Ministry of Education and Science of Ukraine

ODESSA NATIONAL ACADEMY OF FOOD TECHNOLOGIES

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2020

PROCEEDINGS

ODESSA, ONAFT 2020

Ministry of Education and Science of Ukraine

Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2020

Proceedings

Odessa, ONAFT 2020

UDC 001.8(063)

Black Sea Science 2020: Proceedings of the International Competition of Student Scientific Works / Odessa National Academy of Food Technologies; B. Yegorov, M. Mardar (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2020. – 621 p.

Proceedings of International Competition of Student Scientific Works «Black Sea Science 2020» contain the works of winners of the competition.

The author of the work is responsible for the accuracy of the information.

Odessa National Academy of Food Technologies, 2020.

Organizing committee:

Prof. Bogdan Iegorov, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

Prof. Maryna Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

Prof. Stefan Dragoev, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

Prof. Baurzhan Nurakhmetov, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

Prof. Mircea Bernic, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

Prof. Jacek Wrobel, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

Prof. Michael Zinigrad, D.Sc., Rector of Ariel University (Israel)

Dr. Mei Lehe, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

Prof. Plamen Kangalov, Ph.D., Vice-Rector for Academic Affairs of “Angel Kanchev” University of Ruse (Bulgaria)

Dr. Alexander Sychev, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

Dr. Hanna Lilishentseva, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

Prof. Heinz Leuenberger, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

Prof. Edward Pospiech, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

Prof. Lali Elanidze, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

1. FOOD SCIENCE AND TECHNOLOGIES

IMPROVEMENT OF FISH SNACKS TECHNOLOGIES WITH THE APPLICATION OF BIOTECHNOLOGICAL FAT REMOVAL

Authors: German Sapozhnik[1], Yaroslav Kyslytsia[2]
Supervisors: Tatiana Manoli[1], Alina Menchynska[2]
[1]Odessa National Academy of Food Technologies (Ukraine)
[2]National University of Life and Environmental Sciences of Ukraine (Ukraine)

Abstract. *The work contains research aimed at developing an enzymatic method for removing subcutaneous fat in fish snack technology. Based on the results of the research, a technological scheme for the production of snacks from small Azov-Black Sea fish was developed. The paper also describes the recipe and technology of freshwater fish snacks.*

Currently, fish snacks are popular with consumers. But in the conditions of fierce market competition the priority activity is the development of new raw materials, improving the taste characteristics of snacks and increasing the shelf life of finished products.

The most widespread industrial fish species of Ukraine that are caught in sufficient numbers there are Azov-Black Sea fishes Sprattus sprattus and Engraulis encrasicolus. The main problem in the production of quality snack products from these raw materials is the fat content of fish. Oxidation of the subcutaneous layer of fat leads to the appearance of odor and taste, that is, to reduce the shelf life of the product. One of the possible ways to solve the problem is to remove the lipids biotechnologically.

For economic viability, the process of removing the subcutaneous fat was performed using a complex of plant lipolytic enzymes extracted from wheat bran (Technical conditions of Ukraine 46.22.014-95) – flour milling by-products, which are a solid shell of grain obtained by grinding grain and sorting by size and weight.

Keywords: *snacks, chips, fish, fat removal, enzymes, wheat bran, technology.*

I. INTRODUCTION

At present, the main tasks of processing enterprises are to improve the quality and increase output by maximizing the full utilization of raw materials.

Fish is one of the most important sources of animal protein for the human body. Fish proteins include all essential amino acids. Fish proteins are easily absorbed by the human body. Due to its special chemical composition and taste properties, fish is one of the first among the products of animal origin.

The modern buyer prefers products that are environmentally friendly, which are not subject to the processing of synthetic additives, such as dyes, preservatives (except natural), etc. Such products include salt-dried fish. Currently, world and Ukrainian producers produce salt-dried fish in the form of snacks - products intended for rapid consumption and long-term storage. Fish snacks are not only a traditional snack for beer, but also a product that perfectly quenches hunger, packaged in convenient consumer packaging.

The modern technologies make it possible to leave many unique and valuable substances in salt-dried fish products. The optimum amount of salt and the precise selection of residual moisture emphasizes the natural taste of dried fish. The snack industry in supermarket-oriented societies generates billions in revenue annually. The snack market is huge and large corporations are constantly competing, so snacks are moving forward. Therefore, the development of the snack industry in Ukraine is incredibly relevant.

Changes in the raw material base, species composition of raw materials, the development of freshwater fish farming make their adjustments to the technology of production of fish snacks. Their creation on the basis of the most widespread industrial fish species of Ukraine, including freshwater ones, becomes promising.

The purpose of the work is to improvement of fish snacks technologies with the application of biotechnological fat removal.

II. ANALYTICAL REVIEW OF LITERATURE

2.1. Current status and outlook for the fish snack market

Snacks are products for quickly quenching hunger. Light snacks consumed between chores on the go.

At the beginning of its development, food concentrates (snacks) developed very rapidly and grew in the Ukrainian market. Mostly potato chips and salted peanuts were presented.

Fish snacks are in high demand in cities with a population of more than 500 thousand people [23].

Snack products presented on the Ukrainian market today are united by the following product characteristics: long shelf life (about 10 months), mandatory packaging, light weight (less than 100 grams) and readiness for immediate use.

According to «Snack Export» LLC, Ukrainian snack market is estimated at $ 400… 450 million, market growth is 15… 20% per year [22].

Competition in the Ukrainian snack market is high, so manufacturers are constantly looking for new ways to reach new customers: expand the range, use different types and tools of marketing communications, in advertising focus on cheaper snacks. For example, in addition to traditional potato chips, «Kraft Foods Ukraine» also produces corn, and «Technocom» produces rice chips, fruit chips - apple, pear, banana.

Also known technologies for the production of Jerusalem artichoke chips, persimmon, white root vegetables, quince [22].

Due to the lack of culture of consumption of salty snacks in Ukraine as a separate type of production, the domestic market for these snacks is dependent on the beer market. Unlike Ukrainian producers, international companies do not track the relationship between these two markets, abstracting from beer producers. Ukrainian companies are now also trying to get rid of "beer dependence" and increase the market by expanding the range and the production of salty snacks in large-sized packaging. However, since fish snacks are still considered an accompanying beer in Ukraine, the market for such products is directly dependent on the seasonality of the beer market, which falls between April and October. [23].

Currently, the range of fish snacks is quite wide. Salt-dried products are made from these types of fish: anchovy, plaice, pollock, eel, hake, goby, tuna, horse mackerel, perch, cod, and others.

But in the conditions of fierce market competition the priority activities are the development of new raw materials, improving the taste characteristics of snacks and increasing the shelf life of finished products. Creating a novelty allows the manufacturer to capture a larger segment of the market and strengthen its position relative to competitors [1, 22].

The urgent issue is the possibility of producing snack products from the *Sprattus sprattus*, *Engraulis encrasicolus* and freshwater fish *Hypophthalmichthys nobilis*. These are the most widespread industrial fish species of Ukraine, which are caught in sufficient numbers and in close proximity to the production capacities of Ukrainian producers. In 2018, the total catch of aquatic bioresources in the Black Sea, compared to 2017, increased by 3.3 thousand tons and amounted to 8.6 thousand tons. The basis of fishing is: rapana - 5.5 thousand tons; sprat - 1.6 thousand tons, shrimp - 0.5 thousand tons and mussels - 0.3 thousand tons [18, 19]. The catch volume of aquatic bioresources in inland reservoirs has also been increasing in recent years. Thus, in 2018, compared to the previous year, it increased by 4.6 thousand tons and amounted to 46.8 thousand tons, which is 54% of the total catch volume. [15, 18].

The main problem that prevents the production of snack products is the high fat content of fish. Fat oxidation causes odor and taste, that is, spoilage of the product [13, 17].

To ensure a long storage term (10 months), fish are over-dried. The meat becomes quite stiff and fibrous, so its taste characteristics are somewhat reduced. In order to be able to produce products with a softer texture, a number of technological problems need to be addressed. One of the most important of these is the oxidation of the subcutaneous fat [2, 3, 24]. One of the possible ways to solve it is the cleavage of lipids by biologically active compounds − enzymes. For economic feasibility, it was decided to use a complex of enzymes extracted from cheap raw materials of plant origin − wheat bran.

Attempts to solve these problems with the help of biotechnological processing method are outlined in this paper.

2.2. Methods of obtaining lipases

Enzymes are biological catalysts of a protein nature, capable of many times accelerating the chemical reactions occurring in a living organism, but they are not themselves part of the end products of the reactions [6].

The role of enzymes in food technology is extremely important. The production of any food product is based on either biochemical (enzymatic) or physico-chemical processes, or these processes are closely interrelated [11].

Unlike inorganic catalysts, enzymes have their own characteristics. Firstly, the rate of enzymatic catalysis is several orders of magnitude higher (103 to 109) than non-biological catalysis. Secondly, the action of each enzyme is highly specific. Each enzyme acts only on its own substrate or group of related substrates. Thirdly, enzymes catalyze chemical reactions under mild conditions, ie at normal pressure, low temperature (20…50 ° C) and at pH values, in most cases close to neutral [6, 11].

Lipases (from the Greek. Lípos − fat), enzymes of the hydrolases class; catalyze the hydrolysis of ester bonds in triglycerides to form fatty acids and glycerol [6].

The methods of obtaining and removing lipases are given special attention by scientists of the world. Yes, Beryozov TT and Korovkin BF proposed a method of preparative production of wheat germ lipase. They proposed a method of purification and selected the optimal conditions for the release of lipase from wheat germ (Triticum aestivum L.) [16].

Authors such as G. Yu. Nekrashite, I. K. Straykuvene, and others have proposed a method of producing phospholipase D. The invention relates to the microbiological industry, namely the production of enzymes. The aim of the invention is to increase the enzymatic activity in the culture fluid of the target product and reduce its cost. This goal is achieved by the fact that according to methods of producing phospholipase D, including the cultivation of a producing microorganism of the genus *Streptoverticillium* in a nutrient medium containing sources of carbon, nitrogen, mineral salts and water [21].

I. S. Zvyagintseva, V. T. Luka and others received a strain with high lipolytic activity and broad substrate specificity. The invention consists in the fact that by multistage selection the adaptive method was obtained by the yeast strain *Jarrowia lipolytica* VNIIA 304A − an active producer of lipase. High lipolytic activity of the strain and its ability to absorb different substrates is provided by the nutrient medium of a given composition [14].

I. G. Sultanova and K. D. Davranov was proposed the strain of the fungus Rhizopus microsporus − producer of lipase. The invention relates to biotechnology, in particular to obtain the enzyme lipase, hydrolyzing fats. The purpose of the invention is to obtain a strain of the fungus *Rhizopus microsporus*, which has a high ability to form lipase specific for hydrolysis of fish oil. The preparation of lipase obtained from the culture can be used for hydrolysis of fish oils upon receipt of fish products enriched with polyene acids [25].

A rich complex of hydrolytic enzymes can be obtained by *Bacillus subtilis* culture. These are aerobic, gram-positive sticks. The culture is cultured as a method of surface cultivation on bran and in liquid media of special composition by the method of deep cultivation. They can use proteins, carbohydrates, alcohols, organic acids as sources of nutrition.

For a long time in medicines used enzymes of animal origin. However, obtaining these enzymes involves a number of difficulties: the need to use directly the organs of animals, the number of which is limited, in addition, it is a rather time-consuming and expensive process. Plants are a large raw material base, more affordable and cheaper. Therefore, recently enzyme preparations derived from plants are quite widely used.

Plant lipase is found mainly in seeds, fruits, tubers, cereal rhizomes (corn, oats), cruciferous seeds (mustard seeds), especially in legumes (beans, peas), and sunflower seeds.

Wheat flour enzymatic activity (initial rate) is five times higher at 15.1% moisture than at 8.8%. The same behavior is found for lipases of rye, oats and poppy seeds. The temperature optimum of the reaction (for a 24-hour period) for rye was set at 75 ... 90 ° C at 6% moisture, 70 ° C at 15% moisture and 60 ° C at 20% moisture, which reflects the resistance of the enzyme to heating at different humidity levels.

It was found that the highest amount of lipase contains wheat germ. However, the amount of lipase in the wheat germ is less than 5% of the total grain activity.

Earlier works on the purification of wheat lipase indicated that this enzyme acts on ethers (and soluble) ethers and has a pH optimum of 7.4. Maximum enzyme activity was detected with triacetin. Monobutyrin and ethyl acetate, as well as emulsified monoolein, were easily hydrolyzed by the enzyme [6, 16].

III. OBJECT, SUBJECT MATTER AND METHODS OF RESEARCH

The object of research is the technology of snacks from small Azov-Black Sea fish and from freshwater fish based on a biotechnological method of removing the subcutaneous fat.

The subject of research is small fish of the Azov-Black Sea basin is *Sprattus sprattus*, freshwater fish is silver carp (Hypophthalmichthys nobilis), parameters of technological process of degreasing, organoleptic indicators of the quality of fish snacks.

Research Methods. The experimental studies were carried out in the laboratories of the Department of Meat, Fish and Seafood Technology of the Odessa National Academy of Food Technologies (Odessa) and the Department of of the National University of Life and Environmental Sciences of Ukraine (Kyiv).

Determination of physicochemical indicators of raw materials, as well as at different stages of the technological process and the finished product was carried out experimentally using standard methods of research.

Determination of mass fraction of moisture by drying at 100…105 °C, mass fraction of fat by extraction method in the apparatus of Soxhlet, mass fraction of sodium chloride by the argentometric method according to GOST 7636-85. [10].

Study of snack quality according to GOST 34191-2017 and GOST 33803-2016 [8, 9]. Organoleptic evaluation was performed on the basis of a score scale [20].

IV. WORK RESULTS

4.1. Removal of subcutaneous fat of *Sprattus sprattus* with the help of wheat bran enzyme complex

Pre-dried at 35 ° C to constant weight, wheat bran was ground in a mortar to a powdered state. Next, the bran was poured with water (GM 1: 4) at 35 ° C and kept for 30 minutes, stirring. Then it was filtered through filter paper. Black Sea Sprat fillets were filled with extract and kept for 30… 45 minutes.

Determined the change in mass fraction of fat. The results obtained were compared with the control sample − the mass fraction of fish fat, untreated with the enzyme preparation previously defined.

A graphical representation of the results of the experiment is presented in Figure 4.1.

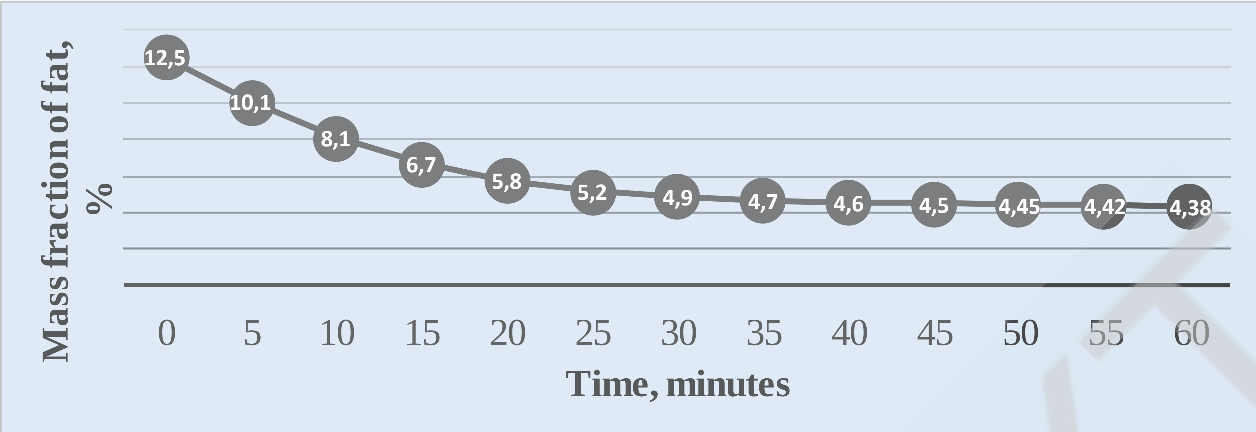


Figure 4.1. Determination of change in mass fraction of Black Sea sprat fat over time.

The results of studies have shown that the mass fraction of fat of the control sample under the action of a complex of wheat bran enzymes decreases from 12 to 4.5%, almost three times. Thus, biotechnological methods based on the use of a complex of enzymes of vegetable raw materials can be used to remove 65% of fat from its original value.

4.1.1. Determination of optimal temperature of action of a complex of lipolytic enzymes of wheat bran. The rate of enzymatic catalysis depends on the temperature of the medium. To determine the optimum temperature of the action of a complex of lipolytic enzymes of wheat bran, the fermentation of fish was carried out at different temperatures for a time equal to 30 ... 45 minutes. A graphical representation of the results of the experiment is presented in Figure 4.2.

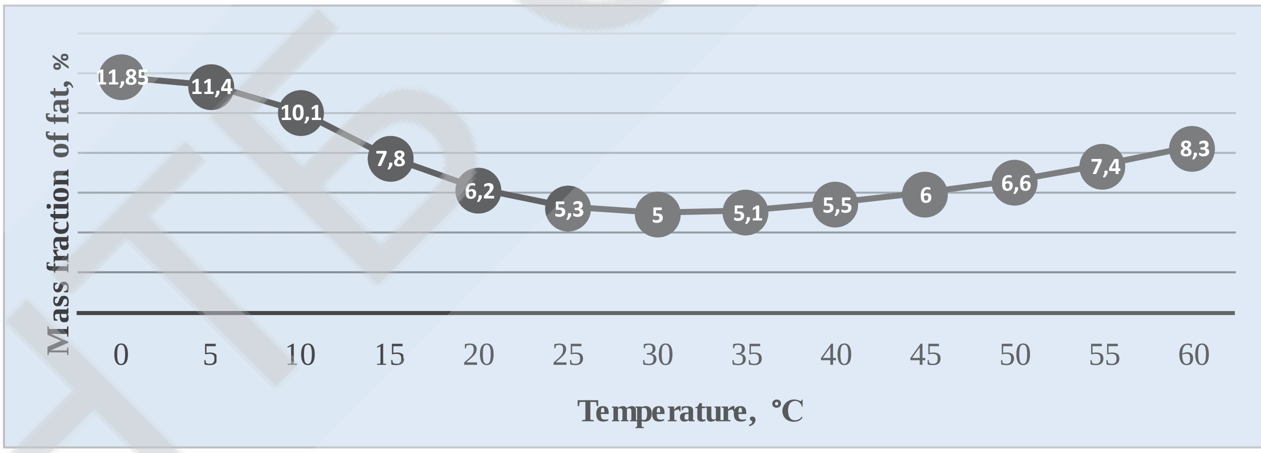


Figure 4.2. The influence of fermentation temperature on the change in the mass fraction of fish fat.

The results of studies have shown that the lipase of wheat bran operates in a sufficiently wide temperature range − from 20 to 45 ° C. In the range from 5 to 20 ° C the rate of hydrolysis increases. In 30 minutes up to 50% of fat is removed from its original value, but the highest activity is observed at 25… 35 ° C and for 30 min. 60-65% of the original fat is removed. In the temperature range from 45 to 60 ° C, the rate of hydrolysis decreases in 30 minutes. removes 33… 50% of the original fat.

4.1.2. Determination of the optimal pH value for enzymatic degreasing. To determine the optimal pH for the complex of lipolytic enzymes of wheat bran, the fermentation of fish was carried out at different pH values for the same time for all samples 30...45 minutes. A graphical representation of the results of the experiment is presented in Fig. 4.3.

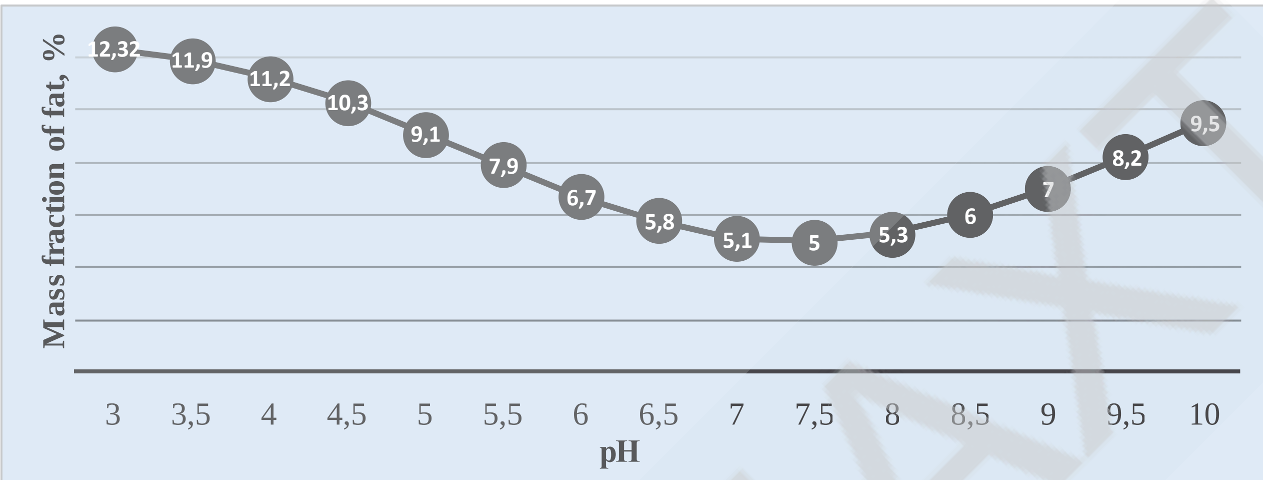


Figure 4.3. Determination of the pH optimum for a complex of lipolytic enzymes of wheat bran.

According to the obtained data, we conclude that in the pH range from 3 to 4 mass fraction of fat is almost unchanged. In the range from 5 to 6, the rate of lipid hydrolysis increases and is 3…5% of fat in 30 minutes, but the fastest cleavage of fat occurs at pH values from 7 to 8 and is 7…8% of fat in 30 minutes. In the range from 9 to 10 the rate of hydrolysis begins to decrease and is 3...5% of fat in 30 minutes.

4.1.3. Vacuum fermentation. If the pressure is below one atmosphere, the air dissolved in the intercellular space of the tissues of the fish will begin to be released and the enzyme solution will be absorbed into its place.

Used enzymes extracted from wheat bran. The fish disassembled into the headless and spinal bone layer, filled with a solution of the enzyme preparation, were placed in a desiccator connected to a vacuum pump. Dilution of 0.8 kgf / cm^2 at 25 °C was created. A graphical representation of the results of the experiment is presented in Figure 4.4.

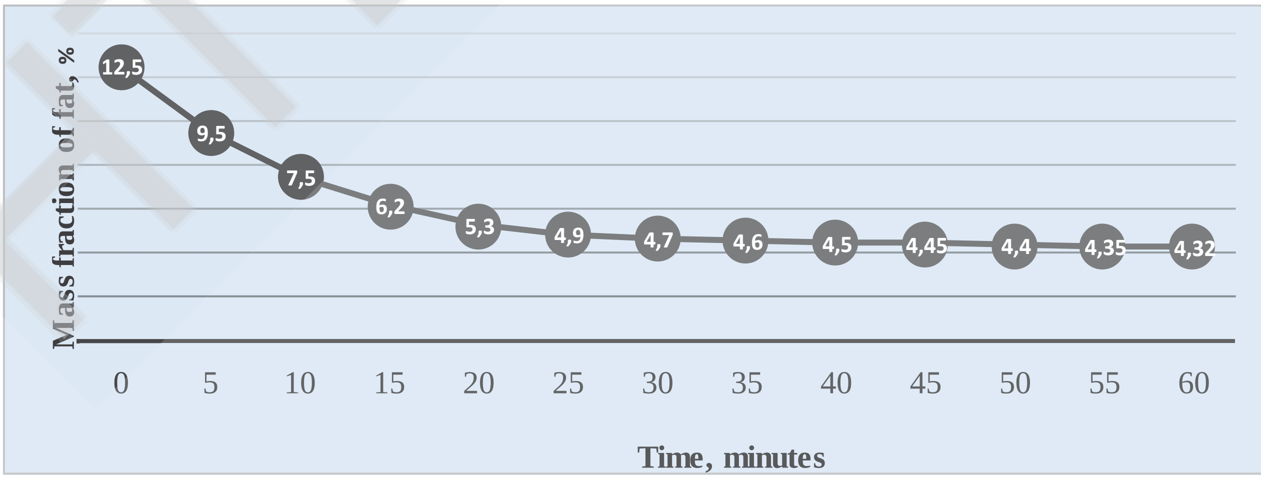


Figure 4.4. The dependence of the effect of fermentation under vacuum on the change in the mass fraction of fat in fish fillets

The obtained data showed that the decrease in mass fraction of fat compared to the treatment at atmospheric pressure is negligible and remained at the level of 4.5…6 %. But at the same time the fermentation time decreased − these results were achieved in 20…30 minutes against 30…45 minutes at normal pressure.

4.2. Investigation of the effect of fish pre-treatment on the drying process

Disassembled into a layer without a head and spinal bone, treated with an enzyme preparation, the fish was dried with a stream of air at a rate of 0.6 m / s, at a temperature of 50 ° C. During the drying process, the fish was weighed and the moisture content was determined.

Drying was stopped after reaching a mass fraction of moisture in fish 25 ... 35%. At the end of the drying did a comparative organoleptic evaluation of fish with pre-enzymatic removal of subcutaneous fat and fish without pre-treatment. Salt treatment and drying time are the same for all samples The results of the studies are shown in Table 4.1.

Table 4.1.

Comparative organoleptic evaluation of dried fish with pre-enzymatic removal of subcutaneous fat and fish without pre-treatment with enzymes

Indicator	Fish without first enzymatic processing	Fish with pre-enzymatic fat removal
Surface color	Light gray	Light gray
Yellowing	Insignificant	None
Humidity	Dry	Dry
Scent	Slight odor of oxidized fat	Odorless oxidized fat
Taste	Peculiar	Peculiar
Hardness	Hard	Hard
Stratification	Fibrous	Fibrous
Oiliness	Significantly oily	Slightly buttery

According to the obtained data, it can be concluded that the fish treated with the enzyme preparation during drying had significantly less fat release to the surface than the fish without enzymatic treatment, which improves the appearance and guarantees a longer storage time.

4.3. Development of technology for the production of snacks using biotechnological method of removing the subcutaneous fat

On the basis of experimental studies, a technological scheme for the production of snacks was developed using a biotechnological method of removing the subcutaneous fat layer shown in Fig. 4.5

Defrosting. The frozen fish should be thawed in defrosting apparatus, baths in running or intermittent water, or in brine at a density of 1.02 g/cm^3 to 1.03 g/cm^3, or in air. The temperature of the water, brine or room air must not be higher than 20 ° C. The ratio of the weight of fish and water or brine in the bath 1:2. Frozen fish washed with water in the air. Do not wash fish thawed in water or brine.

Raw fish, Cooled fish | Frozen fish → Defrosting

↓

A wash

↓

Disassembling, a wash

↓

Salting, soaking

↓

Biotechnological fat removal

↓

Drying

↓

Cooling

↓

Packing, marking

↓

Storage

Fig. 4.5. Technological scheme of snack production using biotechnological method of removing subcutaneous fat.

A wash. Raw fish and chilled fish should be rinsed with clean running or replacement water at a fish to water ratio of 1: 2 before being sent for processing. The water temperature should not be higher than 15 ° C. Wash the washed fish from 20 minutes to 30 minutes on waste tables or sieves for water drainage and without delay send for further processing.

Disassembling. The fish is disassembled into fillets. After disassembly, they are washed with a stream of water.

Salting. Salt the fish in saline with a density from 1.12 g / cm^3 to 1.20 g / cm^3, with a temperature not higher than 20 ° C. The ratio of the weight of fish and saline solution in the salting capacity should be 1:2. Finish salted fish after reaching the mass fraction of salt in fish from 3 % to 5 %. Salting duration from 7 minutes to 15 minutes depending on the type and size of the fish. The fish unloaded from the container drains saltinng solution for no more than 0.5 hours on waste tables (sieves) or in perforated decks. Salt fish with a mass fraction of salt over 5 %, before drying, soak in fresh water or a low salt solution with a density of from 1.02 g / cm^3 to 1.04 g / cm^3 and a temperature not exceeding 10 ° C at the ratio of the weight of fish and water (or salt solution) 1:2. After soaking, the fish should be steeped for 1…2 hours on waste tables (sieves) or in perforated decks to drain excess water.

Biotechnological fat removal. The fish is treated with a solution of the enzyme preparation at a concentration of 0.35 g / ml, a temperature of 35… 40 ° C, a pH of a solution of 7… 8 for 30 minutes. Do not reuse the enzyme preparation.

Drying. The fish should be laid in a thin layer on metal perforated nets, which are placed in several rows in a drying chamber so that they are evenly blown by the flow of heated air at a temperature of 50… 60 ° C. During the drying process, the fish is stirred periodically. The first stirring should be carried out in 1 ... 1,5 hours, the second - in 1 ...

1,5 hours after the first. Drying time from 6 hours to 8 hours.

Cooling. Salt-dried fish is transferred to a clean, dry container for cooling (metal containers, wooden boxes or other containers) to the working room temperature and packed.

Packaging. The dried fish is packaged in plastic material bags in accordance with GSTU 15-19 or the applicable regulatory document under vacuum or without vacuum, the maximum mass of the product is 1 kg, followed by their packaging in boxes of corrugated cardboard in accordance with GOST 13516 product weight limit of 10 kg. The dried fish is packaged in plastic bags in accordance with the "Technological Instruction on Packaging of Foods from Fish and Other Water Resources into Plastic Packages".

Marking. Mark containers with fish snacks in accordance with GOST 7630 and regulations.

Storage. Store fish dried at temperatures from 0 ° C to 25 ° C and relative humidity not more than 75% not more than 10 months.

4.5. Development of freshwater fish chips formulations and technology, evaluation of their quality

In order to expand the range of snack products from affordable domestic raw materials, recipes and technology for the production of silver chips with the addition of algae and greens were developed. For the production of fish chips formulations were developed, which are shown in table 4.2.

Table 4.2

Formulations of fish chips samples

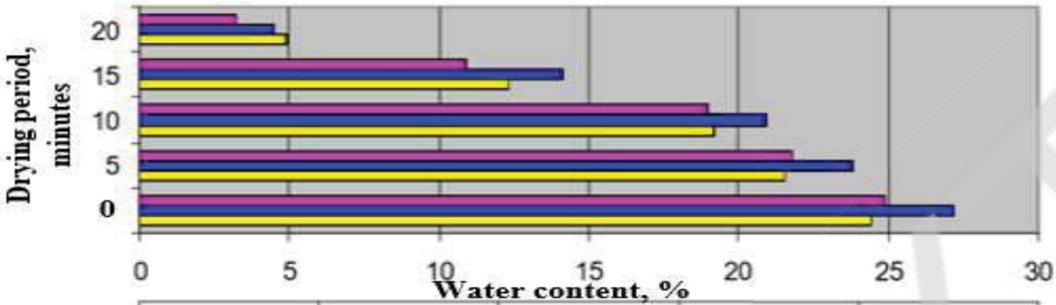
Name of components	Control	Fish chips with dill	Fish chips with kelp
The silver carp	74,4	74,4	74,4
Butter	3	3	3
Chicken eggs	10	10	10
Milk	5	5	5
Wheat flour	6	6	6
Black pepper	0,6	0,6	0,6
Salt	1	1	1
Dill	-	2	-
Seaweed	-	-	2
Total	100	100	100

Chips formulations were selected taking into account the content of their main components: sample 1 - with the addition of dill; sample 2 - with the addition of seaweed, sample 3 - control sample without the addition of dill and seaweed, only on the basis of freshwater fish meat.

The process of production of fish chips consists of the following operations: receiving raw materials, sorting, washing, disassembling, grinding, dough preparation, mixing, molding, drying and baking, packaging in consumer packaging, packaging in transport packaging and sale.

Drying of the chips was carried out at a temperature of 105 ° C, followed by measurement of the moisture content at intervals every 5 minutes. The results of the study are shown in Figure 4.6.

During the research, the time required to dry the finished product was set so that the moisture content did not exceed 5%. Within 20 minutes of drying, the control sample lost - 20.1%, sample 1 - 16.5%, sample 2 - 12.8% moisture.



		0	5	10	15	20
■	1	24,9	21,8	19	10,9	3,2
■	2	27,2	23,8	20,9	14,1	4,5
■	3	24,4	21,5	19,2	12,3	4,9

Figure 4.6. Dependence of moisture loss on drying time:
1- sample 2, 2 - sample - 3, 3 - control sample.

The fish chips were also evaluated according to their own scale 5, where the total number of control points was 19 points, for the dill sample 21 points and for the cabbage 23 points. The results of the study are shown in Figure 4.7.

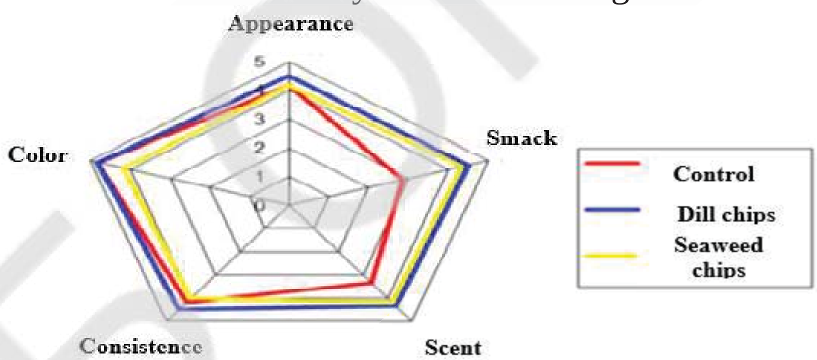


Figure 4.7. Profile of organoleptic evaluation of fish chips.

As a result of organoleptic studies it was found that fish chips in appearance are inherent in this product. The slices are round and almost identical in size. The color of the chips is golden with a brown tinge on the edges. The taste and odor is inherent, with no extraneous odors. Has a taste of additives - dill for 1 sample, and a taste of seaweed for 2 sample. The consistency is brittle and fragile. The overall comparative analysis makes it possible to confirm that all the samples of fish chips have a positive overall impression, a harmonious fish taste.

Positive studies received indicate that this technology is being continued and needs further development.

V. CONCLUSIONS

1. Improvement of the old and the development of new technologies for the production of snacks seem relevant.

2. In today's domestic fish processing industry, most technologies designed to

remove the subcutaneous fat are outdated or ineffective. They are not satisfying in quality and performance. Therefore, the development of an alternative method of removing subcutaneous fat − biotechnological, with enzymes − is relevant today.

3. Based on the results of the studies, it was found that the processing of disassembled fish with a complex of lipolytic enzymes from wheat bran can reduce the mass fraction of subcutaneous fat of *Sprattus sprattus* almost three times. It was found that the time required to remove the fat is 30…45 minutes. Optimal parameters of temperature (35…40 ° C) and pH (7..8) were determined.

4. Studies were carried out to intensify the process of enzymatic removal of the subcutaneous fat − fermentation under vacuum, the results of which were to reduce the fermentation time to 20…30 min.

5. The effect of fish pre-treatment on the drying process is investigated. A comparative organoleptic evaluation of fish pre-treated with enzyme preparation and fish without pre-treatment was performed. Pre-treated fish enzyme preparation in the drying process was observed significantly less release of fat on the surface than fish without enzymatic treatment.

6. The technology of snack production using the biotechnological method of removing the subcutaneous fat was developed. Technological scheme of snack production using biotechnological method of removing subcutaneous fat was developed.

7. The recipe and technology of freshwater fish chips have been developed, which will expand the range of snack products from available domestic raw materials.

VI. REFERENCES

1. Абрамова Л. С. Пути рационального использования сырьевых ресурсов рыбного хозяйства страны. Пищевая промышленность. 2004. №3. С. 6-10.
2. Байдалинова Л. С., Яржомбек А. А. Биохимия сырья водного происхождения. М.: Моркнига, 2012. 506 с.
3. Биотехнология морепродуктов / Л. С. Байдалинова и др. М. : Мир, 2006. 560 с.
4. Богданов В. Д. Сафронова Т. М. Структурообразователи и рыбные композиции. М. : ВНИРО, 1993. 172 с.
5. Бредихина О. В., Новикова М. В., Бредихин С. А. Научные основы производства рыбопродуктов. М. : Колосс, 2009. 152 с.
6. Брухман Э.Э. Прикладная биохимия: перевод с немецкого / предисл. чл. – корр. АН СССР проф. В.Л. Кретовича. М.: Легкая и пищевая промышленность, 1981. 296 с.
7. Голубева В.Н. Кутина О.И. Справочник технолога по обработке рыбы и морепродуктов. Санкт-Петербург: ГИОРд, 2003. 408 с.
8. ГОСТ 33803-2016 Рыба пресноводная сушено-вяленая. Технические условия.
9. ГОСТ 34191-2017. Рыба мелкая вяленая. Технические условия. [Введен 2010–01–01]. М.: Стандартинформ, 2017. 12 с.
10. ГОСТ 7636–85. Рыба, морские млекопитающие, морские беспозвоночные и продукты их переработки. Методы анализа. [Введен 1986–01–01]. М.: Изд–во стандартов, 1985. 75 с.

11. Дж. Рид. Ферменты пищевой промышленности. Москва, 1971. с. 147 – 163.

12. Запорожский А. А. Касьянов Г. И. Биотехнологические методы повышения пищевой ценности мясного и рыбного сырья. Изв. вузов. Пищ. технология. 2007. № 3. С. 5—8.

13. Золоткопова С. В., Палагина И. А., Балашова Е. П. Теоретические представления о химических превращениях липидов. Известия вузов. Пищевая технология. 2006. № 1. С. 21—22.

14. Липазная активность некоторых дрожжей: а. с. 1454852 А СССР, МКИ С 12 N 9/20. № 4280036/31-13; заявл. 19.05.87; опубл. 30.01.89, Бюл. №4.

15. Менчинська А. А., Лебська Т. К. Як подолати кризу в рибній галузі України. Продовольча індустрія АПК. 2017. № 5. С. 6–9.

16. Плешков Б.П. Практикум по биохимии растений. Изд. 2-е, доп. П 38 и перераб. М., «Колос»,1976.

17. Ржавская Ф. М. Жиры рыб и морских млекопитающих: монография. М.: Пищевая промышленность, 1976. 470 с.

18. Рибне господарство. Архів. Державний комітет статистики України. URL :http://www.ukrstat.gov.ua

19. Самофатова В. А., Фалюта Г. І. Аналіз перспектив розвитку рибопереробної галузі України. Економіка харчової промисловості. 2014. № 3. С. 50—52.

20. Сафронова Т. М. Справочник дегустатора рыбы и рыбной продукции: справочник. М.: ВНИРО, 1998. 244 с.

21. Способ получения фосфолипазы Д: а. с. 986923 А СССР, МКИ С 12 N 15/00. № 3328382/28-13; заявл. 29.07.81; опубл. 07.01.83, Бюл. №1.

22. Стан та тенденції розвитку українського ринку снекових виробів – Режим доступу: https://studwood.ru/827522/marketing/stan_tendentsiyi_rozvitku_ukrayinskogo_rinku_snekovih_virobiv

23. Статистика споживання снеків – Режим доступу: revolution.allbest.ru /marketing/00379506 3.

24. Технология продуктов из гидробионтов / Артюхова С. А. и др.; под ред. Т.М. Сафроновой и В.В. Шендерюка. М. : Колос, 2001. 496 с.

25. Штамм гриба Rhizopus microsporus – продуцент липазы: а. с. 1581742 А СССР, МКИ С 12 N 1/14. № 4993263/31-13; заявл. 16.03.88; опубл. 30.07.90, Бюл. №28.

TABLE OF CONTENTS