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Improvement of safety assessment and quality control of fish products [e.g., caviar, caviar of the perch family (Percidae)] based on traceability system

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Abstract

The relevance of the article is due to the importance of setting of safety criteria and quality of fish products and fish processing products in accordance with the traceability system, according to the trends in finding of alternative protein sources in compliance of certain quality criteria. The goal of the article is development of the safety criteria and quality of caviar of the perch family (Percidae), on the basis of comparison of developed specimens with control, and establishment of permissible limits of physical and chemical indicators, amino-acid score indicators for further modelling of the common system of quality traceability system. Methods of theoretical analysis, standard methods referred to in GOST, as well as the method of capillary electrophoresis using the system of capillary electrophoresis "Kapel" were used to determine the basic indicators. The study found that the proposed 4 specimens of perch caviar with added of lingonberry, dill, laminaria and sea buckthorn had a higher biological value than the control specimen. The results make it possible to propose the construction of a quality traceability system for fish products with increased biological value, which will help to solve the problem of providing the market with enriched caviar of the perch family.

Keywords: perch caviar; perch family (Percidae); quality indicators; fish products quality indicators; traceability system.

Practical Application: The obtained results make it possible to propose the construction of a quality traceability system for fish products with increased biological value.

1 Introduction

Fish and fish products are a valuable source of human nutrients. First of all, there are complete proteins, fats, carbohydrates, mineral elements and vitamins. Therefore, fishing industry and sales of fish products in fresh and conserved form are constantly increasing (Tacon, 2020). Fish products, in particular caviar – essential food product in the diet of modern man. Depending on the fish species, it contains between 14 and 31% of proteins, between 0.3 and 15% of fats, 1.5-2.0% of minerals, as well as biologically active substances necessary for normal metabolism. Caviar contains vitamins and enzymes, including lecithin, which is essential for the health state of the human nervous system. In addition, caviar has high tastiness, so is an important part of the trade industry (Binsi et al., 2019). Caviar is a product of high biological value and the number of technologies developed on its basis is constantly increasing (Harris & Shiraishi, 2018). The value of caviar is also enhanced by the fact that the amount of protein and PUFAs (polyunsaturated fatty acids) in caviar is higher than in fish muscles and water is lower. Also, cholesterol in caviar is typically ten times higher than in muscles, but only about one-quarter higher than in the yolk of a chicken egg. Leucine and proline levels in caviar are also significantly higher than in muscles (Iwasaki & Harada, 1985).

Taking into account the latest research on human dietary deficiencies, it was decided to enrich of caviar with additional natural products, which will make it possible to increase the amount of biologically active substances. Caviar is a product high in essential amino acids, polyunsaturated fatty acids. To balance the nutritional value of the product, herbal supplements have been added to the product recipe. As food additives used lingonberry, dill, laminaria and sea buckthorn. The addition of herbal supplements will increase the amount of dietary fibers, organic acids, vitamins. Accordingly, specimens of caviar of Balkash perch (Perca schrenkii) with the addition of lingonberry, dill, laminaria, sea buckthorn were selected as research subjects. In addition, the introduction of a fish traceability system to guarantee safety and quality is now a relevant topic. The establishment of criteria and control points in the production and distribution of fish products corresponds to worldwide trends in food sciences, as well as for the country's economy (Tavakoli et al., 2021). Ensuring food safety is one of the pressing issues of the present. It is worth considering an effective traceability system as a means by which it is possible to track food products throughout the food chain (Chen & Yu, 2022a; Uzakov et al., 2021). The main purpose of the traceability system is to quickly identify the source of the

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problem that affects food safety and take the necessary measures to eliminate the source in such a way that minimal interference in the production process (Kazangeldina et al., 2020; Kazangeldina & Iztelieva, 2021; Zhanabayeva et al., 2021).

Basic instructions for setting up the system are based on Procedural Manual of the Codex Alimentarius Commission (Food and Agriculture Organization, 2015). The article's recommendations were also taken into account art. 58 Council Regulation (EC) No 1224/2009 (Council of the European Union, 2009), which contains requirements for a traceability system for fish products. According to the Council Regulation (EC) No 1224/2009 (Council of the European Union, 2009), all shipments of fish products and aquaculture products must be traced at all stages of production, processing and distribution. In addition, the Council Regulation (EC) No 1224/2009 (Council of the European Union, 2009) states that all fish products must be properly marked so that each shipment can be tracked. To determine critical control points, it is necessary to define basic physical and chemical indicators, compare them with control samples, as well as with the requirements of regulatory documentation. Social and economic efficiency of development is the preservation and protection of human health, a fuller use of the food potential of the offered natural raw materials, expanding the range of fish products in the food and restaurant industry, improving the quality and consumer properties of fish dishes with an increased content of essential amino acids, polyunsaturated fatty acids, vitamins, deficient micronutrients (iodine, selenium, folic acid, tocopherol, beta-carotene), dietary fibers (Kirichuk, 2006; Kok et al., 2012).

The goal of the article is development of the key safety criteria and quality of caviar of the perch family (Percidae), on the basis of comparison of developed specimens with control, and establishment of permissible limits of physical and chemical indicators, amino-acid score indicators for further modelling of the common system of quality traceability system.

2 Materials and methods

In the research process the following methods were used theoretical methods (analysis of the literature; generalization; method of analogies); experimental (establishing, forming, control experiments); method of graphical representation of results. The research was carried out on the basis of the research laboratory on evaluation of quality and safety of food products at Almaty Technological University. The studies were carried out using common methods. There are 4 specimens were selected for the study: perch caviar with lingonberry, dill, laminaria, sea buckthorn. In the course of the research, the key physical and chemical indicators such as the mass fraction of proteins, fats, carbohydrates, moisture were determined. Classical research methods were used, according to GOST 7636-85 "Fish, marine mammals, invertebrates and products of their processing. Methods of Analysis" (State Committee for the Russian Federation for Standardization and Metrology, 1986).

The traceability system is a structured chain that includes numerous steps to satisfy customers` needs for food products on the one hand, and the food standards according to national or international law on the other one. The main goal of this system is to minimize production and, subsequently, distribution of spoiled food products and to prevent the associated poisoning diseases among the consumers. Considering the exposure level of caviar to the fast expiration date, the functioning impeccability of the traceability system is an extremely important production criterion. During the research, the perch caviar transportation process through the following steps of the traceability system was analyzed: determining of all caviar batches, registration of moving and transporting data, and adding them to the electronic traceability system, which includes all information was gained from the previous steps. The gathered data in traceability systems may differ: the final variant depends on information amount, tracking interval, and preciseness level of accuracy of the product movement. The traceability system has significant meaning because of the wide range of product quality it solves. For instance, these systems help food manufacturers to separate the causes of the particular disfunction in the implementation process from the quality control issues. Also, the traceability systems could improve delivery management, alleviate tracking of quality and safety of products, and identify undetectable quality indications. Namely, these systems in the food sector build peace of mind and trust in the whole gastronomic area. In brief, the more perfect a traceability system is, the more efficient and profitable a gastronomic business is.

The mass fraction of the protein was determined by macromethod. This method involves calculating the protein by multiplying the amount of nitrogen remaining after burning in sulphuric acid by an index number 6.25. The mass fraction of the fat was determined by the Soxhlet method. To do this, fat was extracted using an organic solvent from a dry weight. Then its mass is determined by weighing. Mass fraction of carbohydrates was determined by permanganometric method. This is done by standardizing the potassium permanganate solution 5-7 days after its preparation. Ethane diacid is used as a mother substance for standardization. The sample weight of potassium permanganate is carried into the glass, small portions of hot water are topped up. In this case, the liquid is drained periodically from crystals into a measuring flask. The dissolution is accelerated by continuous mixing. When the whole sample weight passes into the solution, the volume of distilled water is refilled to the mark and is thoroughly mixed. The solution is poured into a darkened glass, closed by a cork, let the solution draw during 5-7 days, after this time the solution is filtered.

The sample weight is calculated as for the preparation of 200 mL of a standard ethane diacid solution with a molar concentration of the equivalent 0.02 mol/L. The molar mass of the equivalent $H_2C_2O_4 \cdot 2H_2O$ in the reaction under consideration is 126.07/2 = 63 g/mol. The calculated sample weight $H_2C_2O_4 \cdot 2H_2O$ is weighed on analytical weights, transferred to a 200 ml measuring flask and dissolved when mixed in distilled water, bringing the volume to the mark. The molar concentration of the equivalent of a standard ethane diacid solution is calculated. When determining the mass fraction of moisture according to the standard GOST 24027.2-80 "Method for determining humidity, ash content, extractives and tannins, essential oil" (State Committee for the Russian Federation for Standardization and Metrology, 1981) method in the drying cabinet heated to 100-105 °C, quickly

place prepared weighing bottle with samples weight together with removed lids. At the same time, the temperature in the cabinet drops. The time during which the raw material has to be dried is counted from the moment when the temperature in the cabinet reaches 100-105 °C. Drying is carried out to a constant weight. Also in the course of research, the amino acid composition of fish caviar proteins was compared. For this purpose, the amino acid composition was determined using the M 04-38-2009 "Method of measuring the mass fraction of amino acids by capillary electrophoresis using the system of capillary electrophoresis "Kapel"". The analysis temperature was 30 °C, with a wavelength was 254. The amino-acid score was also determined by calculation method to determine the biological value of the proposed samples.

3 Results

3.1 Study of the main physical and chemical indicators of perch caviar specimens

This article studies and analyses the main physical and chemical indicators of perch caviar. It should be noted that for food purposes in Kazakhstan, caviar of salmon, sturgeon, and common fresh water fishes are most often used. Perch caviar is not a common product also because of lower biological values. Therefore, studies of this product are promising, and help to determine which organoleptic and physical and chemical indicators of perch caviar need to be controlled in the production process, as well as how to influence and improve them through the formation of new functional food structures. It was for the purpose of enriching the product with essential nutrients that samples were developed with the addition of plant raw materials. In order to identify quality indicators on the way toward traceability system construction, it is first necessary to establish basic standards. The chemical composition of caviar in different fish species and in different seasons of the year can vary. Changes in chemical composition of ovarian membrane and caviar may occur as grains mature. Also, the lipid content of full roe is significantly lower than in immature. During the grain of roe maturing process, the amount of water increases significantly. Thus, fat content is 1-2%, water content is 50-70%, nitrogen content is about 26-28%. However, in practice, these indicators often differ. Including due to a violation of technology, caviar treatment. Not to mention possible cases of its falsification in order to increase weight, or conceal signs of vices, staleness. Therefore, laboratory analysis of the study of the main physical and chemical indicators of the control specimen of perch caviar, developed samples and their comparative analysis with the requirements of normative documentation was conducted. The results are presented in Table 1.

On the basis of the data, it is shown that the results of the test specimens deviate from the norm by not more than 1.5% for all indicators except moisture. The amount of moisture in the samples is 6-8.5% lower. This is due to the greater amount of dry residue, due to herbal supplements. Let's look at the obtained indicators on the graph for the for illustration purposes. Thus, Figure 1 shows that the number of all indicators is correlated with the benchmark, which makes it possible to use the data in further studies and conclusions. The perch caviar with sea buckthorn is closest to the control specimen.

Based on the represented data, it is concluded that the benchmarks for the construction of the quality system can be based on the indicators of the control specimens, which correspond to the normative documentation, taking into account the error of 1-2%. The moisture content needs to be adjusted.

3.2 Amino acid score definition

The quantity and quality of protein play an important role as an indicator of the quality and biological value of caviar of freshwater fishes. Since essential amino acids are essential nutrients that are not synthesized in the human body, they must be obtained together with food. Therefore, the composition of perch caviar proteins in accordance with the "ideal" protein, as recommended by FAO (Food and Agriculture Organization)/ WHO (World Health Organization), has been considered. Also score of limiting acid is important as an indicator of the level of accessibility of the product as a whole. Table 2 shows the amino acid levels that have been tested and are comparable to the score of ideal protein.

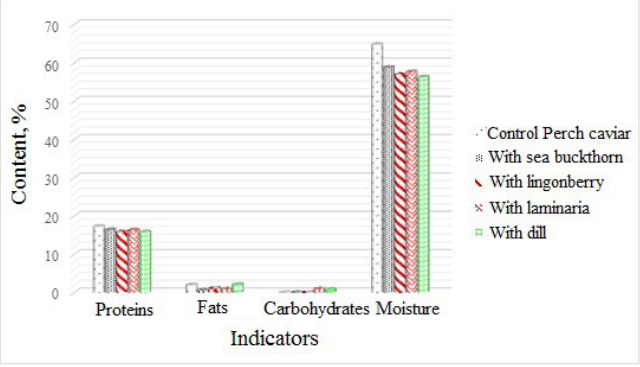

Figure 1. Comparison of protein, fats, carbohydrates and moisture content in developed specimens and control.

Table 1. Physical and chemical indicators of perch caviar and specimens under investigation.

Specimens/ Indicators	Perch caviar	Specimen 1 (with sea buckthorn)		Specimen 2 (with lingonberry)		Specimen 3 (with laminaria)		Specimen 4 (with dill)	
		result	deviation, %	result	deviation, %	result	deviation, %	result	deviation, %
Proteins, %	17.3	16.39	0.91	15.83	1.47	16.31	0.99	15.85	1.45
Fats, %	2	0.62	1.38	1.09	0.91	0.91	1.09	2.13	0.13
Carbohydrates, %	0	0	0	0	0	0.93	0.93	0.83	0.83
Moisture,%	64.82	58.77	6.05	56.94	7.88	57.63	7.19	56.26	8.56

Table 2. Amino acid score of developed specimens of enriched caviar.

Specimens/Amino acid	Ideal score	Specimen 1 (with sea buckthorn)	Specimen 2 (with lingonberry)	Specimen 3 (with laminaria)	Specimen 4 (with dill)
leucine + isoleucine	3.6	1.1	1.6	1.73	1.7
valine	1.8	0.88	1.35	1.42	1.4
methionine + cystine	2.4	0.4	0.74	0.7	0.72
threonine	1.3	0.62	0.95	0.87	0.91
lysine	2.2	0.62	1.72	1.63	1.6
phenylalanine + tyrosine	2.5	1.36	2.58	2.54	2.5

Table 3. Results of studies on vitamin content in tested specimens.

Specimens/Vitamins, mg/100 g	Daily maintenance of human	Specimen 1 (with sea buckthorn)		Specimen 2 (with lingonberry)		Specimen 3 (with laminaria)		Specimen 4 (with dill)	
		content	% of daily maintenance	content	% of daily maintenance	content	% of daily maintenance	content	% of daily maintenance
Vitamin A	0.90	0.043	4.78	0.029	3.22	0.092	10.22	0.085	9.44
Vitamin E	15.00	2.02	13.47	2.08	13.87	2.12	14.13	2.33	15.53
B2 (riboflavin)	1.80	0.8	44.44	0.8	44.44	0.57	31.67	0.66	36.67
B6 (pyridoxin)	2.00	0.74	37.00	0.18	9.00	2.39	119.50	3.76	188.00
B3 (pantothenic acid)	20.00	1.2	6.00	0.85	4.25	0.89	4.45	0.57	2.85
B5 (nicotinic acid)	5.00	0.39	7.80	0.56	11.20	0.91	18.20	0.35	7.00
B9 (folic acid)	0.40	0.09	22.50	0.11	27.50	0.065	16.25	0.044	11.00

On the basis of the obtained data, a graph has been constructed for a visual comparison of the completeness of proteins and examined images. Figure 2 shows that the closest to the ideal protein is perch caviar with laminaria. The combination of fish and algae proteins increases score in comparison with other combinations.

The graph shows that the limit indicator for a specimen with sea buckthorn is methionine + cysteine at 0.4, for a specimen with lingonberry is methionine + cysteine at 0.74, with dill is methionine + cysteine at 0.72, with luminaria is threonine at 1.3 Particularly at this level the human body uptakes all the other essential amino acids. Also according to modern studies, human nutrition should be balanced, rational and healthful, prevent the deficiency of minerals and antioxidant vitamins A, E and B. Therefore, in the process of developing innovative technologies for the enrichment of perch caviar, also investigated the content of fat-soluble vitamins A (retinol), E (tocopherol) and water soluble vitamin B complex. Table 3 shows the results of the studies, and comparing their content with the recommended daily maintenance.

Table 3 shows that 100 g of developed specimens provide between 3 and 10% of daily vitamin A requirements, between 13 and 15% in vitamin E and between 6 and 120% in vitamin B complex. The results are shown on the graphs in Figure 3 in the form of a profile.

From the Figure 3 it can be concluded that the profile of the specimen with a sea buckthorn has the largest area on the graph. That is, this specimen has a composition that more satisfies the daily requirement of vitamin A, E, complex. In this way, the addition of plant supplements to the perch caviar is able to increase the amount of water-soluble vitamins and carbohydrates,

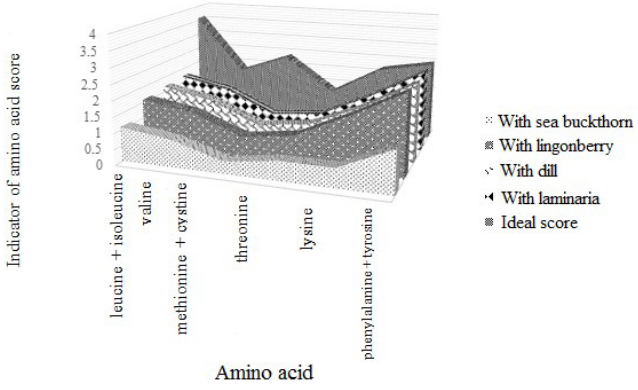

Figure 2. Diagram of comparison of amino acid specimens with ideal protein.

especially dietary fibers. The results will be used to determine the traceability system of perch caviar. Also, following control points will be take into consideration. There are:

– monitoring of the production process along the entire processing chain (from the receiving of fish seed, fish stocking of water body, aquaculture, fish capture, processing, shipment);

– identification of the entire batch (manual and/or automatic identification) through labeling or bar coding;

– collecting a report on the holistic process of production and movement of each batch of products.

According to Technical Regulation of the Customs Union (TR TS 022/2011) "Food products in terms of their labeling" (Comission of the Customs Union, 2011b) the concept of "food

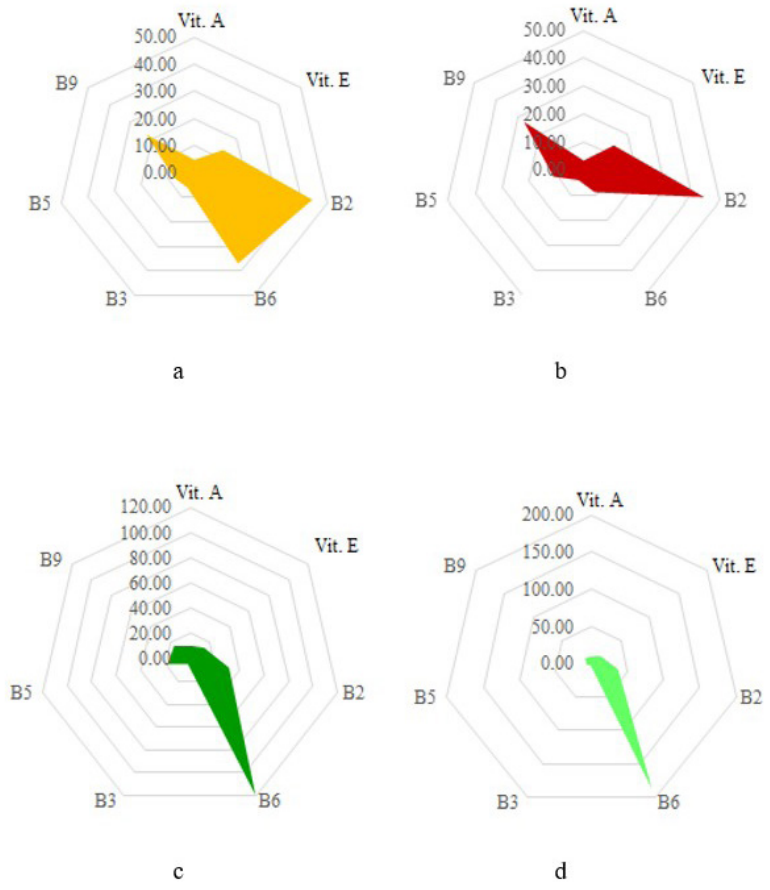

Figure 3. Profiles of vitamin requirement specimens. a – Specimen 1 (with sea buckthorn); b – Specimen 2 (with lingonberry); c – Specimen 3 (with laminaria); d – Specimen 4 (with dill).

product labeling" is planned to provide information about perch caviar, which will be applied to consumer packaging or documentation attached to it. Thus, it is planned to indicate such indicators as energy value; protein content (including amino acid score), fats, carbohydrates; number of vitamins and minerals. The biological value of perch caviar should be given per 100 grams and per batch. In the further construction of the traceability system algorithm, the control points at the relevant stages of the life cycle of perch caviar [GOST 34.003-90, State Committee for the Russian Federation for Standardization and Metrology (1992)] were determined. The control points are:

1. Analysis of conformity of quality, quantity and assortment of products to GOST, regulations and requests of the distribution network and, ultimately, consumers.
2. Analysis of the best way to ship products and observance of terms of shipment and storage.
3. Analysis of the ratio of the quantity of delivered products and output sold.

4 Discussion

It should be noted that the fishing industry in Kazakhstan, in particular the production of fish products from the perch family (Percidae), is in a negative situation. This is due to the increase in poaching, as well as the increasing scale of illegal production of perch. There is no effective legislative framework and, accordingly, executive practice, which regulates the turnover of perch products, including caviar. Therefore, the process of developing the traceability system of perch is necessary to solve the important state problem of protection of perch. Key elements of the traceability system are being developed in the process. Detailed analysis of this issue was also made in the Technical Regulation of the Russia-Kazakhstan-Belarus-Kyrgyzstan-Armenia Customs Union (CU) "On Safety of Fish and Fish Products" (TR TS 040/2016) (Russia-Kazakhstan-Belarus-Kyrgyzstan-Armenia Customs Union, 2017), Technical Regulation of the Customs Union (TR CU 021/2011) "On Food Safety" (Comission of the Customs Union, 2011a) in the part of the regulation of the traceability system implementation, state registration, labelling of food products. In the course of the work, an analysis of existing studies, devoted to the problem of the market conditions of the market outlet of perch caviar, was carried out. Kirillov et al. (2011) analyze the market of agriculture in Kazakhstan and identify it as promising and requiring scientific attention. This correlates with global trends in the aquaculture market (Tacon, 2020).

According to the Guidance on the Implementation of Articles 11, 12, 14, 17, 18, 19 and 20 of Regulation (EC) No. 178/2002 on

General Food Law (Standing Committee on the Food Chain and Animal Health, 2010), modern innovative food development technologies are based on the recommendations and experiences of Western European countries. Thus, Charlebois et al. (2014) described that the developed recommendations on nutrition concern primarily the quality of food, not the quantity of food consumed, and include the following provisions: consumption of more diverse foodstuffs; balance of energy consumption and physical activity; increased consumption of fruits and vegetables; daily intake of starch-containing foodstuffs; reduced consumption of sugar-containing foodstuffs; reduced intake of fats, especially animal fats; reduced intake of trans-fatty acids; use of fat fish, a source of polyunsaturated fatty acids – omega-3 (PUFAs ω-3). According to the studies (Tavakoli et al., 2021), fish and fish products are the source of many nutrients that humans need. And these are, above all, complete proteins, fats, carbohydrates, mineral elements and vitamins. On this basis, fishing industry, marketing and processing products are constantly increasing (Prajapati, 2016). Taking into account the conclusions of Wilson & Beers (2001) on the active development of the world's aquaculture, it is necessary to admit the fact that in order to make full use of its potential it is necessary to improve the systematic management of this sector. In this regard, FAO (Food and Agriculture Organization, 2011) has developed international recommendations to involve the aquaculture sector in the production of certified fish products.

In particular, in the works written by Titlov et al. (2016), it can be saw that the Balkhash perch (Perca schrenkii) is very popular amongst consumers. Perches can live in fresh and salty waters. But at the same time, common perch (river perch) and sea perch are different fish families. Balkhash perch is found only in the Semirechye basin in Kazakhstan. It is endemic to the Balkhash-Alakul hydrologic system. It differs from the common river perch – Perca fluviatilis in appearance. The main subject of study in this article is perch caviar. In particular, caviar is a food product that is derived from ovarian membranes, and which is undergoing a complex process of processing caviar grains (Chen & Yu, 2022b). The female perch lays eggs in the form of long (up to 1 m) webbing made of gelatinous substance, and the accompanying males milt it. Perch caviar is characterized by high water cut. The water content is up to 56%. The diameter is 2-2.5 mm (sometimes 1 mm). Common fresh water fish caviar and other fish are supplied to the sale cans and barrel screened caviar, i.e. free from the connective tissue of ovarian membranes, as well as roe in the sac. Pike perch and Balkhash perch roe in the sac are called halagan.

It should be noted that there is not so much research of perch caviar, as among Russian-speaking authors, as well as in English-speaking sources. Berestovskyi & Frolov (2005) analyzed the occurrence of the perch family (Percidae), and the features of their use in Kazakhstan. In the studies of Balaswamy et al. (2007) can be found the analysis of food compositions based on perch caviar. Blanchard et al. (2005) studied the lipid composition on the basis of river perch caviar Perca fluviatilis. At the same time, studies of the biological value of caviar of other families are found in the scientific literature. For example, Lebskaya & Menchinskaya (2015) carried out a comparative characterization of the nutritional value of carp caviar, sazan, silver carp. Measurements of the amount of essential amino acids of the caviar protein of these fish species are also available. Ensuring the safety of fish products is one of the main objectives of food security. And food security is becoming a global issue. As the importance of fishing industry is expected to increase further, there is a need to improve monitoring and management of fisheries resources. It should be noted that the process of processing fish into value-added products in turn increases the value of the catch, as caviar contain useful micronutrients, in particular fatty acids.

It has been determined that the approach to the fisheries management system should have a more extended socio-economic and environmental scale. The scientific community has been advocating this idea of expanding fisheries management. For example, through the application of the Ecosystem Approach to Fisheries Management (EAFM) (World Trade Organization, 1995). Also, the regulation of the fish market is of national importance for the safe and efficient delivery of fish and fish products from water bodies to markets. There is a need to ensure that the supply of fish products is sufficient to meet market demand. Traceability of fish production is of paramount importance to consumers and public health. Following the conclusions of Mikhaleva et al. (2018), this cannot be done without a systematic approach to the management of business processes in the fish industry. This process should be carried out taking into account the resource, natural-climatic and innovative potential. This is the most important task of the current stage of development of the fishing industry. Aquaculture is now receiving increasing attention, as these areas are important in the socio-economic development of various areas of the global and national economy, and as sources of income, including foreign exchange earnings, and to saturate domestic markets with safe and quality food.

It should be noted that the technology of processing ovarian membranes and fish caviar is quite laborious, has many steps. Therefore, it requires strict observance of all parameters of manufacturing process, processing and preservation of caviar grains. In standard technology, caviar is preserved with salt (sodium chloride) and the addition of antiseptics (sodium benzoate, sorbic acid). The conducted studies correlate with the research of Sytova (2017) about safety and information support of traceability of aquaculture products. The results and conclusions of the study will make it possible in the future to develop a detailed algorithm for determining the criteria for assessing the safety and quality of caviar of the perch family (Percidae) based on the traceability system. Thus, the main control points that are taken into account to ensure the safety of food fish products in the production process are:

- process control and modes of their implementation at all stages of production;
- optimal process sequence, which eliminates contamination (pollution);
- control of operation of technological equipment;
- compliance with storage conditions of fish products, as well as packaging, wrapping materials;

Table 4. Determination of traceability indicators of the production of caviar of the perch family (Percidae).

No.	Indicator	Cause & Effect	Data source for indicator
1	Increase of production	Increase of production → increased likelihood of disease → use of antibiotics → health risk	FAO (worldwide production of perch caviar), Eurostat (production of perch caviar in Europe)
2	Declining number of wild-caught fish	Reduction of wild fish feed stocks → more expensive fish feed → substitution of fish oil and fish feed from cheaper plant protein and fat	International Council for the Exploration of the Sea, FAO
3	Replacement of fish protein and fat with plant protein	Substitution of fish oil and fish feed from cheaper plant protein and fat → production in countries with other control system regulations → increased use of antibiotics, genetically-modified vegetables → unknown growth modification, fish health, caviar	World Trade Organization
4	Fatty acid profile of caviar	Fatty acid profile of final good (decreased omega-3) → reducing health benefits for consumer	Studies by organizations such as VEFTA and the Research Council of Norway
5	New developed chemical additives for modern technology	New packages, chemicals, modern technology → recycling → environmental pollution → accumulation in fish → health risk.	Research organizations
6	Consumer trends for natural and fresh seafood	Natural and fresh seafood → It is required to extended storage period → development of new conservation techniques → new unknown preservative microorganisms → health risk.	Consumer organizations, World Trade Organization

- compliance with the rules of operation of equipment, sanitation and hygiene of premises, technological inventory, equipment;
- choice of the method and frequency of sanitation, disinfection of premises, equipment and inventory;
- maintenance, storage of technical and technological documentation, which confirms compliance with safety and quality requirements;
- operation of a safety system during the production of caviar of the perch family (Percidae).

The Emrisk (2021) project has compiled a list of criteria for ranking of indicators of traceability system. These data are summarized in Table 4.

The presented indicators will form the basis of the algorithm of accumulation and collection of information about the product for the development of traceability system in the production of products from aquaculture and aquatic bioresources. The application of a conceptual approach to the development and phased implementation of a traceability system in the production of caviar of the perch family (Percidae) will make it possible to make the production and turnover of this product transparent. Compliance of its key points will allow to carry out control of safety and quality of caviar of the perch family (Percidae) at all stages of production, shipment, storage, processing, sales taking into account international requirements and national legislation.

5 Conclusion

In the course of the work, an analysis of existing studies on the main indicators of quality and biological value of perch caviar was carried out. To sum up, perch caviar is a valuable foodstuff that requires a scrupulous compliance with technological process. Implementation of international requirements to the safety and quality of aquaculture products through traceability certification systems will allow in accordance with "System of Product Safety Management" and "Model of the System of Safety Management of Aquaculture Products" to increase the competitiveness of national aquaculture products, also to meet the needs and expectations of consumers and commercial parties. This will help to ensure the entry of domestic aquaculture enterprises into the world market, including the European Union countries, as well as their competitiveness in the domestic market.

Thus, the development and introduction of a system of quality traceability and safety of caviar of the perch family (Percidae) at all stages of its production will allow to determine the origin of products, identify the companies responsible for each stage in the production line, monitor irregularities that may have negative consequences for the health of consumers (Carvalho et al., 2022). Thanks to a clear system of control points, information openness end users will be able to learn detailed information about the producer, raw materials, production ingredients. As well as the composition and quality. Will be timely informed in case of risks of purchase of dangerous and low-quality fish products. The presented recommendations on the maintenance of traceability of caviar of the perch family (Percidae) will allow to carry out safety and quality control of food at all stages of production, storage, shipment, processing and sales in accordance with the requirements of national legislation and international requirements.

The practicability of the proposed options for the enrichment of perch caviar is confirmed by studies of physical and chemical indicators. Thus, the content of proteins, carbohydrate, fats in the developed specimens allows to keep quality indicators at the confirmed level. It is also important to study the accessibility of fish caviar specimen protein, which is based on the calculations of the amino acid score. Due to the addition of plant products, the developed samples have a higher biological value, in particular, a higher content of fat-soluble vitamins A and E, water-soluble vitamin B complex. The study identified a number of issues, which require further study. Thus, the received indicators of

biological values should be included in one of the steps of the traceability system – product labelling. Continued work on the traceability system for caviar of the perch family (Percidae) allows to increase in the market consumption of products with increased biological value and guaranteed quality.

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