ones, due to the high content of fish raw materials in the recipe.

Conclusions

The developed technology of fish semi-finished products will significantly expand the range of functional products based on natural components, which will, to some extent, expand the current problem of freshwater fish processing. The positive results obtained indicate the continuation of the study of this technology and require further development.

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Удосконалення технології рибних напівфабрикатів із додаванням нетрадиційної сировини

Наталія Володимирівна Голембовська, Наталія Михайлівна Слободянюк, Валентина Миколаївна Ісраелян

Національний університет біоресурсів і природокористування України
03041, вул. Полковника Потєхіна, 16, м. Київ, Україна

Анотація. З огляду на результати досліджень наукової літератури щодо харчової цінності та біологічної ефективності ягід журавлини та годжі, встановлено, що розроблення технології напівфабрикатів із їхнім використанням є актуальною й має практичне значення в технології виробництва рибних продуктів. Технологія з виготовлення рибних формованих напівфабрикатів відкриває нові можливості в галузі раціонального використання вторинної рибної сировини, дає можливість розширити асортимент рибних продуктів функціонального призначення на основі природних компонентів, що дасть змогу певною мірою розширити актуальну проблему перероблення сировини внутрішніх водойм України. Метою проведених досліджень є визначення біологічної цінності нових рибних напівфабрикатів на основі поєднання прісноводної риби та нетрадиційної сировини. У статті представлені результати досліджень хімічного складу, органолептичної оцінки та фізико-хімічних змін напівфабрикатів із додаванням нетрадиційної сировини та встановлення їхнього терміну придатності. Було встановлено, що в контрольному зразку після 90 діб зберігання проходять процеси гідролітичного псування, що свідчить про інтенсивний гідроліз ліпідів і накопичення вільних жирних кислот у цьому зразку. У дослідних зразках поступово збільшується гідролітичне псування й лише до кінця терміну придатності досягає критичної точки. Окиснювальні процеси в ліпідах напівфабрикатів вивчали за змінами у накопиченні первинних продуктів окиснення – перекисів і вторинних продуктів – карбонільних сполук. За динамікою змін перекисного числа ліпідів напівфабрикатів встановлено, що контрольний зразок упродовж 60-135 діб не підлягає зберіганню, а в дослідних зразках після 135 діб якість жиру погіршується та характеризується як той, що не підлягає зберіганню. Авторами було встановлено, що розроблена технологія рибних напівфабрикатів, значно розширить асортимент продуктів функціонального призначення на основі природних компонентів, що дасть змогу певною мірою розширити актуальну проблему перероблення сировини внутрішніх водойм України

Ключові слова: рибні палички, нетрадиційна сировина, ягоди журавлини, ягоди годжі, напівфабрикати, органолептичне оцінювання