Improving the quality of functional fish products based on management and qualimetry methods

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Abstract. The article proposes a new fish product and process design approach, which includes qualimetry approaches (the property tree, a comprehensive method of qualimetric assessment, qualimetric scaling, expert qualimetry, qualimetric forecasting) and up-to-date quality management methods (ISO 9000, causal diagram, Quality Function Deployment – QFD), safety methods (ISO 22000, decision tree) as well as the results of the practical application of the new approach. The nomenclature of indicators of consumer requirements for the quality of fish cakes and the mandatory requirements of regulatory documentation have been identified, the most popular fish cakes brands among consumers have been identified, and the values of the most important indicators of the quality of fish cakes required by consumers are predicted: protein content (at least 17%), shelf life (12 months), a decrease in fat content (not more than 2.5%) and a price (not more than 50 rubles); moisture content \( \leq 85\% \); the absence of pathogenic microorganisms as well as of artificial food additives and preservatives, the content of healthful functional components of non-synthetic origin. The recipe and production technology of fish cakes with the indicated properties have been developed. Measures have been taken to ensure the safety of the new product and five critical control points (CCP) have been identified, namely, raw material acceptance, weight mixing, frying fish cakes, freezing fish cakes, storage and sale of finished products. The analysis of experimental samples of fish cakes showed their advantage over analogues.

1. Introduction
The domestic and world food market develops rapidly due to the expansion of the product range [1,2]. This is especially relevant for fish products because of the growing trend in the popularity of a healthy lifestyle and the desire of consumers to increase the content of high-grade and easily digestible protein in their diet [3]. Moreover, fish products with a high degree of readiness have an advantage over fish in their consumer properties: the speed of preparation of the product for use, the lack of need for the consumer to take out the bones, and a longer shelf life. The segment of functional foods develops especially fast.

The growth of the fish products market requires new approaches from producers as well as state control and supervision bodies to improve the quality of products and guarantee their quality and
safety [4]. It requires from manufacturers to use only the approaches which are proven in practice and recognized by the international and scientific community. At the same time, the use of non-standard approaches, which are a combination of proven and effective methods in the field of qualimetry and quality management, allows one to optimize the quality management of the designed and manufactured products, i.e. make quality management more efficient and flexible. New approaches to finding ways to increase the competitiveness of products at the design stage can significantly reduce the cost of adjusting finished products after they enter the market. Domestic experience in this field offers methods of qualimetry [5] (in particular, the methodology of qualimetric forecasting), and the world experience offers the QFD methodology. The combination of the QFD expert method with the scientific approach of expert qualimetry to the organization of these expert assessments as well as the application of qualimetric forecasting, will allow developing more precise requirements for the designed indicators of product quality, faster developing a new product with higher quality and bringing this product to the market. This may provide an additional competitive advantage [4].

The aim of the work is to develop a new approach to improving the quality of functional fish products based on the application of methods of qualimetry and quality management.

To accomplish this aim, it is necessary to perform the following tasks: to develop and scientifically substantiate a new approach to improving the quality of fish cakes, to carry out the practical implementation of the proposed approach by applying qualimetric forecasting to identify and analyze the range of consumer requirements for the quality of fish cakes and mandatory documentation requirements, forecasting the values of required properties product of higher quality, the development of recipes and technology for the production of new fish cakes, development of measures to ensure the safety of the production of a new fish product as well as a comparative analysis of the quality of the new product compared to the commercially available counterparts, and the development of technical documentation.

2. The purpose of the study
One of the main problems in the production of food products, in particular, fish products, is the search for new ways to increase competitiveness, primarily due to more accurate forecasting and more complete implementation of consumer requirements for the quality of manufactured or designed products. The aim of the work is to develop such an approach to the production of fish products, which will accelerate this process, increase its efficiency, and thereby achieve a competitive advantage.

3. The object of the study
The objects of the study were production technology of fish cakes, Vici fish cakes (Vichiunai RUS OOO), Bukhta Izobiliya fish cakes produced according to TU 10.20.15-007-75228040-2017 and fish cakes produced according to TU 9261-048-38826547-2016 (“LUBO” LLC).

4. Materials and methods
The following expert qualimetry methods were used in the work: a property tree, a complex method of qualimetric assessment, qualimetric scaling (semantic unipolar 5-point interval scales), a mixed method of forming expert groups (for conducting expert evaluations). Other expert methods used in this work include: QFD methodology, cause and effect diagram, decision tree, and profile method of organoleptic assessment.

Content of fat, protein, and moisture and bacterial contamination were determined by standardized methods. Shelf life of the product was determined according to MUK (Methodological Guidelines) 4.2.1847 - 04. “Sanitary and epidemiological assessment of the justification of shelf life and storage conditions of food products. Methodological conditions”.

The quality of expert assessments was evaluated on the basis of determining the consistency of experts by calculating the coefficient of concordance. All experimental studies were carried out using three-, fivefold repetition and were processed by methods of mathematical statistics.
5. Discussion of the results
Scientific work included two large stages. At first, a new approach to improvement of the quality at the most important stages of the product life cycle (fish cakes) based on the application of the methods of qualimetry and quality management mentioned above was developed. A schematic representation of the proposed approach is presented in figure 1.

![Figure 1. Schematic representation of the developed approach to improving the quality of functional fish products based on the methods of qualimetry and quality management](image)

The second stage of research included testing the proposed approach and its practical implementation. To this end, opinions of consumers of fish cakes were analyzed and the most popular brands of fish cakes were identified (indicated in the objects of study). It was found that the following indicators of consumer preferences have the highest weighting factors in forming consumer requirements for the quality of fish cakes: taste, low calorie content, lack of food additives, consistency, long shelf life, flavor and colour (104, 89, 84, 80, 78, 62 and 54 points respectively). The requirements of normative and technical documentation for fish cakes were analyzed. These results are shown in the left and upper part of the matrix of consumer requirements for the quality of fish cakes (figure 2). In addition, it was found that the healthiness of products is also important for consumers and they wish and are ready to buy healthy products containing useful functional components of non-synthetic origin. Besides, it was found that consumers prefer fish raw materials caught in the sea rather than from fish farms, as such fish contains fewer hormones and antibiotics [6,7], the presence of which is extremely undesirable for the consumer. The obtained data and the results of experimental and
expert studies formed the basis of the matrix of consumer requirements for the quality of fish cakes presented in figure 2.

The following target values of product quality indicators were identified: protein content (at least 17%) and shelf life (12 months); and a decrease in fat content (not more than 2.5%) and prices (not more than 50 rubles); moisture content was $\leq 85\%$; the absence of pathogenic microorganisms and the absence of artificial food additives and preservatives.

The identified target indicators of the quality of the designed fish products were taken into account when developing the production technology (figure 3) and the recipe of new types of fish cakes (table 1).

For the proposed technology for the production of fish cakes, the physical, biological and chemical factors affecting the safety of fish cakes were identified and analyzed, cause and effect diagrams were developed, and CCPs were scientifically substantiated and corrective actions were proposed. The technical documentation: TU 10.20.11-171-00492931-2018 and TI TU 10.20.11-171-00492931 are developed.
Figure 3. Scheme of the technological process for the production of fish cakes with the indication of CCP
Table 1. Recipe of new fish cakes

| Ingredients                                      | Mass of ingredients in (g) / 100g. |
|-------------------------------------------------|-----------------------------------|
| Minced silver carp (Hypophthalmichthys molitrix) | 60                                |
| Boiled and mashed potatoes                      | 11.7                              |
| Breadcrumbs                                      | 9                                 |
| Top-grade baker’s flour                         | 3.3                               |
| Egg white                                       | 8                                 |
| Spinach                                         | 6                                 |
| Table salt                                      | 1.0                               |
| Black pepper                                    | 0.5                               |
| Ginger                                          | 0.2                               |
| Turmeric                                        | 0.2                               |
| Garlic                                          | 0.1                               |
| Total                                           | 100                               |

The produced experimental samples of fish cakes according to the proposed recipe were analyzed by target quality indicators. It was found that the analyzed samples contained 17.2% of protein, 2.3% of fat, and 77.1% of moisture; pathogenic microorganisms, artificial food additives and preservatives were not found. Research of the organoleptic characteristics of the experimental samples showed the superiority of the new product compared to analogues on the market.

Figure 4. Profile assessment of organoleptic properties of fish cakes

6. Conclusion
The practical implementation of the proposed approach to improving the quality of fish products based on the application of quality management and qualimetry methods has shown its viability and effectiveness. The proposed approach allows one to quickly implement in the product new trends in changing consumer requirements for the quality of fish cakes, substantiate the recipe for the designed product, adjust production technology and ensure the safety of the produced fish product. Using this approach can give a competitive advantage to a fish product manufacturer.

In addition, introducing into the recipe a spinach, as a functional component, containing a large amount of potassium, magnesium, phosphorus, A and K vitamins, and dietary fiber, allows one to increase the healthiness of fish products.
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