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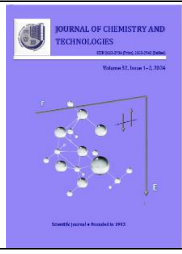

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DEVELOPMENT OF MEAT-CONTAINING SEMI-FINISHED PRODUCTS WITH PIKE MEAT AND HEMP SEED PROTEIN

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Abstract

Aim. The aim of the work was to substantiate the use of regional, non-traditional types of raw materials, such as hemp seed protein from (Cannabis Sativa L.) and pike meat (Esox lucius) in the technology of meat-containing semi-finished products. Methods. Three experimental samples of meat-containing semi-finished products based on the analog were developed, in which mechanically deboned turkey meat was replaced by pike meat, and hemp seed flour was replaced by hemp seed protein hydrated in a ratio of 1 : 1 with water in the amount of 8, 10 and 12 %. Results. Studies of functional and technological indicators showed that hydrated protein from hemp seeds in a ratio of 1 : 1 had the best parameters for introduction into minced meat systems. The water binding capacity of pike meat is 76.41–86.31 %, the stress shear is 4.59–6.27 Pa, the plasticity is 25.31–26.17 cm²/g×10³, which confirms the high functional properties of pike muscle tissue. The introduction of 8–12 % hemp seed protein and 30.5 % of pike into the composition of minced meat-containing semi-finished products increases the water binding capacity of the experimental minced meat up to 97.7 %. The use of hemp seed protein and pike in the recipe of semi-finished products leads to an increase of water binding capacity by 7.45–9.22 %, emulsifying capacity by 8.72–18.21 %, emulsion stability up to 7.65 %, fat holding capacity by 4.18–19.57 %. Use of pike meat and hemp seed protein leads to an increase of protein in finished products by 3.43–12.5 %, a decrease in fat content by 21.01–25.10 % and an energy value of the product by 12.74 %. Conclusions. The use of hydrated hemp seeds protein and pike meat in the technology of patties ensures a high level of functional and technological indicators of minced meat and finished products.

Keywords: hemp seed protein; pike meat; meat-containing semi-finished products; functional technological indicators; nutritional value.

РОЗРОБКА М’ЯСОМІСТКИХ НАПІВФАБРИКАТІВ З М’ЯСОМ ЩУКИ І ПРОТЕЇНОМ НАСІННЯ КОНОПЛІ

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Анотація

Метою роботи було обґрунтування використання регіональних, нетрадиційних видів сировини, таких як м’ясо щуки (*Esox lucius*) та протеїн з насіння коноплі (*Cannabis Sativa L.*) в технології виробництва м’ясомістких посічених напівфабрикатів для підвищення харчової цінності та покращення функціонально-технологічних показників виробів. У дослідних зразках м’ясомістких напівфабрикатів на основі аналогу, в яких замінювали індиче м’ясо механічної обвалки на м’ясо щуки, а борошно з насіння коноплі – на протеїн з насіння коноплі гідратований у співвідношенні з водою 1 : 1 у кількості 8, 10 і 12 %. Дослідження показали, що гідратований протеїн з насіння коноплі у співвідношенні 1 : 1 мав найкращі параметри для введення у фаршеві системи. Показано, що вологозв’язуюча здатність м’яса щуки становить 76.41–86.31 %, граничне напруження зсуву 4.59–6.27 Па, пластичність 25.31–26.17 см²/г×10³, що підтверджує високі функціонально-технологічні властивості м'язової тканини щуки і робить її придатною для виробництва фаршевої продукції. Встановлено, що введення до складу фаршу м’ясомістких напівфабрикатів гідратованого протеїну з насіння коноплі у кількості 8–12 % і м’яса щуки у кількості 30.5 % підвищує водозв’язувальну здатність фаршу дослідних зразків до загальної вологи до 97.7 %. Доведено, що використання протеїну з насіння коноплі у рецептурі напівфабрикатів приводить до підвищення вологоутримуючої здатності на 7.45–9.22 %, емульгуючої здатності на 8.72–18.21 %, стабільності емульсії до 7.65 %, жироутримуючої здатності на 4.18–19.57 %. Використання м’яса свинини, гідробіонтів та протеїну з насіння коноплі у рецептурах м'ясомістких посічених напівфабрикатів дозволяє збільшити вихід готової продукції на 20.36–24.33 % порівняно з контролем, отримати готові котлети з високими органолептичними показниками. Проведені мікробіологічні дослідження розроблених напівфабрикатів та аналога підтверджують мікробіологічну безпечність виготовлених виробів. Запропоновані нововведення зумовлюють підвищення масової частки протеїну у готових виробах на 3.43–12.5 %, зниження вмісту жиру на 21.01–25.10 % і калорійності продукту на 12.74 %.

Ключові слова: протеїн з насіння коноплі; м’ясо щуки; м’ясо-місткі напівфабрикати; функціонально-технологічні показники; харчова цінність.

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Introduction

Numerous demographic, socio-economic, cultural, and political factors influence the development of new food production. The listed factors and the environment greatly influence consumer lifestyles and eating patterns and shape consumer attitudes toward purchasing healthy, environmentally friendly and socially conscious plant-based food [1]. In this context, and to adapt formulations and technologies to the needs of consumers, food scientists must monitor the main and new trends shaping the food industry. Understanding current issues and changing consumer preferences and expectations is vital when developing new products.

Due to the growing demand for a healthy lifestyle and appropriate nutrition, the problem of providing the population with high-quality food products that have a positive effect on the functioning of organs and systems of the human body remains unsolved today. In the production of modern food, including meat and/or meat-containing ones, it is first of all important to reduce the content of saturated fat (replacement with functional ballast substances), and/or to replace saturated fats with mono- and polyunsaturated omega-3 fatty acids [2; 3].

The most expedient when developing new recipes for meat products is the use of components that have a low cost, quick recovery of the resource and meet the national stereotypes of the Ukrainian consumer's diet. [4]. This can contribute to reducing the number of high-calorie products, replenishing the line of dietary products, as well as expanding the range of high-biological value products rich in essential amino acids, polyunsaturated fatty acids, and vitamins.

A promising direction in the production of new types of meat products is the combination of raw materials of different origins, which allows to obtain food products enriched with natural nutrients [5; 6]. Moreover, such a technological approach contributes to the rational use of raw materials and allows to expand the range of products.

The increase in the production of meat products is inextricably linked to the problem of rational use of raw materials [7]. The use of non-traditional raw materials not only helps to solve the problem but also compensates for the lack of biologically active substances, and increases the functional properties, biological and nutritional value of ready-made food products. The rational use of resources and the composition and properties of products are influenced by the combination of the main meat raw material with protein products of plant and animal origin and aquaculture products [8–10].

Conceptual approaches to the creation of combined products are based on solving the problem of preserving and maintaining human health. The production of combined meat products based on meat and protein preparations obtained from various raw material sources involves the mutual enrichment of their composition, the combination of functional and technological properties, the increase of biological value, the improvement of the organoleptic indicators of the finished product, and the reduction of its cost price.

Today, it is not a matter of replacing animal proteins with vegetable proteins, but of enriching existing recipes with high-quality, ecologically clean plant raw materials, therefore, the search for new sources of food protein in the current situation is an urgent problem that needs to be solved.

An important reserve in solving this issue can be non-traditional high-protein plants, which in some regions of Ukraine, particularly in Sumy, have a high sustainable yield. Technical hemp *(Cannabis Sativa L.)* meets these requirements by having high productivity, as well as significant advantages compared to leguminous and cereal plants. A wide range of properties of this culture determines great prospects for its use in meat products [11; 12]. The development of their production technology is relevant and necessary, as it allows for obtaining environmentally friendly products of increased biological value, balanced amino acid, and fatty acid composition, enriched with vegetable protein and dietary fibers.

On the other hand, hydrobionts can also become the basis for the creation of multicomponent food products, primarily, freshwater aquaculture, which includes pond fish. The use of fish raw materials in the technology of combined food products allows you to enrich them with biologically active components balanced in terms of amino acid composition and to give them functional properties [13; 14].

The pike *(Esox lucius)* – a species of fish of the *Esocidae* family – is a poorly researched object of freshwater aquaculture as a possible component of the formulation of combined food products. The lack of carbohydrates, high protein content, and low energy value make this fish indispensable in dietary and health nutrition [15]. The beneficial properties of the pike are determined by the chemical composition of the fish, which is charac-

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terized by a high content of essential substances for the human body [16]. Vitamins A, B, folic acid, and choline, as well as magnesium, phosphorus, sodium, selenium, and manganese, are contained in high concentrations in pike muscle tissue. Nutritionists recommend including pike meat in low-calorie or protein diets. Regular consumption of pike meat or products with it helps to reduce the risk of developing cardiac arrhythmia [17]. Pike is very useful for people who have problems with the gastrointestinal tract, obesity, and hypovitaminosis.

The regular presence of pike dishes in the menu can increase the tone of the nervous system, as well as reduce the risk of type 2 diabetes [18]. Due to the high content of polyunsaturated fatty acids in pike fat, it can help reduce the level of cholesterol in the blood, has a preventive effect on the development of cardiovascular diseases [19].

Due to its low energy value, pike meat is a dietary product. This fact should be taken into account when developing an optimal diet for people with health restrictions. Furthermore, pike meat is rich in powerful natural antiseptics, which not only strengthen immunity but also help to resist bacterial infections. Because of this, the use of pike meat is recommended for the prevention of influenza. The calorie content of the pike is only 84 Kcal per 100 grams of product [20].

Taking into account some peculiarities of the morphological and chemical composition of fish, as well as certain technological properties of raw materials, there is a need for a detailed study of these factors and their implementation in the technology of food production. Therefore, from a scientific and practical point of view, the development of food products, the biological value of which would not be lower than the "ideal" protein under the condition of using non-traditional protein substitutes for meat raw materials, is relevant. To obtain the maximum result, a thorough study of their influence on the course of the technological process of manufacturing products is necessary, as well as determining the nutritional and biological value of finished products and establishing rational methods of combining raw materials.

The purpose of the study was to develop meat-containing semi-finished products with regional, non-traditional types of raw materials, such as «Hemp seed protein» (*Cannabis Sativa L.*) and pike meat (*Esox Lucius*). To achieve the goal, the following tasks were set:

- study of functional and technological indicators of selected ingredients: «Hemp seed protein» *(Cannabis Sativa L.)* and pike meat *(Esox lucius)*;
- research of functional and technological indicators of model meat-containing systems;
- determination of the impact of the use of non-traditional regional ingredients on the sensory parameters and safety of the developed meat-containing semi-finished products;
- research on the content of main nutrients and energy value of new product samples.

Materials and methods

Experimental design

Semi-fatty pork with a fat content of 30...50% according to DSTU 7158:2010 was used for experimental research; protein from hemp seeds according to TU U 10.4-39224310-002:2019; minced meat from pike, according to DSTU 7972:2015; fresh onion, according to DSTU 3234-95; ground black pepper, according to DSTU ISO 959-1:2008; table salt, according to DSTU 3583:2015; breadcrumbs by DSTU 8708:2017; chicken eggs according to DSTU 5028:2008; drinking water, according to DSTU 7525:2014. In the process of conducting the research, the recipe [21] served as control.

The ratio of the components of the control formulation and model samples is given in table 1.

Table 1

Recipes of control and experimental samples of meat-containing semi-finished products, %

Ingredients	Recipe samples of meat-containing patties			
	Control	Sample 1	Sample 2	Sample 3
Pork	30.5	36.5	34.5	32.5
Mechanically deboned turkey	30.5	-	-	-
Pike meat	-	30.5	30.5	30.5
Hemp seed flour	12.0	-	-	-
Hemp seed protein	-	8.0	10.0	12.0
Breadcrumbs	4.0	4.0	4.0	4.0
Onion	1.5	1.5	1.5	1.5
Ground pepper	0.06	0.06	0.06	0.06
Chicken eggs or mélange	2.0	2.0	2.0	2.0
Salt	1,2	1.2	1.2	1.2
Water	18.2	18.2	18.2	182
Total	100	100	100	100

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Preparation of meat-containing patties

The technological process of cutlets production consists of the preparation of raw materials, the preparation of minced meat and fish, the formation of semi-finished products, packaging, labeling, and storage. Fig. 1 shows a technological scheme for the production of chopped meat-containing semi-finished products.

After deboning and veining, the pork meat was chopped in a grinder with a 2–3 mm grate diameter. Then, peeled and washed onions were crushed in a grinder with a hole diameter of 3–5 mm.

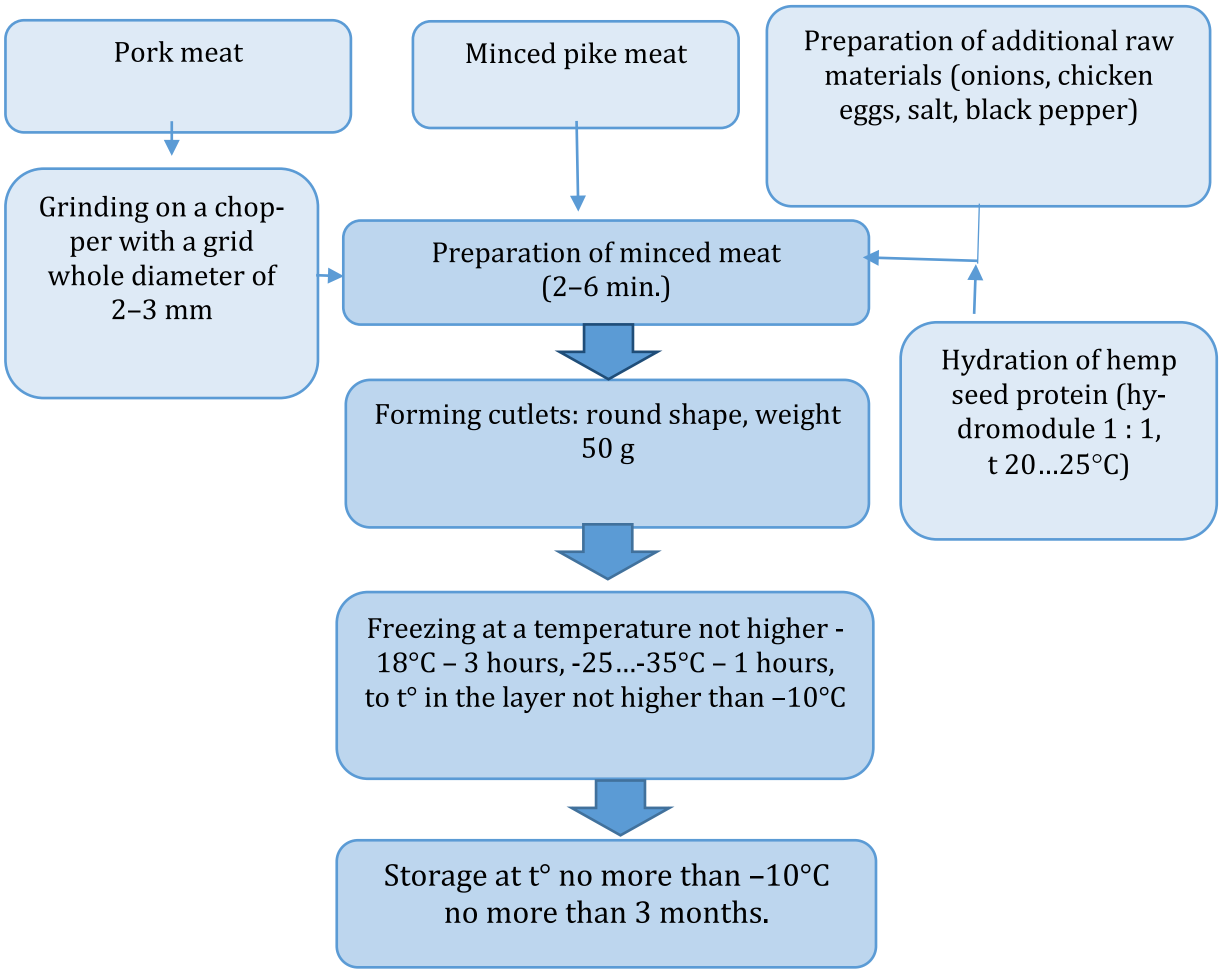

Fig. 1. Technological scheme for the production of semi-finished products

Pork was combined with chopped fresh onions, after which the pike minced meat, pre-hydrated hemp seed protein, table salt, chicken eggs, and ground black pepper were added and thoroughly mixed until the components were evenly distributed. Products were formed from the finished minced meat and fish, breaded in breadcrumbs, then packed, frozen and stored for 3 months at no more than –10°C.

Taking into account the specifics of hydrobiont processing, fish raw materials were processed in a separate room according to the following technological scheme (Fig.2.), which included the following operations: defrosting, soaking, cleaning, grinding, cutting off heads, fins, tails; washing; preparation of minced meat.

The cooled fish was washed with clean fresh water to remove mucus and surface contamination. The washed fish was immediately cut into carcasses, the head was separated the entrails removed, and the black film was removed and cut into fillets.

The processed fish was washed with water to remove the remains of blood and films, and after draining the water (within 5 minutes) it was sent to the Neopres SM-150. Minced fish, prepared per the technological instructions, was sent to prepare minced semi-finished products.

To ensure the appropriate quality and water-holding capacity of minced fish, the temperature was maintained at no higher than 10–12 °C during all technological operations of its preparation.

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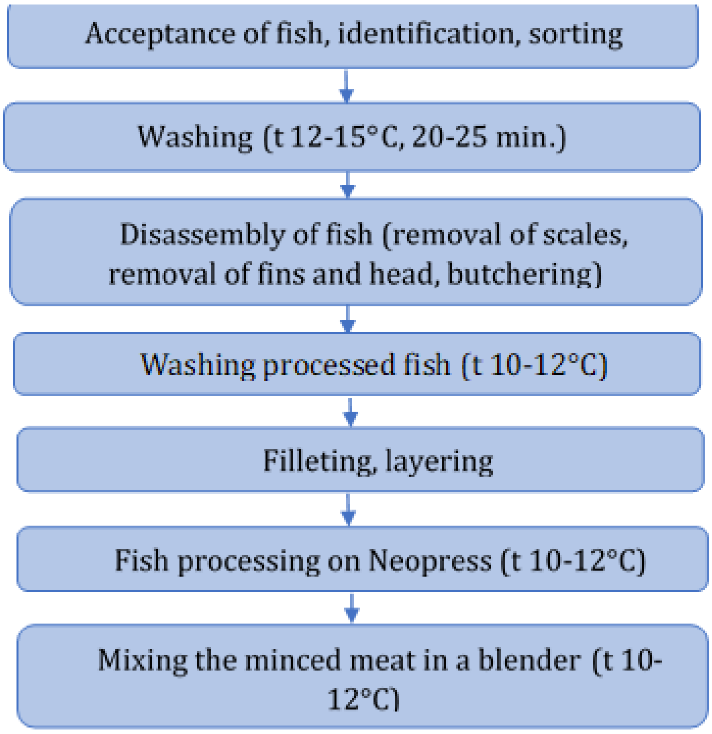

Fig. 2. Technological scheme of preparation of minced fish

Determination of critical coefficients

Critical coefficients were determined by the method [19]. Coefficient of protein watering (C_w) was calculated as ratio between moisture content and total protein; protein-water factor (PWF) as ratio between total protein and moisture content; lipid-protein coefficient (LPC) - as ratio between fat content and protein content; food saturation factor (FSF) as total protein, total fat and moisture content.

The coefficient of chemical composition (CCC) was calculated according formula:

$$CCC = [F/M] \times P,$$

where F – total fat, %, M – moisture content, %, P – total protein, %.

Determination of nutritional value

To determine the nutritional value of meat-containing semi-finished products, the moisture content was determined by the gravimetric method [22], the protein content by the Kjeldahl method [23], the fat content by the Soxhlet method [24], and the mass fraction of mineral substances [22]. The energy value was calculated according to the method [25].

Determination of cooking yield

Percentage of cooking yield was determined by calculating the weight differences of the samples before and after cooking. The cooked samples were cooled down to room temperature for 30 min and were reweighed to calculate the cooking yield.

Determination of functional and technological parameters

WBC (water-binding capacity) of minced meat was determined by the pressing method [26]. WBC_a – the ability of minced meat to bind moisture in relation to the total moisture of the sample; WBC_m – the ability of minced meat to bind moisture in relation to the mass of the sample. WHC (water-holding capacity) was determined as the difference between the mass fraction of moisture in the minced meat and the amount of moisture released during heat treatment. The pH value was determined using a digital pH-meter pH-150MI according to the method [20]. The fat-holding capacity was determined after drying the sample by mass and grinding in a porcelain mortar with sand and α-monobromonaphthalene. In the filtered solution, the refractive index was measured, which was used to calculate the FHC [20]. The emulsifying capacity was determined as the ratio of the volume of emulsified oil to the total volume of oil, obtained after suspending a weight of minced meat in oil and subsequent centrifugation for 10 min. The stability of the emulsion was determined by heating the emulsified minced meat at a temperature of 80°C, cooling by centrifugation at a rotation frequency of 500s-1 for 5 min. Emulsion stability was calculated as the ratio of the volume of emulsified oil to the total volume of the emulsion [26].

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The plasticity was determined by the area of the spot of minced meat formed under the action of a static load of 1 kg for 10 minutes according to the method [27]. The rheological parameters of the meat-containing systems were determined using a rotary viscometer. The RV-8m viscometer was used with a corrugated rotor (corrugation step 2 mm) with an inner cylinder (Rc) of 0.605 cm, the outer radius of the rotor Rn – 1.9 cm, the length of the rotor was equal to 8 cm on a scale using a stopwatch. Processing of the obtained results was carried out according to the methodology [27]. Losses during cooking were calculated from the difference in weight before and after cooking, and the moisture content was determined by drying the samples [27].

Microbiological safety assessment

When assessing the microbiological safety of chopped semi-finished products, test plates certified by international organizations (AOAC, AFNOR, NordVal) with a nutrient medium on a substrate (petri films) were used [28]. 3M Petrifilm Aerobic Count plates for determination of KMAFAnM, 3M Petrifilm Coliform Count Plate - for determination of total coliforms capable of growing at temperatures of 30–37 °C, 3M Petrifilm Series 2000 Rapid Coliform Count Plate – for determination of coliform bacteria. Microbiological indicators are determined after 3 months of storage of frozen products.

Organoleptic evaluation

The organoleptic evaluation of semi-finished products was carried out on a five-point scale with the participation of 10 tasters [29]. Such indicators as appearance, consistency, taste, juiciness, smell, color were evaluated.

Statistical analysis

The absolute measurement error was determined according to the Student's test, the confidence interval was P ≤ 0.95, the number of repetitions in the calculations was 3–4, and the number of parallel tests of the studied samples was 3.

Result and discussions

The choice of «Hemp seed protein» as a component of plant raw materials in the formulation of semi-finished products is due to its high nutritional value, fatty acid and amino acid composition, and the presence of many minerals [30–32]. A necessary condition for the effective use of a functional ingredient is knowledge of its functional and technological properties. Therefore, at the first stage of our research, experiments were conducted to establish the functional and technological properties of «Hemp seed protein» at different ratios of the product and the water used for hydration.

«Hemp seed protein» (TU U 10.4-39224310-002:2019, LTD "Desnaland", Ukraine) was chosen for the experiments. or experiments, samples were taken in a hydrated form in a ratio of 1 : 1, 1 : 2, and 1 : 3, t 20...25 °C. «Hemp seed protein» had a yellow-green color, the smell and taste were pure and impersonal, without extraneous odors and flavors, metallomagnetic contaminants and pest infestation, which met the requirements of the Technical Regalements.

Functional and technological indicators of «Hemp seed protein» of different degrees of hydration are presented in the table 2.

Table 2

Functional and technological indicators of «Hemp seed protein» of different degrees of hydration (n=3, h≤0.95)

Index	Hydromodule		
	1 : 1	1 : 2	1 : 3
WBC_a	79.63±1.58	67.81±0.76	43.16±1.37
WBC_m	69.27±0.54	61.13±1.13	49.65±0.97
EC	38.16±2.07	35.27±1.33	30.21±1.56
pH	7.01±0.03	7.01±0.03	7.00±0.01

The obtained results indicate high functional and technological indicators of «Hemp seed protein» due to the high concentration of protein substances (more than 50 % according to the manufacturer) and the presence of complex carbohydrates with an increased ability to adsorb and retain moisture. However, with an increase in hydration (up to 1 : 3), the samples lose their technological characteristics. Thus, WBC_a ranged from 79.63 ± 1.58 % in the sample with a hydromodule of 1 : 1 to 43.16 ± 1.37 % in the sample with a hydromodule of 1:3. A similar trend was noted in relation to WBC_m and emulsifying capacity (EC). With an increase in the amount of water taken for hydration, the functional and technological indicators of «Hemp seed protein» worsened. This requires finding ways to increase the technological and rheological indicators of hydrated protein. In general, the hydrated «Hemp seed protein» in a ratio of 1:1 had high enough parameters for introduction into minced meat systems.

It was established that the pH of «Hemp seed protein» at different degrees of hydration is close to neutral (pH = 7), so it has no negative effect on

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the functional and technological indicators of finished products.

The possibility of using fish in the recipe of chopped semi-finished products is largely determined not only by the yield of edible parts and chemical composition but primarily by the structural and mechanical properties of muscle tissue. To evaluate the functional and technological properties of minced fish and rheological indicators, it is customary to determine the coefficients of structure formation and critical coefficients (table 3).

Table 3

Functional and rheological indicators of minced meat from pike muscle tissue depending on the fishing season (n=3, h ≤ 0.95)

Index	Fishing season			
	Spring	Summer	Autumn	Winter
WBC_m, %	76.41±1.38	86.31±0.99	85.79±0.37	80.63±1.48
WBC_a, %	76.61±0.96	78.81±1.16	77.18±1.26	76.12±1.27
Shear stress, Pa	4.59±0.12	6.27±0.11	6.31±0.20	5.11±0.13
Plasticity, $sm^2/g\times10^3$	25.31±0.85	26.17±0.68	25.73±1.01	25.73±1.14
C_w	2.51	2.56	2.61	2.33
PWF	0.46	0.56	0.52	0.42
LPC	4.22	4.33	4.37	4.31
CCC	0.08	0.09	0.31	0.08

From the data presented in Table 3, it can be seen that the degree of protein hydration of pike muscle tissue is dependent on the season. An increase in this indicator is observed in fish caught in the summer and autumn seasons, which affected the better structural properties of minced fish.

Also, the connection of WBC_m and WBC_a with the coefficients C_w, PWF, LPC was established, namely, the higher the specified coefficients, the higher the indicators of the moisture-binding capacity of minced fish. Based on the obtained data, it can be concluded that according to functional and rheological indicators, pike muscle tissue is suitable for the production of minced meat products, which can be used in the production of combined semi-finished products.

Experimental data of functional and technological indicators of the model minced meat-containing systems of the developed semi-finished products are presented in the figures 3 and 4.

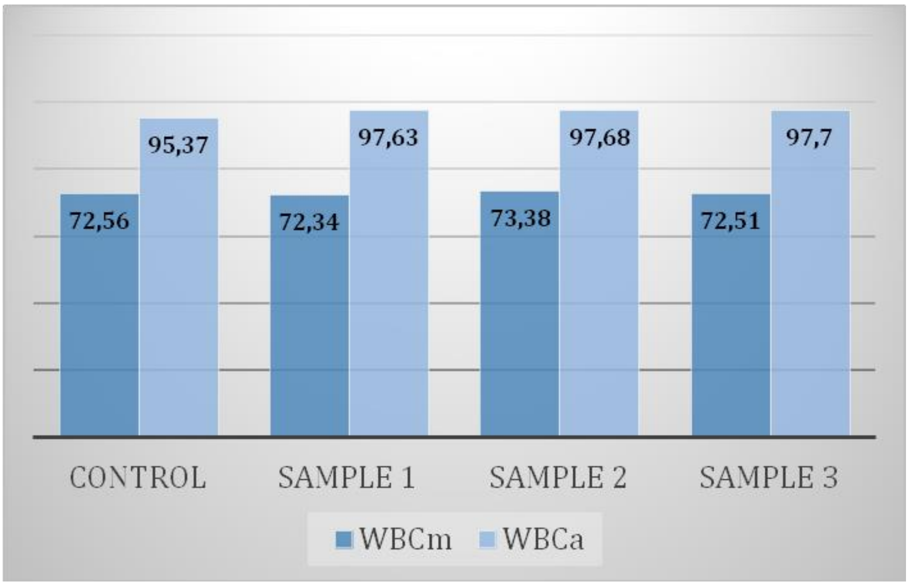

Fig. 3. Dependence of WHC of model minced meat-containing system on formulation

The WBC_m indicator was in the range of 72.56–73.38 % and was practically the same in all samples. WBC_a was the largest in the test sample of minced meat made according to recipe 3 and was 97.70 ± 0.04 %, which is 2.09 % higher compared to the control. In general, replacing the muscle tissue of warm-blooded animals with vegetable protein and fish protein did not impair the water-binding properties of the model minced meat.

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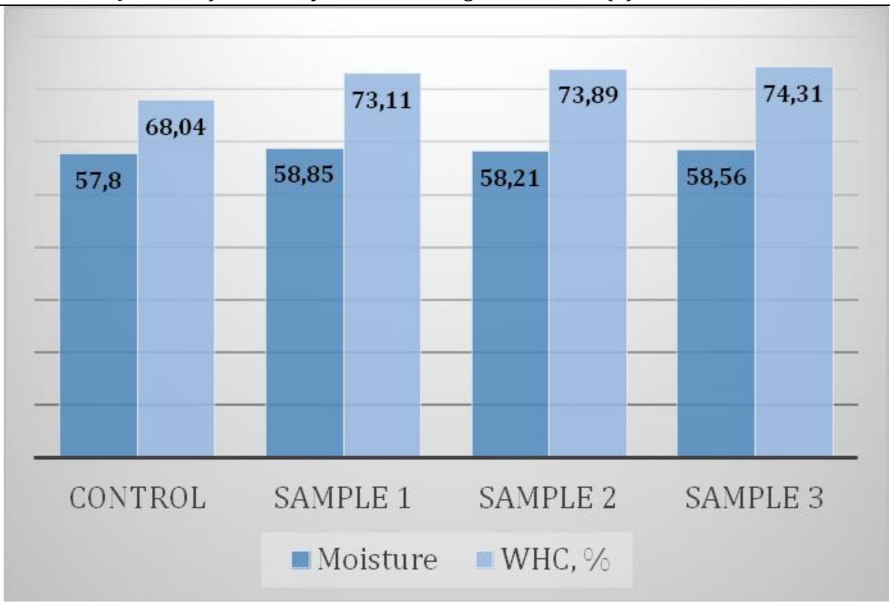

Fig. 4. Moisture content and water-holding capacity of experimental samples

An increase in the water-holding capacity of the model minced meat-containing systems made according to experimental recipes was noted. Thus, the higher concentration in experimental samples of mincemeat was 73.11–74.31 %, which is 7.45–9.22 % higher than in mincemeat of the control recipe. The tendency to increase WBC and WHC in experimental samples can be explained by the introduction of «Hemp seed protein» into the meat-containing system, which leads to an increase in the mass fraction of high-molecular substances capable of swelling, binding, and retaining moisture [33; 34].

To study the ability of the developed model minced meat-containing systems to bind and retain fat, indicators of emulsifying capacity and emulsion stability were investigated. The results of studies of these indicators are shown in the figures 3.4 and 3.5.

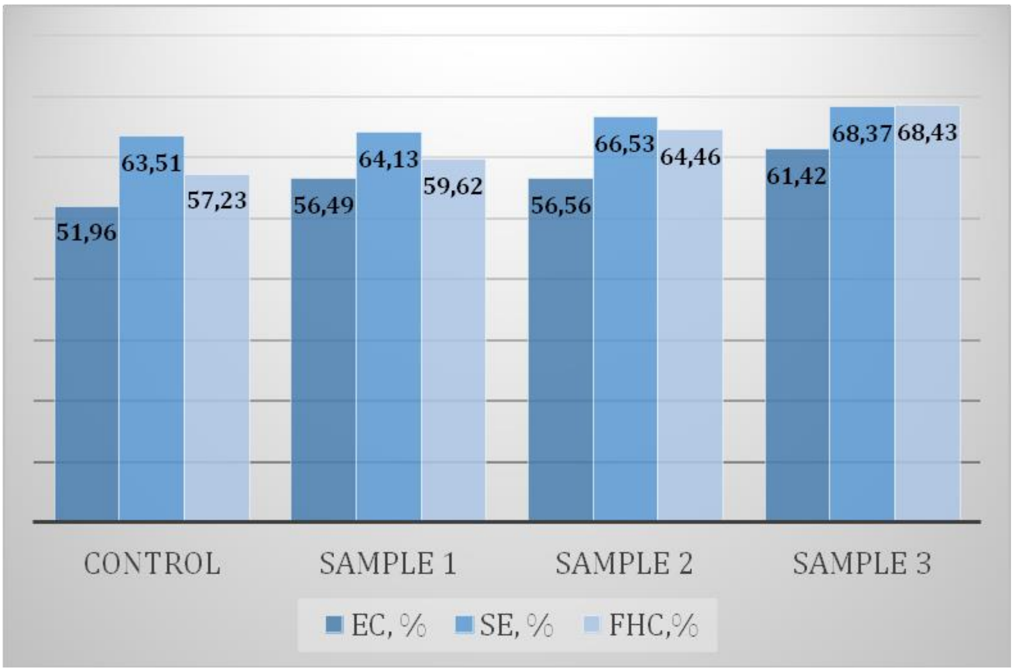

Fig. 5. Emulsifying properties of meat-containing model systems

With an increase in the proportion of vegetable raw materials in the recipe, there is an increase in the fat-holding capacity (FHC) of minced meat-containing system up to 68.43 %, while this indicator in the experimental samples is higher than the control by 4.18–19.57 %. This is due to the rational ratio of the content of proteins, fats, and dietary fibers in the developed

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recipes. It was established that the ability of the minced meat-containing system to retain fat in its structure differs depending on the composition of the product. The EC of the experimental minced meat-containing system varied from 56.49 ± 1.26 to 61.42 ± 1.49 %, which is 8.72–18.21 % higher compared to the control. The presence of biopolymers in the «Hemp seed protein» [35], which can form hydrate shells on the surface of fat capsules, leads to the retention of the lipid fraction of meat raw materials in an emulsion state. On the other hand, freshwater fish meat proteins also have a high water-binding capacity and can participate in the formation of fat phase shells, enhancing dispersion and stabilizing the fat emulsion [36]. An increase in the emulsifying capacity of minced meat-containing system led to an improvement in the ability to bind fat and retain it after heat treatment. Thus, the emulsion stability in the test samples of minced meat-containing systems was 64.13–68.37 %, which is 0.98–7.65 % compared to the control. The increase in ES occurred in proportion to the increase in the concentration of «Hemp seed protein» in the recipe. Changes in shape, volume, weight, color, formation of taste and aroma, and changes in structural and mechanical characteristics occur during the heat treatment of chopped semi-finished products.

Table 4 presents the results of studies of functional and structural and mechanical indicators of finished semi-finished products.

Table 4

Functional-technological and structural-mechanical indicators of semi-finished products after heat treatment (n=3, h≤0.95)

Indexes	Samples of meat-containing semi-finished products			
	Control	Sample 1	Sample 2	Sample 3
WBC_{m}, %	54.8±0.11	60.5±0.32	58.81±0.7	58.12±0.33
WBC_{a},%	86.11±0.15	84.83±0.19	84.15±0.19	85.13±0.16
Plastisity, sm^2/g	7.3±0.19	6.8±0.18	6.3±0.21	6.8±0.27
Cooking yield, %	98.37±0.6	118.4±0.3	122.3±0.3	121.7±0.7

As we can see from Table 4, due to the increase in the WBC in the experimental samples of semi-finished products, the yield of finished products increased. The yield of the developed semi-finished products was 118.4–122.3 %, which is 20.36–24.33 % higher than in cutlets made according to the control recipe. Thus, the use of pork meat, hydrobionts, and plant raw materials, namely hemp seed protein, in the recipes of meat-containing chopped semi-finished products allows to obtain high-quality products and provides the products with stable functional and technological properties.

We conducted an organoleptic characterization of chopped semi-finished products before and after heat treatment. It was established that the finished semi-finished products are almost indistinguishable from each other in terms of appearance and consistency.

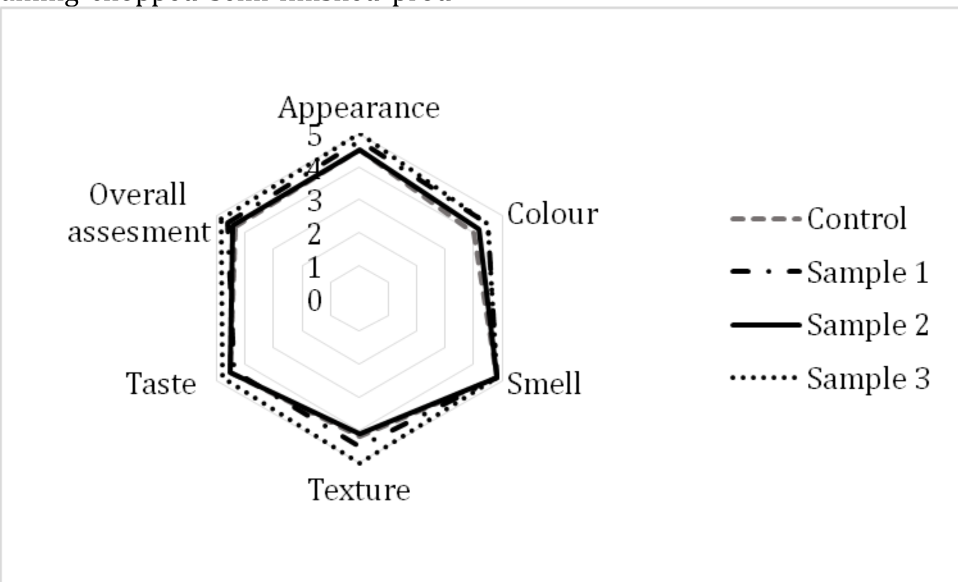

Fig. 6. Results of organoleptic evaluation of meat-containing chopped semi-finished products.

As a result of the work, the tasting commission noted the good appearance of the products, pleasant taste and smell, juicy consistency and appropriate color. According to the calculation of

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points, sample 3 received the highest average score – 4.82 points.

The obtained results of determination of microbiological indicators in finished products are presented in the table 6.

Table 6

Microbiological indicators of meat-containing chopped semi-finished products

Samples of semi-finished products	MAFAM, colony-forming organisms/g	Bacteria's Escherichia Coli в 0,1 g
Control	4.7×10^5	Not detected
Sample 1	4.8×10^5	Not detected
Sample 2	5.5×10^5	Not detected
Sample 3	6.1×10^5	Not detected

Microbiological indicators of meat-containing chopped semi-finished products should not exceed the criteria established by regulatory legal acts. According to DSTU 4437:2005, the permissible amount of MAFAM is no more than 1.0×10^7 CFO in 1 g. Escherichia coli bacteria and Proteus are hygienic criteria for product safety. The detection of bacteria of this group in the finished product may indicate that the raw materials from which this product was produced have been affected or that there has been a violation of the technological regime. According to the data in Table 6, all samples of semi-finished products, including control, did not exceed the requirements of the established norms of microbiological safety. Bacteria of the Escherichia coli group were not detected, and the amount of MAFAM was within the normal range. So, we can conclude that the meat-containing chopped semi-finished products of both the control and developed recipes are completely safe for consumption.

In meat-containing semi-finished products of a combined composition of pike meat and «Hemp seed protein», the content of the main nutrients and energy value were studied. The results of the research are presented in table 7.

Table 7

Nutritional and energy value (n=3, h≤0.95)

Index	Control	Sample		
		1	2	3
Protein, g/100 g	15.45±0.97	15.98±1.32	16.63±1.25	17.38±1.54
Fat, g/100 g	15.42±0.65	12.18±0.45	11.94±0.84	11.55±0.75
Ash, g/100 g	1.25±0.05	1.19±0.04	1.30±0.02	1.48±0.05
Carbohydrates, g/100 g	2.88±0.56	2.83±0.61	2.82±0.89	2.85±0.78
Energy value, kcal /100 g	212	185	185	185

Analysis of Table 7 showed that the protein content in all samples was sufficiently high and ranged from 15.45 ± 0.97 to 17.38 ± 1.54 g/100 product. At the same time, in the developed samples of semi-finished products, the protein concentration was 3.43–12.49 % higher than in the control. The mass fraction of fat in the experimental samples was significantly reduced due to the replacement of mechanically deboned turkey, which contains no more than 10.4% fat [37], with pike meat, the fat content of which ranges from 0.8 to 1.2 g/100 g depending on age and fishing season [38].

Because of reducing the fat content in the developed products, the energy value also changed. Thus, in combined semi-finished products, the calorie content of 100 g of the product was 185 kcal, while the energy value of the analog was 212 kcal per 100 g, which is 12.74 % higher compared to the experimental ones.

Conclusions

The conducted studies demonstrated a high level of functional and technological properties of «Hemp seed protein» (TU U 10.4-39224310-002:2019, LTD "Desnaland", Ukraine), which makes it a promising ingredient for use in minced emulsions. Hydrated «Hemp seed protein» in a ratio of 1:1 had the best parameters for introduction into meat-containing systems. The WBC of pike meat is 76.41-86.31%, the shear stress is 4.59-6.27 Pa, the plasticity is 25.31-26.17cm^2/g×10^3, which confirms the high functional technological properties of pike muscle tissue and makes it suitable for the production of minced meat products, including semi-finished products.

It was established that the introduction of 8–12 % «Hemp seed protein» (TU U 10.4-39224310-002:2019, LTD "Desnaland", Ukraine), hydrated in a ratio of 1 : 1, t 10…12 °C) and 30.5 % of pike meat into the composition of meat-containing semi-finished products increases WBC up to 97.7 %. It has been proven that the use of «Hemp seed protein» in the recipe of semi-finished products leads to an increase of WHC by 7.45–9.22 %, EC by 8.72–18.21 %, emulsion stability up to 7.65 %, FHC by 4.18–19.57 %. The use of pork, hydrobionts, and vegetable raw materials in the recipes of meat-containing semi-finished products allows an increase in the yield of finished products by 20.36–24.33 % compared to control, following the increase in the share of «Hemp seed protein», get-ready cutlets with high organoleptic indicators.

The conducted microbiological studies of the developed semi-finished products and control confirm the microbiological safety of the products.

Use of pike meat and «Hemp seed protein» (TU U 10.4-39224310-002:2019, LTD "Desnaland", Ukraine) as an ingredients of meat-containing semi-finished products leads to an increase in the mass fraction of protein in finished products by 3.43–12.5 %, a decrease in fat content by 21.01–25.10 % and reduce calorie content of the product by 12.74 %.

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