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SCIENTIFIC SUBSTANTIATION OF TECHNOLOGY OF PASTA BASED ON FRESHWATER MUSSELS ENRICHED WITH SELENIUM

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Annotation. The possibility of using dietary selenium-protein additive "Neoselen" for enrichment of pastes based on mussels with organic selenium has been investigated. The formulation of the pastes involved the use of the soft body of the freshwater mussels of the genus Anodonta. The influence of the introduction of different percentage of the additive "Neoselen" on the organoleptic properties of the developed pastes based on freshwater mussels was investigated. It is found that the addition of additive "Neoselen" even more than 5% does not impair the taste and color of the developed pastes. Moisture content, moisture retention, fat-holding capacity and active acidity of the developed pastes were investigated. The moisture-holding and fat-holding capacity of the developed paste is determined. The difference in the consistency of pastes based on freshwater mussels with different percentage of unpowered additives was investigated by determining the values of plastic viscosity and modulus of elasticity. The regularities of the influence of the additive "Neoselen" on the general chemical and mineral composition of pastes based on freshwater mussels have been established. It is established that the addition of 1%, 3% or 5% in the paste of additive "Neoselen" can enrich it by 34.8, 50.4 та 66.0 mkg of selenium, respectively. Studies have shown that in the composition of both the control and experimental samples of pastes in the amount of protein, minerals and water content. With the increase of the content of the additive "Neoselen" in the formulation of pastes, the content of protein and minerals increases. The complex of qualitative characteristics of the developed pastes is investigated. The regularities of the influence of the component composition on the organoleptic and physicochemical and functional-technological characteristics of the minced systems based on freshwater mussels and the additive "Neoselen" have been established. It is established that the optimal doses of the use of additive "Neoselen" in the formulation of pastes ranges from 3-5%.

Keywords: freshwater mussels, functional products, dietary selenium-protein supplement, pastes.

НАУКОВЕ ОБГРУНТУВАННЯ ТЕХНОЛОГІЇ ПАСТ НА ОСНОВІ ПРІСНОВОДНИХ ГІДРОБІОНТІВ, ЗБАГАЧЕНИХ НА СЕЛЕН

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Анотація. Досліджено можливість використання добавки дієтичної селен-білкової «Неоселен» для збагачення паст на основі гідробіонтів органічним селеном. Розроблена рецептура паст передбачала використання м'якого тіла прісноводного молюска роду *Apodonta*. Досліджено вплив внесення різної відсоткової кількості добавки «Неоселен» на органолептичні властивості розроблених паст на основі прісноводних молюсків. Встановлено, що додавання добавки «Неоселен» навіть понад 5% не погіршує смак та колір розроблених паст. Досліджено вміст вологи, вологоутримуючу, жирутримуючу здатність та активну кислотність розроблених паст. Досліджено відмінність консистенції паст на основі молюска прісноводного з різним процентним внесенням добавки «Неоселен», шляхом визначення значень пластичної в'язкості та модуля пружності. Встановлено закономірності впливу добавки «Неоселен» на загальний хімічний та мінеральний склад паст на основі прісноводних гідробіонтів. Встановлено, що внесення до складу паст добавки «Неоселен» у кількості 1%, 3% або 5% вдається збагатити її на 14.8, 30.4 та 46.0 мкг селену відповідно. Дослідження показали, що у складі, як контрольного так і дослідних зразків паст по кількості переважає вміст білка, мінеральних речовин та води. Зі збільшенням вмісту «Неоселен» у рецептурі паст вміст білка та мінеральних речовин підвищується. Досліджено комплекс якісних характеристик розроблених паст. Встановлено закономірності впливу компонентного складу на органолептичні та фізико-хімічні та функціонально-технологічні характеристики фаршевих систем на основі прісноводних гідробіонтів та добавки «Неоселен». Встановлено, що оптимальні дози використання добавки «Неоселен» у рецептурі паст коливається в межах 3–5%.

Ключові слова: прісноводні молюски, функціональні продукти, добавка дієтична селен-білкова, пасти.

Introduction. FORMULATION OF THE PROBLEM.

In recent years, the demand for physiological food has increased significantly. The concept of healthy, or better known, health nutrition science originated in Japan. Foods that have a physiological effect include foods that contain nutrients or biologically-active substances that boost immunity, improve physiological processes in the human body. Such products help prevent disease and aging of the body [1].

In the regions of our country the level of consumption of high-grade proteins has significantly decreased, the balance of lipid composition is not rational, there is a noticeable lack of some minerals and vitamins. The deficit of full protein consumption in Ukraine in northern regions in 2018 is 45.5%; for southern regions – 34% [2,3]. In the search for alternative sources of protein, it is advisable to develop food technologies based on freshwater hydrobionts.

Literature review.

The practice of using freshwater hydrobionts in food technology in the world is considerable.

Modern science knows the possibility of using the Nile tilapia, as the main species of fish cultivated around the world and in Brazil. The study focuses on the development of fish snack technology, where Nile tilapia mince is used as the main formulation component. Currently, the organoleptic and physico-chemical characteristics of tilapia-based minced meat and fish snacks have been thoroughly described [4].

Since the 1960-s, numerous studies have established the possibility of obtaining fish snacks (snacks, burgers) from surimi [5].

Russian scientists have studied samples of food stuffing made from freshwater "goldfish", which can be put into production for the purpose of processing unproductive species of the Volga–Caspian pool and obtaining culinary products based on it [6].

Indonesian scientists have investigated the effectiveness of the process of mixing minced meat using the indicator – "mixing index". Used samples: *Oreochromis niloticus*, Walleye pollack surimi and a mixture of both [7].

Scientists of the Republic of Korea have studied the physicochemical and sensory characteristics of minced meat, made with different concentrations of the additive based on the powder *Astragalus membranaceus* [8].

Brazilian scientists have investigated the conditions of convective drying of fermented–modified paste on the basis of fish fillets *Engraulis anchoita* [9].

Among the local freshwater aquatic organisms there is a group of industrial, but not sufficiently caught species such as the freshwater mussel of the genus *Anodonta*. The soft body of the freshwater mussel *Anodonta* (hereinafter referred to as – freshwater mussel) is the ideal raw material for the production of functional foods. It contains a complete protein content of all essential amino acids [10]. An analysis of the fattyacid composition of the freshwater mussel soft body shows that its lipids contain polyunsaturated fatty acids, including ω -6 and ω -33, as well as eicosopentaenoic, docosopentaenoic and docosahexaenoic fatty acid [11]. Freshwater mussel have been found to contain valuable micro and macronutrients. It has been investigated that in terms of microbiological and safety indicators, freshwater mussel soft body the requirements of current regulations [12].

It should be noted that fast–growing culinary products – fish cutlets, nuggets and more – are increasingly popular with consumers. All this gives grounds to offer freshwater mussel mince as a basis for the creation of physiological food paste.

One of the promising directions for the use of freshwater mussel is the production of molded products in which it is possible to introduce into the stuffing various food additives and components in order to improve the organoleptic, structural and mechanical properties and enrichment with essential substances. Among the indispensable nutritional factors that are necessary to maintain homeostasis of the human body are the mineral compounds. Some of the most deficient are selenium compounds – potent carcinogens, metabolic regulators, components of most hormones and enzymes [13]. One of the ways of realizing this direction may be the enrichment of minced meat based on a freshwater mussel with DSPA "Neoselen" [14]. The technology of DSPA "Neoselen" containing organic selenium, which is obtained as a result of the interaction of selenium salts and globular whey proteins, is scientifically substantiated [16]. It is established that DSPA "Neoselen" has a curative and prophylactic value and, in addition, is an emulsifier of dispersed polycomponent systems. Its introduction into the formulation of food does not affect the organoleptic properties, increases the emulsion resistance and enriches the body with organic selenium [17].

The purpose of the research – is the scientific substantiation of technology of pasta based on freshwater hydrobionts and the dietary selenium–protein additive.

To achieve this goal it is necessary to solve the following problems:

1. To determine the organoleptic properties of pastes on the basis of freshwater mussel and different concentrations of DSPA "Neoselen".
2. Investigate the water–holding capacity (WHC), fat–holding capacity (FHC) and grazing pH on the basis of the freshwater mussel and different concentrations of DSPA "Neoselen".
3. Determine the rheological properties of the developed pastes, namely the viscosity and modulus.
4. Determine the total physicochemical and mineral composition of pastes based on freshwater mussel and different concentrations of DSPA "Neoselen".
5. To substantiate on the basis of the received data technology of pastes of physiological action.

Materials and methods of research

Research materials.

For research, freshwater bivalve mussel of the genus *Anodonta*, harvested in the Desna River were used (Sumy Oblast) and DSPA "Neoselen" TU U 10.8–01566330–329: 2018 "Mineral and organic food additives. Specifications".

Preparation of prototypes.

Freshwater mussel paste was prepared by finely grinding boiled and cooled to 40 ± 1 °C freshwater mussel on a cutter with a speed of $2600\text{--}2700\text{ s}^{-1}$ for 15 min. To the resulting paste we have added the DSPA "Neoselen". Prepared peeled and boiled potatoes and onions, as well as additional flavor components (egg powder, salt, etc.) were added to the total mass of freshwater mussel minced and continued to grind for 5 min. The resulting paste mass was packed into 1.5–2 kg polystyrole bags and frozen to minus 18 °C. For the manufacture of pastes, the following recipe components are required (table 1).

Table 1 – Recipes of developed pastes

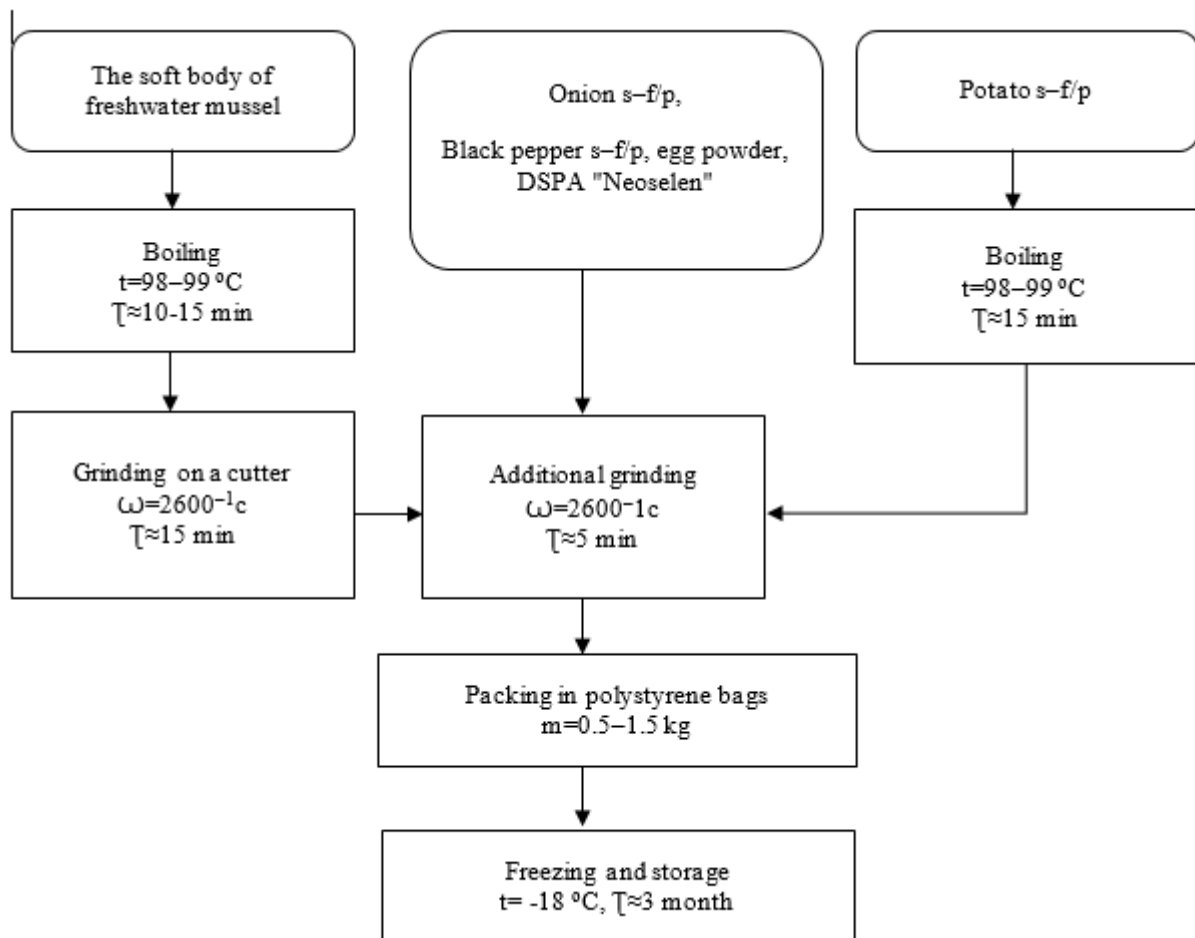
Ingredients	Norm, kg per 100 kg of raw material	Technical documentation
The semi–finished product of freshwater mussel	70	TU U 10.2–3316908299–001:2014
Onion	5	DSTU 3234–95

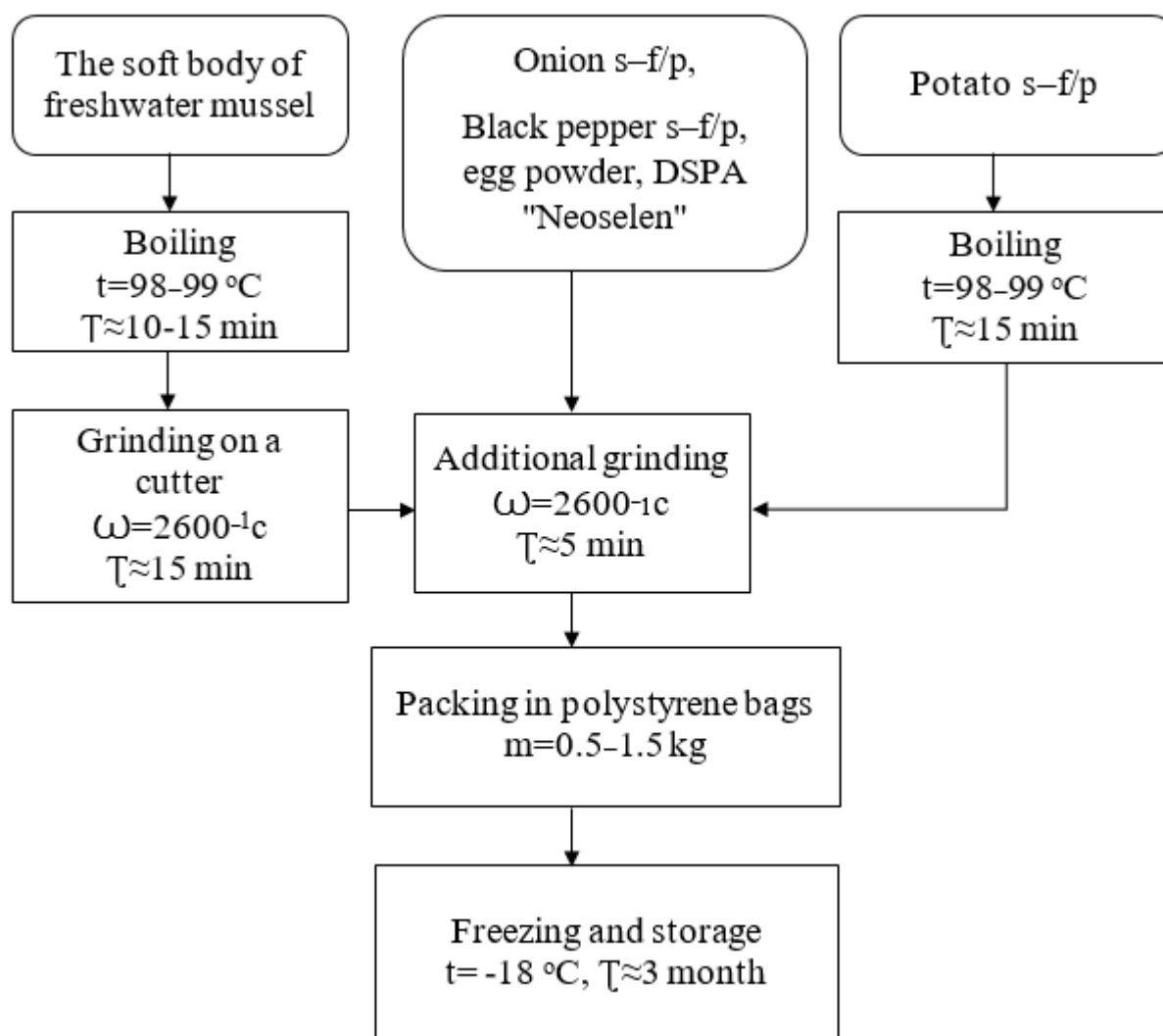
Black paper	0.02	DSTU ISO 959-1:2008
Aroma paper	0.02	DSTU ISO 2254:2008
Salt for food "Extra"	2.5	DSTU -3583-97
Egg powder	4.0	TU U 15.8-32086437-001:2007
Potatoe	18.0	DSTU 4506:2005
Complete	100 kr	

The following prototype pastes were prepared with the DSPA "Neoselen":

- control (model paste without additives);
- sample №1 (paste with 1% DSPA "Neoselen"),
- sample №2 (paste with 3% DSPA "Neoselen"),
- sample №3 (paste with 5% DSPA "Neoselen").

Also, losses were mixed when mixing the paste components, which was 1%. The technological scheme of making paste based on freshwater mussel and DSPA "Neoselen" is presented in Fig. 1. Where: s-f/p – means semi-finished product.





Оставьте пожалуйста ту, которая подходит. Одну из двух.

Шрифт на рисунку повинен бути однаковим. Інтервал числових значень розділяйте тире, а не дефісом. Чи є у тексті розшифрування абрєвіатури "s-f/p"?? Якщо немає, то вставити перед рисунком.

Fig. 1. The technological scheme of paste on the basis of mussel of freshwater enriched DSPA "Neoselen".

The calculation of the additive was carried out taking into account the daily norms of selenium consumption (for men – 70 mcg/day, women – 55 mcg/day [18]. Selenium should enter the human body only in organic form. Thus, the risk of poisoning by this trace element is eliminated [19].

100 g of DSPA "Neoselen" contain $0.78 \pm 0,1 \times 10^{-3}\%$ elemental selenium (or $0.78 \pm 0,1$ mg/100 g DSPA "Neoselen"), which is in the supplement in combination with whey proteins. That is, 1g of DSPA "Neoselen" contains 7.8 mcg of organic selenium. Thus, by replacing 1%, 3% or 5% of the minced system to DSPA, it is possible to enrich it with 14.8, 30.4 and 46.0 mcg of selenium, respectively. The recommended dosage of mcg per kg of finished product is not more than 10 g [20].

Research Methods.

Organoleptic parameters were evaluated by the profile method using a 5-point scale to analyze the intensity of individual features (appearance, smell, color, taste, consistency – juiciness and density) and graphically depicted in the form of profilograms.

The total chemical composition was determined by standard methods according to DSTU 8030:2015. The determination of total nitrogen was performed by a method based on the oxidation of organic matter by burning it in sulfuric acid in the presence of a catalyst in a Kjeldahl flask, followed by the determination of the nitrogen content by titration according to DST ISO 5983–2003.

The results of determining the level of the main micro and macronutrients of paste from hydrobionts: iodine, copper, magnesium, sodium, phosphorus, zinc, iron were determined by the method of atomic absorption

spectrophotometry on the atomic absorption spectrophotometer "AAS-30" with the corresponding light filter ISO 90-1: 2004; potassium content was determined on a KFC-2 photoelectro calorimeter according to DSTU ISO 7485-2003.

The shear stress of the test specimens was determined with a S1 spindle using a Reotest-2 rotary viscometer (Russia) for 30 s, with a shear gradient of 100 s^{-1} . The determination temperature is 15°C . The effective viscosity was calculated by the formula (Oswald de Valais equation):

$$\eta_{\text{ef}} = \frac{\theta}{\gamma}, \quad (1)$$

where η_{ef} – is the effective viscosity, Pa s;

θ – is the shear stress Pa;

γ – is the shear rate, (s^{-1}).

The modulus of elasticity was determined using modified weights of Kargin-Sogolova by studying the compression strain of structured systems under the action of a teflon nozzle.

Instant elastic modulus is determined by the formula:

$$E_{\text{pr}} = \sigma/\varepsilon_0 \quad (2)$$

where E_{pr} – is the modulus of instant elasticity, Pa;

σ – voltage such as, Pa;

ε_0 – is the relative conditional momentary deformation.

The mass fraction of moisture was determined in the test samples of pastes, on the Chizhov device according to DSTU ISO 6496: 2005.

The moisture-holding capacity (MHC) of paste was determined by a gravimetric method based on the determination of the amount of water released from the product by light pressing, which is absorbed by filter paper. MHC were calculated by the formula:

$$\text{MHC} = 100 - (b - c) \times 100 / (a \times M) \times 100 \quad (3)$$

where MHC – moisture-holding capacity, %;

a – mass of sample, g;

b – is the mass of the filter paper after pressing and removing the sample, g;

c – is the mass of filter paper after pressing, removing and drying it, g;

M – mass fraction of moisture in the sample, %.

To determine the fat-holding capacity of pastes (FHC), 5 g of paste was quantitatively transferred to centrifuge tubes, where 30 cm³ of refined sunflower oil was added, stirred for 1 min at a stirrer speed of 1000 s^{-1} and kept at rest for 30 min. After holding, the tubes with the mixture were centrifuged for 25 min at 3200 s^{-1} , weighed, drained of the oil above the paste, the tubes were placed in an inclined position to remove excess fat, and kept for 10 minutes. Sediment tubes are weighed and calculated by the formula by the formula:

$$\text{FHC} = 100 - (b - c) \times 100 / (a \times b) \times 100 \quad (4)$$

where FHC – fat-holding capacity, %;

a – the weight of the tube with protein and bound oil, g;

b is the weight of the test tube with paste, g;

c – a sample of a paste, g.

The active acidity of the paste was determined by a potentiometric method on a pH-meter "pH-410". A portion of 1g paste was dissolved in 100 ml of distilled water and 0.1 g of a 0.1-n sodium thiosulfate solution was added.

Standard error and mean values were determined using multi-regression (descriptive statistics in MS office excel).

Results and Discussion

Organoleptic studies of the developed samples of pastes have been carried out. Investigated the taste, smell, color, consistency. Profiles of organoleptic evaluation of the paste are shown in fig. 2.

Fig. 2. Profiles of organoleptic evaluation of paste based on mussel of freshwater enriched DSPA «Neoselen»

The results of the tasting evaluation showed that the addition of 1% DSPA "Neoselen"– sample №1 has almost no effect on the organoleptic characteristics of pastes. Sample №3 with the addition of 5% DSPA "Neoselen" has a slight taste of selenium. The freshwater mussel present in the paste in combination with the flavoring organic substances of the other components causes the formation of original taste sensations. Summarizing the results of the tasting studies, it can be stated that the paste has a delicate and characteristic freshwater fish smell, taste, color and appearance.

The main requirement of the technology for the production of stuffing is the dispersed state of the components of the paste and the associated state of moisture and fat. Therefore, the content of moisture, high schools and high schools is one of the most important indicators in paste technology. These functional and technological indicators are presented in table №2.

Table 2 – Functional and technological properties of pastes**(n=5, P≥0,95)**

Sample	WHC, %	FHC, %	Moisture, %	Active acidity, pH
Control	70.6	72.0	70.9	6.2
Sample №1	72.3	72.2	72.1	6.3
Sample №2	73.9	72.7	72.9	6.3
Sample №3	75.4	72.9	72.7	6.2

The addition of DSPA "Neoselen" helps to stabilize the minced systems. Studies of model samples of pastes with different concentrations of DSSB "Neoselen" showed that the addition of 5% of it has a positive effect on the organoleptic and functional–technological properties of minced meat. This is evidenced by the highest rates of high schools and high schools in the sample №3.

Developed pastes based on freshwater mussel and DSPA "Neoselen" are a plastic–bonding system characterized by a plastic viscosity index and a modulus of elasticity. The consistency of the finished paste depends directly on the overall chemical composition and the degree of grinding. For each sample, the values of plastic viscosity were obtained and the modulus of elasticity given in table 1.

Table 3 – Values of structural – mechanical parameters of pastes**(n=5, P≥0.95)**

Indicator	Control	Sample's number		
		1	2	3
Plastic viscosity, Pa s	0.8	0.04	0.038	0.037
Modulus of elasticity, 10 ⁻³ , Pa s	0.2	0.2	0.19	0.17

Samples №1 and №2 have about the same plastic viscosity. Differences in the values of the modulus of elasticity of different samples of minced meat can be explained by the different contents of the DSPA "Neoselen". The viscosity ratio in all samples indicates the rate of destruction of the structure, the smallest value in sample # 3 indicates that the structure of the sample is less likely to be destroyed, and most of sample №1.

To study the nutritional value of pastes based on freshwater mussels and DSPA "Neoselen" their chemical composition was investigated. The chemical composition of pastes determines their nutritional and biological value. The study of the general chemical composition of the paste with DSPA "Neoselen" and control samples, which is presented in table. 4.

Table 4 – Chemical composition of pastes**(n = 5, P≥0.95)**

Indicators	Control	Sample's number		
		1	2	3
The mass fraction, %:				
water	79.9	78.6	79.1	79.5
minerals	2.3	2.5	3.1	3.4
row fat	1.1	1.15	1.15	1.15
total protein	11.3	11.4	11.7	11.8
crude fiber	0.1	0.2	0.2	0.2
nitrogen–free extractives	5.2	6.15	4.75	3.95

Studies have shown that in the composition of both the control and experimental samples of pastes in the amount of protein, minerals and water content. The content of protein and mineral substances increases with the increase of the content of DSPA "Neoselen" in the paste formulation.

Mineral substances occupy a special place in ensuring the proper functioning of the body, so it was expedient to determine their content in the composition of pastes based on freshwater mussels enriched with DSPA "Neoselen" (table 5).

Table 5 – The mineral composition of the paste**(n = 5, P≥0.95)**

Indicators	Control	Sample's number		
		1	2	3
Calcium, mg/100 g	110	190	190	185
Phosphorus, mg/100 g	240	350	346	335
Potassium, mg/100 g	290	260	256	249

Sodium, mg/100 g	155	130	134	122
Magnesium, mg/100 g	186	170	150	178
Copper, mcg/100 g	39	35	33	333
Manganese, mg/100 g	2.88	3.41	3.41	3.41
Zinc, mg/100 g	1.90	0.63	0.53	0.59
Iron, mg/100 g	2.3	3.15	3.67	3.55
Selenium, mcg/100 g	7	14.8	30.4	46.0
Iodine, mcg/100 g	57	55	59	67

The obtained data show that the control samples of pastes based on the freshwater enriched DSPA "Neoselen" contain all the basic macro- and microelements, such as calcium, phosphorus, potassium, sodium, magnesium, iron, and selenium. Selenium content in the control samples is 7 mcg/100 g, which almost 10% satisfies the daily requirement for its consumption for an adult. And in the test sample № 3 its content reaches 46.0 mcg/100 g, which is almost equal to 60% of the daily intake rate. The data obtained indicate that pastes based on freshwater mussel enriched with DSPA "Neoselen" can be considered as a product of high biological value.

Conclusions. Thus, experimental studies confirm the possibility of producing pastes based on freshwater mussel with the addition of DSPA "Neoselen" as a product that has a physiological effect. It is established that the optimum doses of use in the recipe of DSPA "Neoselen" paste from 3% to 5%.

Based on the organoleptic analysis, it is determined that the paste has a delicate and characteristic freshwater fish smell, taste, color and appearance. Addition of DSPA "Neoselen" even over 5% does not impair the organoleptic properties.

The addition of DSPA "Neoselen" helps to stabilize the minced systems. Studies of model samples of pastes with different concentrations of DSPA "Neoselen" showed that adding it in the amount of 3% to 5% best affects the functional and technological properties of minced meat. This is evidenced by an increase in the rates of universities and universities in the sample №1 and №3.

With the content of DSPA "Neoselen" in the paste formulation of 5%, the system has the best adhesive properties, characterized by an increase in the viscosity of the paste by increasing the concentration of solids.

The data obtained make it possible to substantiate the paste technology based on the freshwater mussel enriched DSPA "Neoselen" of physiological action.

Literature

1. Державний комітет статистики України. URL: <http://ukrstat.gov.ua>
2. Gardner J.P., Skibinski O.F., Bajdik C.D. Healthy food and viability differences between the national edulis and their hybrids from two sympatric populations in S.W. Biol. Bull. 1993. № 185. P. 405–416.
3. Міністерство охорони здоров'я України. URL: <http://mon.gov.ua>
4. João De Paula Cortez Netto, Paulo Roberto Campagnoli de Oliveira Filho, Judite Lapa-Guimarães, Elisabete Maria Macedo Viegas Physicochemical and sensory characteristics of snack made with minced Nile tilapia. Food Science and Technology. 2014. 34(3). P. 591–596. DOI 10.1590/1678-457x.6395
5. Mello S. C. R. P., Freitas M. Q., São Clemente S. C., Franco R. M., Nogueira E. B., Development and bacteriological, chemical and sensory characterization of fishburgers made of Tilapia minced meat and surimi. Arquivo Brasileiro de Medicina Veterinária e Zootecnia. 2012;64(5):1389–1397. DOI 10.1590/S0102-09352012000500041
6. Mukatova M.D., Kirichko N.A., Romanenkova E.N., Zotova N.Yu. Development of technology for washed minced fish production from low-profit objects of fishing in the Volga-Caspian Basin. Vestnik MGTU. 2016. 19(3). P. 625–632. DOI 10.21443/1560-9278-2016-3-625-632
7. Onibala H. Application of mixing index (IP) for the evaluation of gel-forming ability in myofibril-protein gels of fish pastes. Jurnal Teknologi dan Industri Pangan. 2010. 21(1). P. 87–90.
8. D.H. Kim Quality characteristics of fish paste prepared with Astragalus membranaceus powder. Food Engineering Progress. 2011. Vol. 15. P. 362–369.
9. Moraes K., Almeida L.A. Drying conditions of an enzymatic modified paste of anchovy in the lipid oxidation, available lisina and antioxidant activity of the product. Ciência Rural. 2013. 43(3). P. 530–536.
10. Golovko N., Golovko T., Gelikh A. Investigation amino-acid structure of proteins bivalve freshwater Mussels from the family Anodonta of the northern Ukraine. Eastern-European Journal of Enterprise Technologies. 2015. № 5/11 (77). P. 10–16.
11. Golovko N., Golovko T., Gelikh A. Investigation fatty acid and mineral of soft body bivalve freshwater mussels from the family Anodonta of the northern Ukraine. Technological Audit and Production Reserves. 2016. № 3/3 (29). P. 17–23.
12. Golovko N., Golovko T., Gelikh A. Research qualitative composition of minerals soft body freshwater bivalve mussels of the genus Anodonta and marine counterpart – the mussels of the genus Mytilus. Progressive engineering and technology of food production enterprises, catering business and trade. 2015. № 2 (22). P. 270–278.
13. Verhagen H., Kaste D., Heidi P. Assessment of health claims, content, and safety of herbal supplements containing Selenium. Food & Nutrition Research. 2010. 54(0). P. 1–33. DOI 10.3402/fnr.v54i0.5221

14. Delange F. Selenium deficiency in Europe and its consequences: an update. *European Journal of Nuclear Medicine and Molecular Imaging*. 2002. Vol. 29, № S2. P. 404–416. doi:10.1007/s00259-002-0812-7
15. Спосіб отримання напівфабрикату з молюска прісноводного: пат. на корисну модель №123318, Україна, МПК А23L 3/00, А23L 17/50 / Головка М. П., Головка Т. М., Геліх А. О., Крикуненко Л. О.; заявник та патентовласник Харк. держ. ун-т. харч. та торг. № u201708203; заявл. 07.08.2017; опубл. 26.02.2018, Бюл. № 4. 5 с.
16. Спосіб одержання біологічно активної добавки «Неоселен»: пат. на корисну модель 104883 Україна: МПК А 23 J 1/20, А 61 К 31/095 / Черевко О. І., Головка М. П., Применко В. Г., Головка Т. М.; власник ХДУХТ. № u201507794; заявл. 05.08.2015; опубл. 25.02.2016, Бюл. №4.
17. Головка М.П., Применко В.Г., Головка Т.М. Дослідження конкурентопридатності соусів емульсійного типу, збагачених на селен. *Східно-Європейський журнал передових технологій*. 2015. № 5/11 (77). С. 42–48.
18. Wang Y., Shu X., Hou J. Efficacious Pathway for Selenite Biotransformation and Detoxification Selenium. *International Journal of Molecular Sciences*. 2018. Vol. 19(12). P. 38–49.
19. Faganeli J., Falnoga I., Horvat M. Selenium and Mercury Interactions in Apex Predators from the Gulf of Trieste (Northern Adriatic Sea). 2018. Vol. 10(3). P. 278.
20. Chu D., Pak S.W., Kim E.K. Thin Film Transistors with a Broadband Photoresponse Se. *Scientific Reports*. 2018. Vol. 8(1). P. 1–8.

References:

1. Derzhavnyj komitet statystryky Ukrai'ny. Available from: <http://ukrstat.gov.ua>
2. Gardner J P, Skibinski O F, Bajdik CD. Helthy food and viability differences between the national edulis and their hybrids from two sympatric populations in S.W. *Biol. Bull.* 1993;185:405–416.
3. Ministerstvo ohorony zdorov'ja Ukrai'ny. Available from: <http://mon.gov.ua>
4. João De Paula Cortez Netto, Paulo Roberto Campagnoli de Oliveira Filho, Judite Lapa-Guimarães, Elisabete Maria Macedo Viegas Physicochemical and sensory characteristics of snack made with minced Nile tilapia. *Food Science and Technology*. 2014;34(3):591–596.
5. Mello S C R P, Freitas M Q, São Clemente S C, Franco R M, Nogueira E B. Development and bacteriological, chemical and sensory characterization of fishburgers made of Tilapia minced meat and surimi. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*. 2012;64(5):1389–1397.
6. Mukatova MD., Kirichko NA., Romanenkova EN., Zotova NYu. Development of technology for washed minced fish production from low-profit objects of fishing in the Volga-Caspian Basin. *Vestnik MGTU*. 2016;19(3):625–632.
7. Onibala H. Application of mixing index (IP) for the evaluation of gel-forming ability in myofibril-protein gels of fish pastes. *Jurnal Teknologi dan Industri Pangan*. 2010;21(1):87–90.
8. Kim DH. Quality characteristics of fish paste prepared with *Astragalus membranaceus* powder. *Food Engineering Progress*. 2011;15:362–369.
9. Moraes K, Almeida LA. Drying conditions of an enzymatic modified paste of anchovy in the lipid oxidation, available lisina and antioxidant activity of the product. *Ciência Rural*. 2013;43(3):530–536.
10. N. Golovko, T. Golovko, A. Gelikh Investigation amino-acid structure of proteins bivalve freshwater Mussels from the family Anodonta of the northern Ukraine. *Eastern-European Journal of Enterprise Technologies*. 2015;5/11(77):10–16.
11. Golovko N, Golovko T, Gelikh A. Investigation fatty acid and mineral of soft body bivalve freshwater mussels from the family Anodonta of the northern Ukraine. *Technological Audit and Production Reserves*. 2016;3/3(29):17–23.
12. Golovko N, Golovko T, Gelikh A. Research qualitative composition of minerals soft body freshwater bivalve mussels of the genus Anodonta and marine counterpart – the mussels of the genus *Mytilus*. *Progressive engineering and technology of food production enterprises, catering business and trade*. 2015;2(22):270–278.
13. Verhagen H, Kaste D, Heidi P. Assessment of health claims, content, and safety of herbal supplements containing Selenium. *Food & Nutrition Research*. 2010;54(0):1–33.
14. Delange F. Selenium deficiency in Europe and its consequences: an update. *European Journal of Nuclear Medicine and Molecular Imaging*. 2002;29(S2):404–416.
15. Golovko M P., Prymenko V G., Golovko T M. Doslidzhennja konkurentoprydatnosti sousiv emul'sijnogo typu, zbagachenyh na selen. *Shidno-Jevropejs'kyj zhurnal peredovyh tehnologij*. 2015;5/11(77):42–48.
16. Wang Y, Shu X, Hou J. Efficacious Pathway for Selenite Biotransformation and Detoxification Selenium. *International Journal of Molecular Sciences*. 2018. Vol. 19(12). P. 38–49.
17. Faganeli J, Falnoga I, Horvat M. Selenium and Mercury Interactions in Apex Predators from the Gulf of Trieste (Northern Adriatic Sea). 2018. Vol. 10(3). P. 278.
18. Chu D, Pak S W., Kim E K. Thin Film Transistors with a Broadband Photoresponse Se. *Scientific Reports*. 2018. Vol. 8(1). P. 1–8.
19. Golovko N , Golovko T , Gelikh A. Research qualitative composition of softwater freshwater minerals bivalve mussels of the genus Anodonta and marine counterpart – the mussels of the genus *Mytilus*.

Progressive engineering and technology of food production enterprises, catering business and trade. 2015 ; 2 (22) : 270–278.

13 . Verhagen H , Kaste D , Heidi P. Assessment of health claims, content, and safety of herbal supplements containing Selenium . *Food & Nutrition Research* . 2010; 54 (0) : 1–33 .

14. Delange F. Selenium deficiency in Europe and its consequences: an update. *European Journal of Nuclear Medicine and Molecular Imaging*. 2002; 29 (S2): 404–416.

[PMC free article] [PubMed] 17. Golovko M P., Prymenko V G., Golovko T M. The investigation of competitiveness of sousiv emul'sijnogo typu, collected in selenium. *Shidno–Yevropejs'kyj zhurnal per edovykh tekhnologii*. 2015; 5/11 (77): 42–48.

18. Wang Y , Shu X , Hou J. Efficacious Pathway for Selenite Biotransformation and Detoxification of Selenium. *International Journal of Molecular Sciences*. 2018. Vol. 19 (12). P. 38–49.

19. Faganeli J, Falnoga I, Horvat M . Selenium and Mercury Interactions in Apex Predators from the Gulf of Trieste (Northern Adriatic Sea). 2018. Vol. 10 (3). P. 278.

20. Chu D, Pak S W., Kim E K. Thin Film Transistors with a Broadband Photoresponse Se. *Scientific Reports* . 2018. Vol . 8 (1). P . 1–8.

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