Development of fish soups technology with using food supplements from fish remaining feedstock

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Abstract. This article describes the technology for the whiting cream puree production using food supplement from fish remaining feedstock. The sociological survey results and analysis of consumer preferences of Murmansk population regarding enriched food are presented, the degree of public awareness of the food effect quality to the general health state, interest in a balanced diet to maintain health is studied, and the population attitude to the enrichment of traditional products with natural nutrients such as like calcium and phosphorus. A basic recipe for puree soup has been developed and has been optimized by computer simulation. To search for a near-optimal mineral composition and consistency of soup, has been used the planning and experiment method with processing non-linear regression of the results by the Datafit 9.0 computer program. The chemical composition experimental results of the puree soup and its caloric content are presented, and the content of calcium and phosphorus in one portion is determined with analysis of the results. It is ascertained that the course belongs to high-protein, medium-calorie and is a source of calcium and phosphorus. Optimal for the absorption and assimilation of the ratio of phosphorus to calcium in the diet according to various sources ranges from 1: 1 to 1: 1.5. The ratio of phosphorus to calcium in haddock bones flour is 1: 1.3, in the prepared soup-puree 1: 1, and, therefore, can be considered optimal. The prepared course has excellent organoleptic characteristics, high nutritional value and can be used as an additional source of calcium and phosphorus.

1. Introduction

Improvement of fish processing technologies is an actual production and socially significant task [1]. One of the trends of intensification of processes for obtaining food products is the use of low-profitable fish feedstock and processing remaining [2].

In the current, the products formed during the complex processing fish are remaining mainly used for technical and cattle or pat feed purposes. However, they contain a wide range of biologically valuable components and are a promising remaining for obtaining enriched food [3]. In particular, bones of cod fish species that remain on fillet cutting are a source of bioavailable calcium and phosphorus. Calcium is a necessary element of the bone mineral matrix, regulates the nervous system,

muscle contraction. Phosphorus is the basic element of skeleton bones and teeth, has the ability to inhibit oxidative processes, is part of the phospholipids, nucleotides and nucleic acids [4].

Currently, fast-frozen meals, including soups, which are ready for use after a short heat treatment in order to bring them to the serving temperature, are of great importance in public catering. At the same time, the assortment of quick-frozen soups in retail chains is not sufficient, therefore, the development of new recipes is an urgent and actual task. Use of fish raw materials such as blue whiting will make these products accessible to the masses of consumers, and the enrichment with bioavailable components, such as phosphorus and calcium, will be used in preventive nutrition of population various groups [1,5].

In accordance with the State policy on healthy nutrition for the period up to 2020, one of the priority tasks in the field of food production is to expand the range of functional products, dietary (therapeutic and preventive) foods and biologically active food additives [6].

The purpose of this work is to scientifically substantiate and develop the technology of fish soups using food additives from families of cod cutting fish waste and raw materials.

To achieve this goal, the following tasks were formulated:

- to conduct a sociological consumer preferences survey and analysis of the Murmansk population with respect to fortified foods in order to study the degree of public awareness about the food quality impact on the general health condition, interest in a balanced diet to maintain health level and find out the population’s attitude to the enrichment of traditional products with natural nutrients, such as calcium and phosphorus;
- develop a recipe for fish soup with the introduction of functional additives;
- determine the biological value of products.

2. Materials and methods

Marketing research in the work was carried out by the method of questioning, the sample size was 100 random respondents. The object of the research was the whiting cream purée, prepared in accordance with the technological scheme. Inserted raw materials, consistency, regulatory additives and other components comply with the requirements of actual regulatory documents.

To determine the product quality indicators and samples was used the organoleptic evaluation method.

For an objective assessment of the "consistency" indicator, the kinematic viscosity index was experimentally determined using an ATV viscometer. The calculation was made by the standard method.

Sampling of the finished product and preparing them for analysis was carried out according to standard methods. The determination of the product quality organoleptic indicators was carried out by the specially developed point scale. The results are presented in the form of profilograms.

Mathematical modeling of the formulations was made by the rotatable central compositional planning of the experiment. The Fisher criterion (F-criterion) was applied in assessing the adequacy of the obtained mathematical relationships. For statistical processing of experimental results, the nonlinear regression method was employed. Nonlinear regression coefficients for experimental curves were calculated by regression analysis of the Datafit 9.0 computer program [7].

Determination of mineral components - by standard methods.

3. Results and discussions

At the initial stage of the research, a marketing study was conducted on how often using fortified foods among the population of Murmansk. As a result, it was found that only 14% of the surveyed respondents regularly consume products with added micronutrients, and 72% buy these products very rarely. Thus, simultaneously with the development of new technologies for fortified food products, it is necessary to carry out work to increase public awareness (advertising) of their benefits and ways of expanding the range.

About a one third of respondents (35%) prefer the use of vitamin complexes and dietary supplements to solve problems caused by unbalanced nutrition. The same number of respondents opted for fortified products.

In the course of the work, it was revealed that more than half of the respondents rarely use foods rich in phosphorus and calcium. So, 48% of respondents consume milk and dairy products only 2-3 times a week, legumes, which are a rich source of calcium, 75% of respondents consume an average of 1-2 times a month. About half of the respondents (44%) consume fish and seafood 1-2 times a month.

Analyzing the obtained experimental data, we can conclude about the potential need for additional intake of calcium and phosphorus to all social levels of the Murmansk population. Vitamin and mineral replenishment of 48% respondents is carried out with the help of vitamin complexes and dietary supplements on average 1 to 2 times a year and 26% with regular courses, which, in general, indicates the interest of the population to maintaining health and preventing diseases.

However, according to numerous studies, a person needs regular intake of micronutrients for normal life. Therefore, the enrichment of food with mineral compounds with the development of new formulations and technologies is relevant and actual.

At the Department of Food Production Technologies of the Murmansk State Technical University, over the course of several years, a search has been made for technological solutions for waste processing from cutting commercial fish feedstock remaining of the Northern Basin fishing industry and at the moment a technology has been developed for the production of fish bone flour rich in mineral compounds, which was used in the development of puree soup enriched with bioavailable phosphorus and calcium. Waste from cutting haddock was used as a raw material for production.

In the development and optimization of the recipe for the puree soup at the initial stage, based on the traditional recipes [8], a basic recipe was developed, which is presented in table 1.

Table 1. The basic recipe of fish soup-puree "Northern"

Product designation	The quantity of 1 liter		The quantity of 1portion	
	Gross mass (gr)	Net mass (gr)	Gross mass (gr)	Net mass (gr)
Frozen blue whiting	516 / 475	220 / 180 *	180 / 166	77 / 63 *
Fresh potato	160	120	56	42
Fresh onions	90	75	31	26
Fresh carrot	94	75	32,5	26
Fresh celery root	12	10	4	3,5
Amaranth flour	7,6	7,6	2,2	2,2
Haddock fish bones flour	4,5	4,5	1,3	1,3
Butter oil	25	25	9	9
Natural milk cream fat content of 22%	80	80	28	28
Fish broth	650	650	228	228
		1000		**350**

* In the numerator the blue whiting fillet mass with skin, in the denominator – the boiled fillet mass

Prototypes produced by traditional technological schemes.

In order to determine the effect of fish bone meal on the quality of the finished puree soup, prototypes of products with different percentages of the developed mineral additive were made. Sample No. 1 is made on the basis of the basic recipe and was the control. Samples No. 2 - 4 are made with the introduction of fish meal in an amount of from 5 to 15% by weight of the base sample in 5% increments. The results of an ogranoleptic assessment of the samples quality are shown in Figures 1-3.

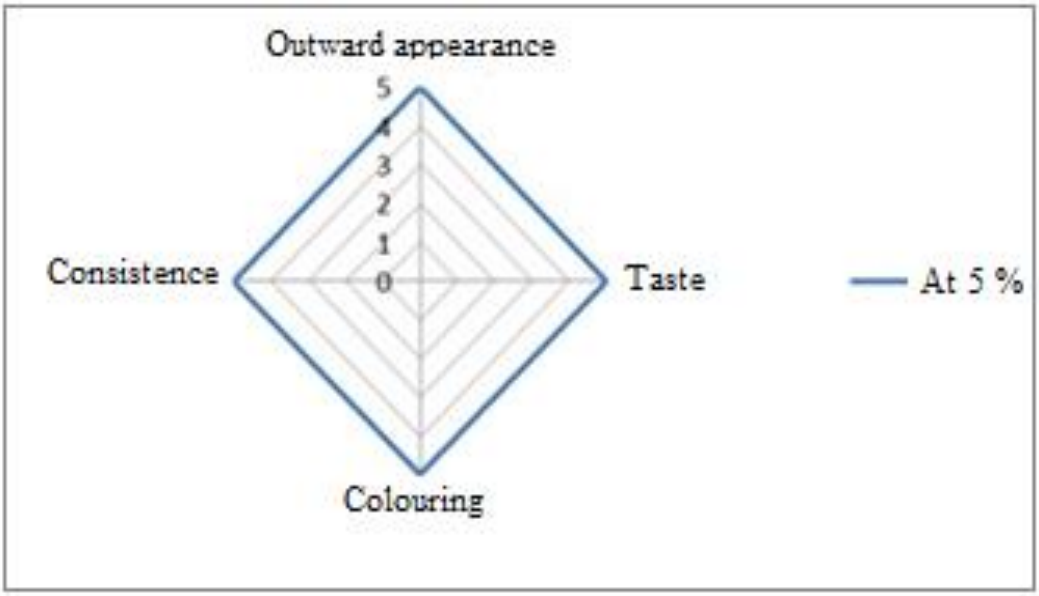

Figure 1. Profilogram of the quality of puree soup with the addition of 5% bone meal..

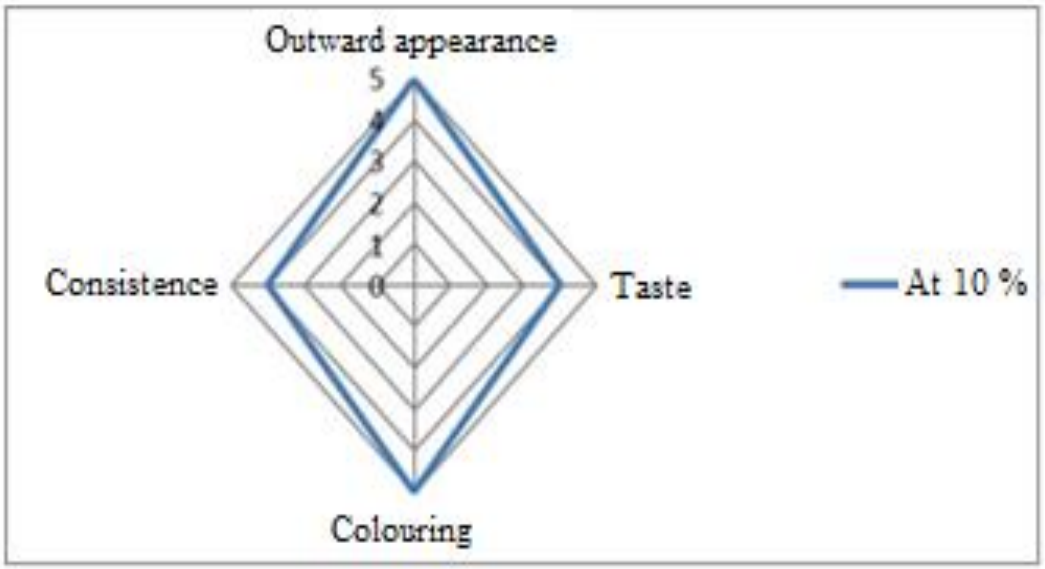

Figure 2. Profilogram of the quality of puree soup with the addition of 10% bone meal.

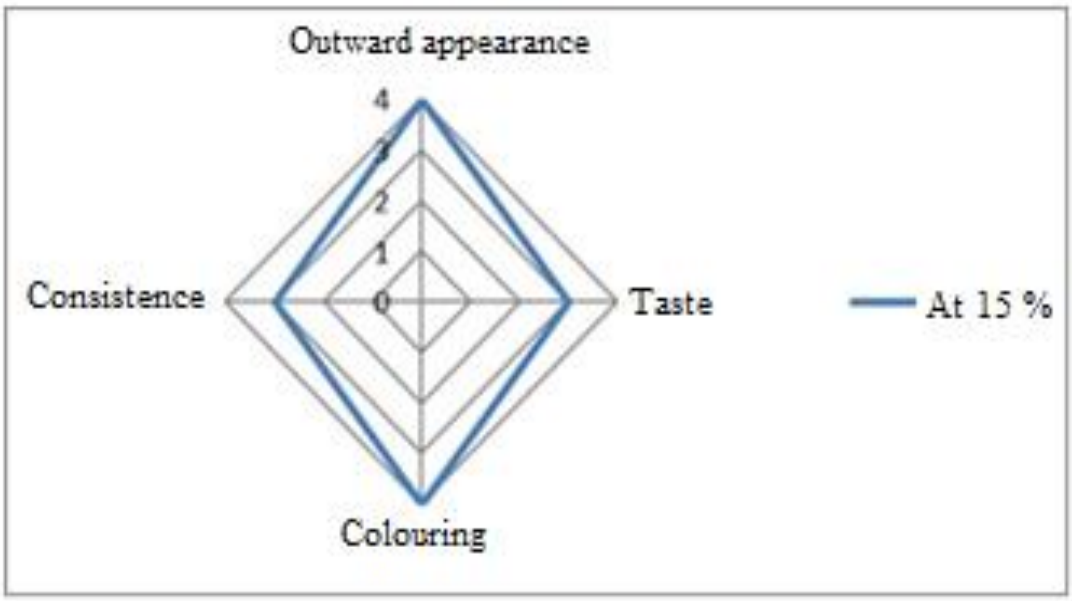

Figure 3. Profilogram of the quality of puree soup with the addition of 15% bone meal.

The soup, made according to the basic recipe, had a too watery consistency, not proper for this type of product. When adding bone meal at the rate of 5% by weight of the net soup, the product had a viscous homogeneous consistency, there were no lumps. When eating a course, the taste of bone meal and its grossness were not felt. The color of the soup is light yellow due to the presence of browned onions and carrots. As the proportion of flour added increased, the consistency of the soup became thicker. The amount of flour did not significantly affect the taste and color of the finished product. When the proportion of bone meal was 15% of the net weight of the soup, the consistency became too thick, which was not typical for this type of product. Considering all these characteristics and the quality of the prototypes, the proportion of flour was fixed at 5% of the net weight of the soup.

During research in bone meal, the calcium content was determined, which was 13%. So, when eating a portion of the puree soup with a net weight of 350 grams, the amount of calcium consumed will be 2.24 grams, which exceeds the daily need of an adult. At the same time, when eating other products containing calcium, the daily dose may exceed the recommended [9] by 2 or more times. What can adversely affect human health. Therefore, it was decided to reduce the amount of bone meal by increasing the proportion of amaranth flour in the recipe.

Based on the results obtained, taking into account the content of mineral compounds in the flour from the bones of fish, the recipe for the puree soup was adjusted to reduce the proportion of mineral components. With a decrease in the proportion of flour from the bones of fish, the consistency of the soup deteriorated; in this reason to maintain the level of product quality, it was necessary to increase the proportion of amaranth flour, which acted as a thickener in the basic recipe [10, 11].

Amaranth flour gives the course a viscous, velvety consistency, and the browned amaranth flour has a pleasant nutty flavor and aroma, which has a beneficial effect on the organoleptic characteristics of the finished product. Potatoes, bulb onions, carrots, and celery stalks were used as herbal ingredients. The share of the vegetable part is 30%. Also, to obtain a product with a delicate texture, creamy taste and aesthetic cream color, natural cow milk cream was introduced into the recipe. Salt and ground white pepper were used as flavoring additives.

In order to optimize the formulation, a two-factor experiment plan was created. Factors fixed at a constant level: the proportion of fish, vegetables, salt, spices and broth per 1000 g of finished products, temperature conditions, cooking time, the size of the cells of the sieve for wiping.

Variable factors:

X_1 - the proportion of amaranth flour applied per 1 kg of the finished dish yield, %;

X_2 - the proportion of flour made from the bones of fish per 1 kg of the yield of the finished dish, %.

Response function: generalized optimization parameter,Y, which includes an organoleptic score of the quality of the finished product (Y_1) in points and the kinematic viscosity of the finished culinary product at a temperature of 40ºC (Y_2) in mm² / s (cSt).

A graphical model of the experiment in the form of the surface of the response function is presented in Figure 4.

Experimental research data were processed by the DataFit 9.0 computer program based on non-linear regression method. The resulting regression equation adequately describes the effect of changes in the amount of amaranth flour and fish bone flour on the generalized quality indicator

$$Y = -0{,}58 + 3{,}17x_1 - 2{,}12x_1^2 + 1{,}70x_2 - 1{,}87x_2^2 \quad (1)$$

Differentiating and solving this equation, we obtained the following variable values: $X_1 = 0.75$ %; $X_2 = 0.46$%.

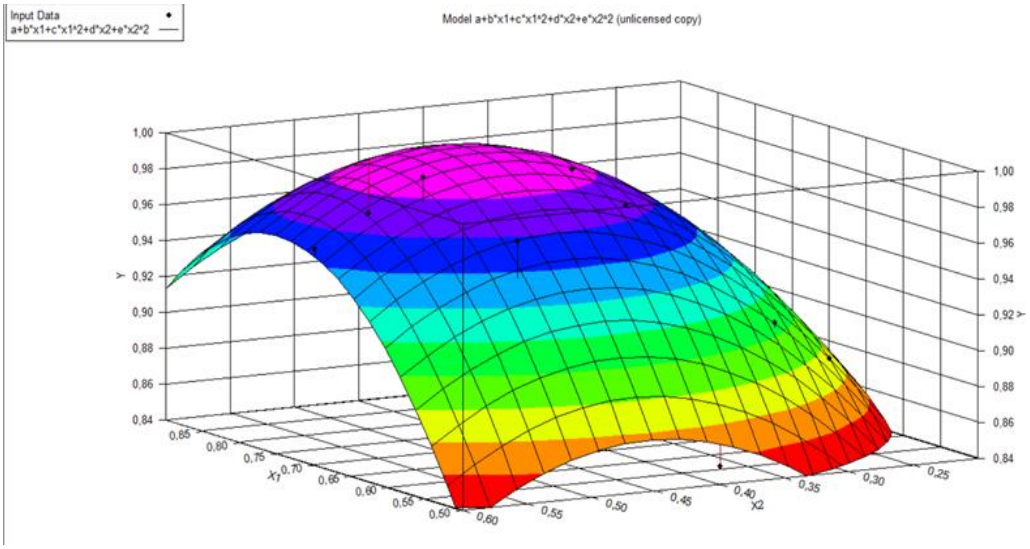

Figure 4. The surface of the response function.

According to the results of the calculations, the optimal proportions of amaranth flour are added - 0.75% by weight of the finished dish and fish bone meal - 0.46% by weight of the finished product. The obtained parameters allow to obtain a high-quality product with a pleasant moderately pronounced taste and aroma without unpleasant tastes of amaranth flour and fish bone meal; homogeneous, creamy consistency; the color of the product is light creamy with an orange tint.

For the soup-puree "Northern" was determined by the chemical composition at the time of culinary readiness. The values of the amount of nutrients and energy value are rounded according to the current regulatory documentation [9]. The results are presented in table 2.

Table 2. Food and energy value of the soup-puree "Northern"

Nutritional value per 100 gr of product			Energy value per 100 gr of product, kcal / kj
Protein, gr	Fat, gr	Carbohydrate, gr	
9,5	3,0	4,0	80 / 335

The content of mineral substances in the finished culinary product "Northern Fish Puree" is presented in Table 3.

Table 3. The content of mineral substances in the soup-puree "Northern"

Type of macronutrient	Adequate level of consumption, mgr	Contents per 1 portion (net mass 350 gr), mgr	Percentage of adequate daily intake, %
Calcium	1000	370	37,0
Phosphorus	800	385	48,1

In the developed soup puree, the ratio of proteins: fats: carbohydrates is 3: 1: 1, the energy value per 100 g of product is 80 kcal / 335 kJ. Therefore, the product belongs to high-protein, medium-calorie and is a source of calcium and phosphorus [9].

Optimal for the absorption and assimilation of the ratio of phosphorus to calcium in the diet according to various sources ranges from 1: 1 to 1: 1.5 [4, 9, 12]. The ratio of phosphorus: calcium in flour from haddock bones is 1: 1.3, and in the finished soup-puree 1: 1, and, therefore, can be considered optimal.

Calcium supplementation with food has a positive effect on the absorption and assimilation of macronutrients, which, according to nutritionists, is associated with food stimulation of motility and increased production of digestive enzymes [4]. The developed product is considered enriched and can be recommended as an additional source of bioavailable calcium and phosphorus [13, 14].

4. Conclusion

Thus, as a result of the research, the technological scheme and recipe of the whiting mashed potatoes with the addition of fish remaining feedstock materials were developed. It has been established that the eating of a soup portion with the addition of 5% of its net weight exceeds the daily share of calcium intake, which is unacceptable due to the presence of other foods containing it in the daily diet of consumers.

The optimization of the previously developed recipe for blue whitened fish puree soup with the addition of the fish bones flour based on organoleptic and structural-mechanical indicators by mathematical modeling methods made it possible to establish the optimal ratio of introduced components. The finished product has excellent organoleptic characteristics, high nutritional value and can be used as an additional source of calcium and phosphorus.

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