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Effectiveness of Using Beer Groats in the Technology of Semifinished Fish Products

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Abstract. The relevance of this study is conditioned upon the practical need to use beer groats as a structure-forming agent in the technology of fish moulded semifinished products. In this regard, this study is aimed at identifying the effectiveness of using beer groats in the technology of fish moulded semifinished products, namely the organoleptic and functional-technological properties of finished products. To solve the tasks set, generalisations, comparisons, and the following research methods were used: moisture content – by drying the sample to a constant mass; ash content – by the generally accepted weight method; fat content – by the Soxhlet method; protein content determination – by the Kjeldahl method according to DSTU 8030, DSTU 8718; weight loss during heat treatment of samples was determined by weighing before and after heat treatment. This paper presents the results of studies of the physical and chemical parameters of minced meat from chilled and frozen common rudd, namely: water retention capacity, stability of the emulsion and weight loss upon heat treatment, which confirmed the need to use structure-forming agents to improve the functional and technological properties of minced meat. The results of studies of the viscosity and stickiness of minced fish indicate that the adhesive properties of muscle tissue are reduced when frozen. This can be explained by the fact that denaturation changes occur during freezing, which affect the protein structure. The paper presents the results of studies of the chemical composition of beer groats, depending on the degree of grinding. During the research, it was found that the composition of beer groats with a particle size of less than 0.73 mm is the best choice for adding as a structure-forming agent, more than 0.73 mm is advisable to use as breeding. A comparative organoleptic evaluation of the quality of finished fish products with different breadings showed that breeding fish cutlets in beer groats is promising, as it improves the organoleptic indicators of the quality of the finished product: the crispy crust gives the finished dish an attractive appearance and complements the taste. The practical value of this paper lies in the possibility of using research data in the brewing, fishing, and other branches of the food industry for effective, waste-free use of raw materials to produce high-quality goods

Keywords: minced fish, structure-forming agents, functional and technological properties, breeding, fish cutlets

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Introduction

Analysis of the market of fish semifinished products in Ukraine indicates that the Ukrainian consumer is increasingly making a choice in favour of frozen semifinished products, which save time on cooking. The most common are cutlets, meatballs, chops, dumplings, and varenyky. The largest share falls on moulded semifinished products [1-3].

Ukrainian scientists – N.M. Oliinyk et al. have established that the frozen food market in Ukraine has quite a large potential. However, there are also problems that hinder the development of the entire industry. First, these issues include technological difficulties, seasonality of demand, the need to organise “cold logistics”, weak quality control of raw materials, and the duration of return on investment [1].

The study by L. Peshuk et al. presents the results of the development of meat and fish moulded semifinished products for herodietic nutrition. To produce meat and fish semifinished products, poultry meat was used, as the most accessible raw material for the Ukrainian consumer, as well as sea fish – hake, pollock, oceanic – saithe, haddock [2].

However, to improve the consistency of finished products, it is relevant to introduce structure-forming agents into the recipe of minced fish and moulded semifinished products. Accordingly, the selection of an optimal, cost-effective structure-forming agent is an urgent task.

The use of plant-based additives in the production of moulded fish products allows not only regulating the structural properties of minced meat systems, but also improving their organoleptic parameters, nutritional and biological value, and enriching them with dietary fibre. These statements are supported by N.V. HOLEMBOVSKA, S. IKRAM in their papers. The authors believe that currently the topical issue is the enrichment of the daily diet with biologically active substances contained in plant raw materials. They effectively eliminate the deficiency of vitamins, organic acids, and minerals [3; 4].

I.V. DIETRICH et al. improved the technology of semifinished products based on hydrobionts using vegetable raw materials. Due to the modification of the recipe of fish-squid semifinished products, namely: adding pumpkin, a new product was obtained that has improved organoleptic properties, compared to the prototype [5].

Notably, Ukrainian breweries have a large amount of waste, 80-85% of which is beer groats, which contain vegetable protein, carbohydrates, fibre, macro- and microelements, lipids. According to its functional and technological properties, malt beer groats belong to food additives that improve the consistency of moulded semifinished products. This additive is used in various industries, namely petroleum, medical, construction, etc. However, research on its application in the food industry is quite limited. Yi-Ting et al. improved the technology of making cupcakes using beer groats flour. The authors note that today the use of flour in the production technology of cupcakes is relevant, since this additive is a valuable source of minerals, protein, and fibre. It is also proved that beer groats flour reduces the ability of wheat flour to form a gluten framework, weakens the elastic properties of gluten and limits its ability to swell [6].

In the production of minced fish and culinary moulded semifinished products, the task of improving their functional and technological properties arises, which can be solved by using various structure-forming agents.

The studies of Ukrainian researchers address the theoretical framework of the technology to produce moulded fish semifinished products using various food additives [7-9;]. However, there are no conceptual developments in the field of research of fish moulded semifinished products with the addition of beer groats, which determines the relevance and practical significance of this study.

The purpose of this study was to establish the feasibility of using beer groats in the production technology of minced fish and culinary moulded semifinished products, namely fish cutlets. To achieve this purpose, the following main tasks were set: to analyse the current state of the market of moulded semifinished products, to identify promising areas for research of beer groats in the technology of fish moulded semifinished products.

Materials and Methods

The study was conducted in May-August 2021 based on laboratories of the Faculty of Food Technologies and Product Quality Management of the Agro-industrial Complex. The objects of the study were formed fish semifinished products, namely cutlets based on minced meat from common rudd and champignons with the addition of beer groats (sample 1), cutlets based on minced meat with the addition of beer groats (sample 2). The control selected cutlets based on minced pollock.

The technological process of production of fish cutlets included the following stages: washing, chopping fish, cooking minced meat, forming the product, breading, heat treatment, preparation of added components, packaging, cooling, and storage. Dry beer groats were crushed and sifted into 2 fractions, then sent for breading and cooking minced meat. Beer groats were used as breading – 5%, structure-forming agent – 4%.

Moisture content – according to the method of drying the sample to a constant mass; ash content – according to the generally accepted weight method; fat content – according to the Soxhlet method; protein content determination – according to the Kjeldahl method according to DSTU 8030, DSTU 8718 [10; 11].

Creating recipes for fish moulded semifinished products, cutlets were taken as a control sample, the recipe of which included minced pollock, onions, carrots, black pepper, salt, sugar, water, wheat bread, egg powder, milk powder, butter. Wheat flour was used as breading. The recipe of the developed sample No. 1 included minced meat from common rudd with the addition of beer groats and champignons, sample No. 2 – minced meat from common rudd with the addition of beer groats and sweet pepper. In prototypes No. 1 and No. 2, breading from beer groats was used.

Organoleptic quality assessment was performed according to the 5-point scale developed by the authors of this paper (Table 1).

Table 1. Rating scale for fish semifinished products

Indicator	Feature	Points
Appearance	The structure is irregular in shape, without breading	1
	Partial breading, deformed structure	2
	Structure changed, partial breading	3
	The structure is normal, the breading is not uniform	4
	Regular shape structure, full breading	5
Product colour	Very modified, with grey inclusions	1
	Heterogeneous, with grey inclusions	2
	Normal, characteristic, with light grey inclusions	3
	Pleasant, characteristic of this type of product	4
	Homogeneous, characteristic of this type of product	5
Colour on the cut	Raw meat on the cut	1
	Uneven, colourless, grey	2
	Brown meat	3
	Light meat	4
	White meat on the cut	5
Smell	Unpleasant, very sharp	1
	Unpleasant, sharp	2
	Normal, slightly modified	3
	Nice, fishy	4
	Pleasant, harmonious	5
Taste	Unpleasant, repulsive	1
	Altered, unpleasant	2
	Normal, slightly modified	3
	Nice, fishy	4
	Harmonious, pleasant, fishy	5
Consistency	Brittle, hard, dry	1
	Slightly brittle, hard, dryish	2
	Not tender enough, not juicy	3
	Dense, slightly soft, tender	4
	Juicy, dense, tender	5
Juiciness	Fragile, decaying, with grey inclusions and voids	1
	Slightly disintegrates, with grey inclusions and breaks	2
	Preserved shape, slightly disintegrating, soft	3
	Well-preserved shape, not fragile, not falling apart, soft	4
	Fully preserved, undamaged shape, uniform	5

Stickiness and viscosity were determined by loading on a FUDOH type rheometer, using spherical steel indenters with a diameter of 5 mm and 10 mm, an indenter movement speed of 6 cm/min, at least 10 tests were performed for each sample. The depth of immersion was set to 10 mm.

Mass losses during heat treatment of samples were determined by weighing before and after heat treatment (after cooling to 40±2°C).

Results and Discussion

At the first stage of research, the functional and technological properties of minced meat from common rudd were determined, namely: emulsion stability (ES), water retention capacity (WRC), losses during heat treatment (LHT) (Table 2).

Table 2. Physical and chemical parameters of minced meat from chilled and frozen common rudd

Type of fish	ES, %	WRC, %	LHT, %
Common rudd, chilled	88.4	66.3	11.3
Common rudd, frozen	82.9	63.3	15.5

The results of studies show that the physico-chemical parameters of minced meat from chilled common rudd have high values of emulsion stability and water retention capacity, which explains the low values of their LHT. However, in frozen fish, these indicators decrease, and LHT increases. Accordingly, it is necessary to use structure-forming agents to maintain the functional and technological properties of minced meat at a high level.

It is known that the viscosity of minced meat is one of the indicators that directly described the quality of minced meat [13]. The viscosity of minced meat from chilled common rudd is 37.4 Pa·s, frozen – 61.3 Pa·s. Notably, in minced frozen fish, the stickiness index changes, which indicates that the adhesive properties of muscle tissue decrease upon freezing (Table 3).

Table 3. Rheological indicators of minced meat from common rudd

Type of fish	Viscosity, Pa·s	Stickiness, Pa
Common rudd, frozen	61.3	2300
Common rudd, chilled	37.4	2560

This is explained by the fact that denaturation changes occur upon freezing, which directly affect the protein structure [7; 8; 14]. To improve the consumer properties of fish cutlets, it is advisable to use various food additives.

Malt beer groats are a natural product, from light yellow to deep brown, with a specific bread flavour [15]. Studies have shown that dry beer malt groats, divided into fractions, have a different chemical composition (Table 4).

Table 4. Chemical composition of beer groats, depending on the degree of grinding

Size of particles, mm	Water	Lipids	Protein	Mineral substances	Carbohydrates
Less than 0.25	4.1	6.8	25.9	2.0	61.2
0.25	4.0	6.1	22.5	2.4	65.0
0.58	4.3	4.9	18.5	2.9	69.4
0.73	4.4	3.5	16.1	2.7	73.3
1.0	5.1	4.3	12.4	2.8	75.4

The composition fraction of beer groats with a particle size of less than 0.25 mm contains the largest amount of protein and lipids – 25.9% and 6.8%, respectively, but the amount of carbohydrates in it is 61.2%, as well as minerals (2.0%), which is the lowest value compared to other fractions.

According to the studies conducted, the composition of beer groats with a particle size of less than 0.73 mm is the best choice for adding as a structure-forming agent for fish cutlets. Thus, it is advisable to use a fraction with a particle size greater than 0.73 mm as breading. Recipes for fish cutlets are presented in Table 5.

Table 5. Recipes for fish cutlets per 100 kg

Components	Consumption, kg		
	Control	Sample 1	Sample 2
Minced meat from common rudd	–	59.3	51.0
Minced pollock	62.5	–	–
Fresh onion	4.0	4.0	3.0
Carrot	5.0	–	–
Black pepper	0.2	0.2	0.2
Allspice	–	0.2	–
Food grade salt	1.0	1.0	2.0

Table 3, Continued

Components	Consumption, kg		
	Control	Sample 1	Sample 2
Sugar	0.3	0.3	0.3
Breading from beer groats	-	5.0	5.0
Wheat flour	6.0	-	-
Beer groats additive	-	4.0	4.0
Water	6.0	8.0	6.0
Wheat bread	6.0	-	-
Egg powder	4.0	4.0	3.5
Sweet pepper	-	-	6.0
Champignons	-	4.0	-
Dry milk	2.0	2.0	3.0
Olive oil	-	6.0	4.0
Butter	3.0	2.0	2.0
Total	100	100	100

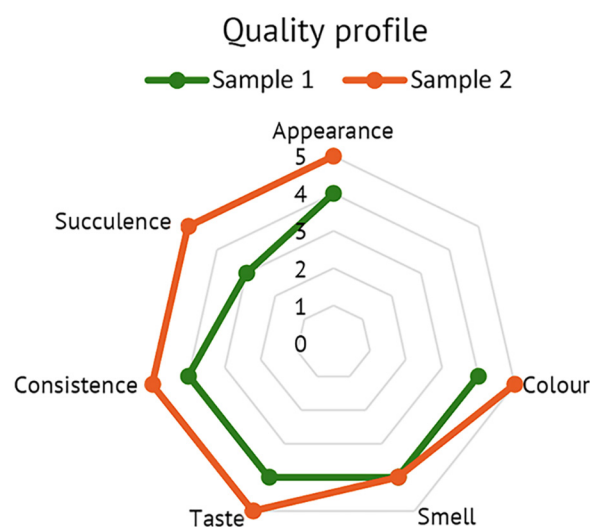


Figure 1. Quality profile

As a result, a comparative organoleptic assessment of the quality of finished fish products with different breading was performed (Fig. 1). Sample 1 – minced fish cutlets in flour breadcrumbs; sample 2 – minced fish cutlets in beer groats breadcrumbs.

According to the results of organoleptic evaluation, sample No. 1 received fewer points compared to sample No. 2. The crust was not tight, due to which the colour of the fried product was uneven, the fish cutlets were not juicy enough and dry. Sample No. 2 received the highest scores. In this sample, breading improves the

organoleptic quality indicators of the finished product. The finished semifinished products have a golden colour, are evenly baked, and have a harmonious smell.

Thus, the use of beer groats as breading provides high taste qualities of finished products – carbohydrates contained in beer groats are somewhat destroyed under the influence of elevated temperature and a humid environment, starch is denatured, a ruddy crust forms on the surface of fish cutlets, which gives the cutlets an attractive appearance. The rational amount of beer groats introduced as breading is 5.0%.

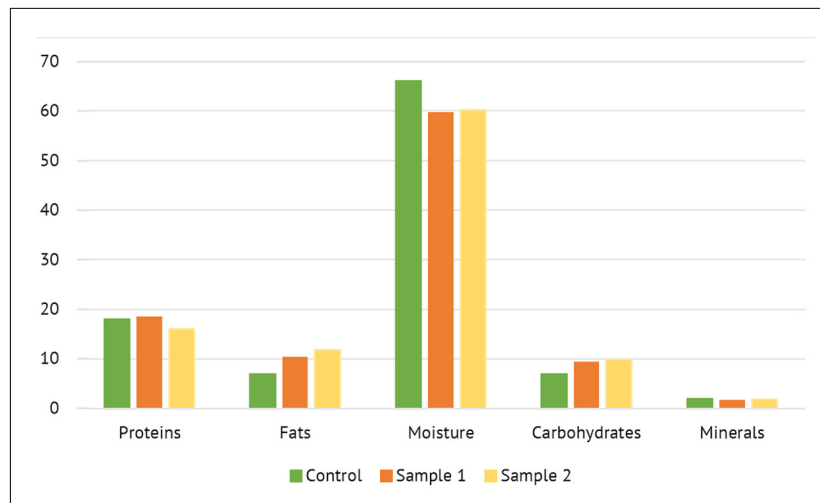


Figure 2. Chemical composition of finished fish semifinished products, %

Developed moulded fish semifinished products are characterised by high-protein values in all samples – 16.1-18.6%, lipids – 7-11.9%, carbohydrates – 7-9.9%, minerals – 1.8-2.0% as components that determine their nutritional value. The high content of lipids in cutlets is associated with heat treatment in heated oil (roasting), where partial absorption of vegetable oil occurs.

Previous studies of researchers have established the effectiveness of using fish as a structural component of minced meat systems. Studies show that one of the key criteria for the quality of minced meat systems is the indicators of higher education institutions. Myofibrillar proteins, which belong to salt-soluble proteins and are characterised by high biological value, are distinguished by high WRC. In the meat of fish (carp, silver carp), their share is from 75 to 80% of the total amount of protein. The high content (compared to meat of farm animals) of hygroscopic proteins explains the reason for the slight loss of moisture during heat treatment of fish, as well as causes high juiciness and yield of finished products. Accordingly, studies have confirmed the need to introduce structure-forming agents into minced meat systems [12].

In the studies by A. Marcus & G. Fox, N. Ishiwaki, et al. comparable results are highlighted, which confirm that the protein content in the beer groats fractions differs by almost 2 times, and primarily depends on the degree of grinding. The content of water, lipids, carbohydrates, and minerals is more stable and differs by 1.2-1.4 times [15; 16]. Scientists have found that breadings strengthens the surface

layer of fried fish cutlets, gives them a monolithic appearance, the skin is uniform and firmly held on the surface of the product, which provides the necessary juiciness of finished moulded products, a delicate consistency, preserving the fishy taste and smell [17-19].

Conclusions

As a result of the conducted studies, it was found that the physio-chemical parameters of minced meat from chilled red fish are higher than those of frozen fish. ES chilled – 88.4%, frozen – 82.9%, respectively; WRC chilled – 66.3%, frozen – 63.3%. However, the value of the LHT indicator, on the contrary, increases in frozen fish and amounts to 15.5%, in chilled fish – 11.3%, which confirmed the feasibility of using structure-forming agents.

It was found that the best choice for adding as a structure-forming agent for fish moulded products is the composition of beer groats with a particle size of less than 0.73 mm, for breadings more than 0.73 mm.

According to the results of the organoleptic assessment, it was proved that breadings fish semifinished products in beer groats provides an improvement in organoleptic quality indicators of the finished product, compared to breadings in wheat flour.

Based on the results obtained, the authors of this paper determined the areas of further research: to investigate the effect of introduced beer groats on the structural and mechanical properties of fish moulded semifinished products during storage.

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Ефективність використання пивної дробини у технології рибних формованих напівфабрикатів

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Анотація. Актуальність досліджень зумовлена практичною необхідністю застосування пивної дробини, в якості структуроутворювача, в технології рибних формованих напівфабрикатів. У зв'язку з цим дана стаття спрямована на виявлення ефективності використання пивної дробини у технології рибних формованих напівфабрикатів, а саме на органолептичні та функціонально-технологічні властивості готової продукції. Для вирішення поставлених завдань використовувались узагальнення, порівняння та наступні методи досліджень: вміст вологи – методом висушування зразка до постійної маси; зольність – загальноприйнятим ваговим методом; вміст жиру – методом Сокслета; визначення вмісту білка – методом Кьельдаля згідно з ДСТУ 8030, ДСТУ 8718; втрати маси при тепловій обробці зразків визначали методом зважування до та після термічної обробки. У статті представлено результати досліджень фізико-хімічних показників фаршу з охолодженої та мороженої червонопірки, а саме: водоутримуюча здатність, стабільність емульсії та втрати маси при тепловій обробці, що підтвердили необхідність використання структуроутворювачів з метою поліпшення функціонально-технологічних властивостей фаршів. Результати досліджень в'язкості та липкості рибних фаршів свідчать, що адгезійні властивості м'язової тканини знижуються при заморожуванні. Це можна пояснити тим, що при заморожуванні відбуваються денатураційні зміни, які впливають на структуру білка. Наведено результати досліджень хімічного складу пивної дробини, залежно від ступеня подрібнення. Під час досліджень з'ясовано, що склад пивної дробини з розміром частинок менше 0,73 мм є найкращим варіантом для додавання в якості структуроутворювача, понад 0,73 мм доцільно використовувати в якості панірування. Проведена порівняльна органолептична оцінка якості готової рибної продукції з різним паніруванням показала, що панірування рибних котлет в пивній дробині є перспективним, оскільки забезпечує поліпшення органолептичних показників якості готового продукту: хрустка шкоринка надає готовій страві привабливий зовнішній вигляд і доповнює смак. Практична цінність наукової роботи полягає у можливості використання даних досліджень у пивоварній, рибній та інших галузях харчової промисловості з метою ефективного, безвідходного використання сировини для виробництва якісної продукції

Ключові слова: рибний фарш, структуроутворювачі, функціонально-технологічні властивості, панірування, рибні котлети