

Conference Paper

Research of the Nutritional Value of Combined Fish Pastes for Functional Food

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Abstract

The article deals with the assessment of the nutritional value of fish products based on minced fish, which is becoming more common at present. Thus, the Japanese industry produces more than 1 million tons of products of six hundred items based on minced fish and mashed potatoes. Analysis of production experience shows that in recent years, products made from minced meat, imitating seafood specialties, have been the most popular. In various studies conducted by various authors on the use of fish as a food product, there is no information on recipes that allow the use of most pelagic fish in the dietary diet. To address these issues, it is necessary to investigate the influence of culinary and technological methods on the chemical composition, structural and mechanical properties of fish, and the taste of the finished product. It is known that the chemical composition of fish is subject to considerable fluctuations and significantly affects the choice of recipes and the method of culinary processing. Presented in the literature, the averaged data of various researchers on the chemical composition of fish of mass fishing that are promising for dietary nutrition require clarification for different functional food groups.

Keywords: fish mass, nutritional value, organoleptic indicators

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1. Introduction

According to many experts, the health of the nation is only 25–40 % relied on the health care system, while the health impact of socio-economic conditions and lifestyle is 52–55 %. In turn, system of nutrition is one of the determinative health aspects of a human lifestyle. The advanced population of economically developed countries has realized the need to consume natural food products enriched with the missing components, the main of which are minerals, vitamins, fiber, et al. [1, 2].

At the beginning of the twenty-first century, we can describe the state of health of the population of the Russian Federation by the following data: the total healthy people compose 20–25 % of the total population, 30–35 % has any diseases and practically

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the rest are sick people. The Concept of State Policy in the Field of Healthy Nutrition is aimed at solving the tasks of ensuring the satisfaction of the needs of the population in the healthy nutrition, taking into account the rational ethnic traditions, economic situation and requirements of medical science.

There is no doubt that the leading in terms of the degree of negative impact on the health of the population is currently a shortage of micronutrients--vitamins, mineral elements, certain polyunsaturated fatty acids, et al. This is leading primarily to a sharp decrease in the organism's resistance to adverse environmental factors. The main reasons of the negative aspects in the health of the people are due to the violation of the functioning of antioxidant protection systems and the development of immunodeficiency states. Against the background of the modern concept of functional nutrition, a new attitude towards fish products has emerged, which is practically the only and unique source of diverse, and especially omega-3, polyunsaturated fatty acids that play a responsible role in the human body.

2. Objects and Methods

The objects of research of this work were:

- highly mineralized minced fish, used as an additive in the production of fish pastes (hereinafter referred to as MMF -- mineralized minced fish);
- fish paste, the main raw material of which for 50 % consisted of MMF, and for 50 % consisted of pollock muscle tissue, carrots, onions, water, salt, spices (the sample No. 2);
- fish paste, the main raw material of which for 25 % consisted of MMF, and for 75 % consisted of pollock muscle tissue, carrots, onions, water, salt, spices (the sample No. 3);
- fish paste, the main raw material of which for 15 % consisted of MMF, and for 85 % consisted of pollock muscle tissue, carrots, onions, water, salt, spices (the sample No. 4).

Knowing the amount of proteins, we can get only an approximate idea of the nutritional value of the product. Currently, there are twenty indispensable amino acids that are formed during the breakdown of proteins. To study the nutritional value of the developed fish pastes, it was necessary to study the amino acid composition of proteins of components of fish pastes [3--5]. The qualitative composition of the proteins

of the samples of fish pastes studied was investigated due to the method of liquid chromatography and the results of it is presented in Table 1.

TABLE 1: Content of amino acids in fish pastes.

The name of amino acid	Mass fraction, %				
	MMF	sample 1	sample 2	sample 3	sample 4
Ala	2.504	3.294	4.156	4.723	5.002
Arg	2.941	3.704	4.776	5.691	5.746
Asp	0.801	1.086	1.320	1.512	1.555
Aspartic acid	3.796	5.380	7.405	9.409	10.684
Val	1.46	1.930	2.700	3.076	3.547
His	2.224	3.122	3.896	4.742	4.796
Gly	4.278	4.259	4.049	4.045	3.638
Glutamic acid	5.034	6.133	7.313	8.700	9.311
Ilu	1.149	1.984	2.803	3.208	3.752
Leu	1.894	3.495	4.887	5.429	6.248
Lys	1.709	2.974	4.189	5.07	5.11
Sulfur-containing, including Met Cys	1.597	1.909	2.35	2.555	2.699
	0.896	1.461	1.985	2.226	2.446
	0.701	0.448	0.365	0.329	0.253
Pro	2.582	2.590	3.252	3.639	3.646
Ser + Glu	4.060	5.058	6.280	7.788	8.082
Tyr	0.806	1.397	1.914	2.109	2.388
Thr	1.627	2.351	3.024	3.623	3.769
Phe	1.224	2.098	2.967	3.402	3.882

As follows from the data in Table 1, with increasing the amount of MMF in fish pastes, the content of Ala, Arg, Asp, Val, His, Lys, Leu, Ilu, Met, Pro, Ser, Glu, Tyr, Thr, Phe reduces and opposite, the amount of Gly, Cys increases. The decrease in the content of the amino acids is explained by adding of salmon heads containing of cartilage tissue that contains a significant degree of proline and hydroxyproline [6--7].

It is interesting to note that as the amount of MMF additive decreases, the amount of the sulfur-containing amino acid Cys decreases, but the amount of sulfur-containing amino acids increases due to an increase in Met [8].

The biological value of the protein is determined by the content of eight essential amino acids, which are represented by branched-chain amino acids--leucine, isoleucine, valine, aromatic--phenylalanine, tryptophan and aliphatic--threonine, lysine, methionine.

However, the total content of essential amino acids does not fully characterize the biological value of the protein. Lack of one essential amino acid leads to incomplete

absorption of others. This pattern is subject to the law of Liebig, according to which the growth of living organisms is depended on the indispensable substance that is present in the smallest amount [9--10].

To determine the biological value of the protein under study, the method based on the use of amino acid score (AAC) was taken, which makes it possible to identify the limiting amino acids. All amino acids with AAS below 100 % are limiting, and the amino acid with the lowest AAS is the main limiting one [11]. Table 2 shows the amino acid values of the samples of studied fish pastes.

TABLE 2: Value of the amino acid score of the investigated samples of fish pastes.

The name of amino acid	Amino acid score, %			
	sample 1	sample 2	sample 3	sample 4
Ilu	47.2	66.7	76.4	89.3
Leu	72.8	101.8	113.1	130.2
Lys	70.8	99.7	121.6	133.6
Phe	74.9	106.0	121.5	138.6
Met	66.4	90.2	101.2	111.2
Thr	84.0	108.0	129.4	134.6
Val	46.0	64.3	73.2	84.5

Analysis of these data shows that valine is the main limiting amino acid. Its amino acid rate, depending on the amount of the added additive, ranges from 46.0 to 84.5 %. The other limiting amino acid is isoleucine, the amino acid rate of which varies from 47.2 to 89.3 %. The rest of the amino acids are in the amount approaching the etalon of protein [12--14].

3. Results

According to the results of calculation there is a graph of the dependence of essential amino acids on the amount of added MMF additive constructed and it is presented in Figure 1.

An increase in the amount of MMF additive leads to a decrease in AAS from 1.154 for sample 4 to 0.646 for sample 1. There were indicators of the content of mineral substances in the studied samples given in Table 3.

Analysis of the data obtained showed that the content of ash elements range from 2.97 for sample 1 to 0.99 for sample 4. The dynamics of an increase in the mass fraction of macro- and microelements is observed in all four samples. Especially the influence of MMF additive affects the amount of calcium (from 0.09 % in sample 4 to 0.41 % in

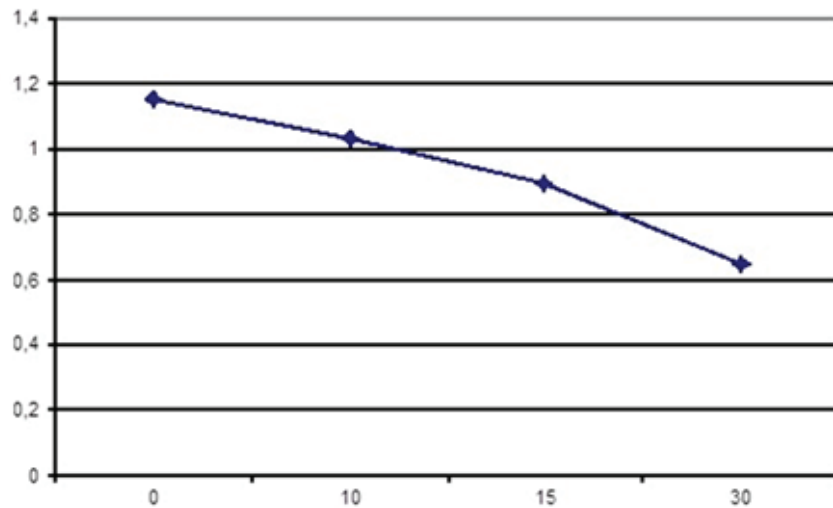


Figure 1: Dependence of amino acid score of essential amino acids on the amount of MMF additive.

sample 1) and phosphorus (from 0.13 % in sample 4 to 0.28 % in sample 1). Of particular interest is the change in the ratio of calcium and phosphorus: in MMF additive is 1: 0.6; in sample 1 -- 1: 0.7; in sample 2 -- 1: 0.8; in sample 3 -- 1: 1; in sample 4 -- 1: 1.6.

TABLE 3: Content of mineral substances in the studied samples.

Mineral substances	Content of mineral substances in the studied samples, %				
	MMF	sample 1	sample 2	sample 3	sample 4
Ash (without table salt), %	4.83	2.97	2.26	2.19	0.99
<i>Macroelements, %</i>					
potassium	0.72	0.25	0.22	0.22	0.20
calcium	1.24	0.41	0.24	0.18	0.09
magnesium	0.028	0.027	0.025	0.025	0.024
sulfur	0.11	0.107	0.104	0.098	0.094
phosphorus	0.57	0.28	0.20	0.18	0.14
<i>Microelements, mg/kg:</i>					
iron	24.22	11.45	7.32	5.70	3.69
zinc	39.9	16.9	11.8	7.04	5.23
manganese	3.59	2.07	1.29	1.28	1.23
cobalt	0.031	0.021	0.019	0.016	0.013
fluorine	20.65	20.06	14.59	12.38	11.55
cuprum	0.78	0.46	0.37	0.32	0.26

The enrichment of the studied products with MMF additive, which is a natural source of calcium has a positive feature: calcium ions in natural forms are better absorbed by the body (by 60 % or more), while calcium absorption from chemical compounds ranges from 15 to 35 % [2].

TABLE 4: Fatty acid composition of fish pastes.

The name of fatty acid	Content from total amount, %				
	MMF	sample 1	sample 2	sample 3	sample 4
<i>Saturated fatty acids (SFA)</i>	29.7	32.8	31.2	32.0	36.3
mirictic C14:0	6.3	7.4	7.1	7.5	7.3
palmitic C16:0	15.9	18.3	18.0	17.5	22.5
stearic C18:0	3.9	3.9	3.7	3.4	3.2
arachin C20:0	1.9	1.8	1.9	2.1	1.8
behenic C22:0	1.7	1.4	1.4	1.5	1.5
<i>Monounsaturated fatty acids (MFA)</i>	29.6	30.3	30.9	30.8	29.2
palmitoleic C16:1	7.7	8.4	8.3	8.9	8.7
oleic C18:1	21.9	21.9	22.6	21.9	20.5
<i>Polyunsaturated fatty acids (PFA)</i>	40.7	36.9	37.0	37.2	34.5
linoleic C18:2	5.7	6.1	5.8	5.9	5.4
linolenic C18:3	1.7	1.7	1.9	1.8	1.7
<i>Sum of monounsaturated fatty acids C20:n</i>	13.7	12.5	12.8	12.8	11.6
<i>Sum of polyunsaturated fatty acids C22:n</i>	19.6	16.6	16.5	16.7	15.8
Fat mass fraction, %	28.9	14.0	10.6	7.4	1.2

While rising MMF additive a content of all the microelements found in pastes increases: iron by 2.01–7.76 mg / kg, cobalt by 0.003–0.008 mg / kg, manganese by 0.05–0.84 mg / kg, fluorine by 0.83–8.51 mg / kg, zinc by 1.81–11.67 mg / kg, cuprum by 0.06–0.2 mg / kg. The fatty acid composition of fish pastes samples allowed investigating gas-liquid chromatography and presenting it in Table 4 and in Figure 2.

When creating functional food formulations, it is necessary to take into account the inability of the body in some situations to synthesize linoleic and linolenic acid from nutrients coming from outside. The lack of food intake of linoleic acid causes a violation of the biosynthesis of arachidonic acid, which is part of prostaglandins. Prostaglandins, having a harmonious effect, regulate various vital processes of the body. The lack of precursors of the synthesis of prostaglandins in the diet leads to a disturbance of the state of the body tissues.

A comparative analysis of the data in Table 4 shows that the content of saturated fatty acids slightly decreases with the increasing amount of MMF additive from 32.8 % in sample 1 to 36.3 % in sample 4, where this additive is absent [15–19]. The amount of monounsaturated fatty acids is about the same for all samples (from 29.2 % to 30.9 %), while polyunsaturated acids increase. The triglycerides of sample 4 contain 34.5 %, and sample 1 – 36.9 %.

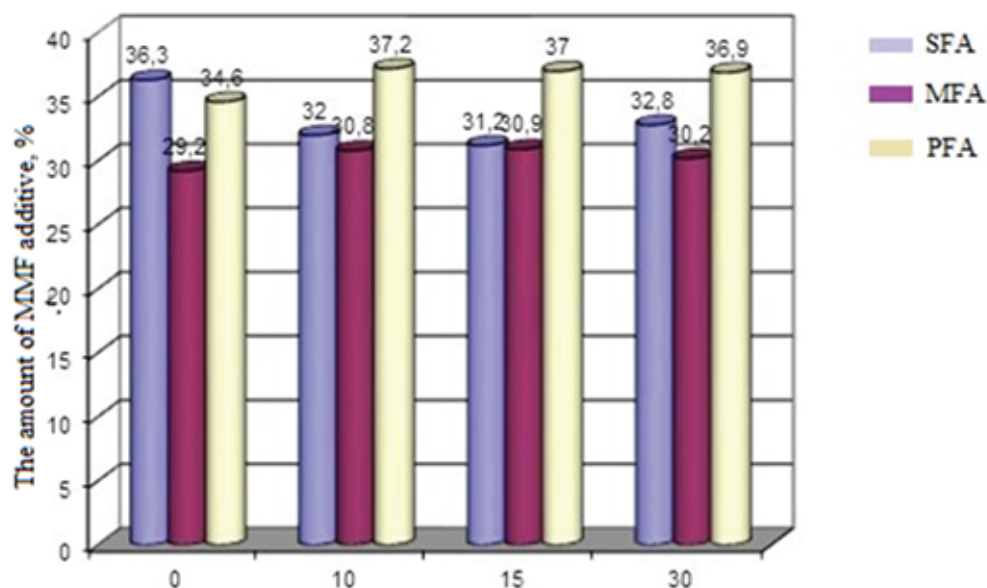


Figure 2: Fatty acid compositions of triglycerides of fish pastes, %.

In general, the addition of MMF to fish paste does not have a very noticeable effect on the composition of their fatty component. This can be explained by the fact that sample 4 that does not contain an MMF additive has a low fatty content (1.2 %). In addition, the composition of the triglycerides PO and sample 4 differs very little, for example, they are almost the same in the amount of myristic, palmitic, oleic, polyunsaturated C20, C22 and the content of arachidic, behenic, linoleic, linolenic fatty acids. Therefore, the introduction of MMF into fish pastes affects mainly the amount of valuable fats [20--23].

Studies of the qualitative composition of proteins, the content of the most important macro- and microelements, the fatty acid composition of the pasty products studied showed: the partial replacement of fish raw materials with MMF additive in pastes prepared on the basis of cod muscle tissue allows obtaining a product enriched with minerals, but at the same time decreases the amount of protein.

The amount of MMF additive affects the mass fraction of fats, but their fatty acid composition is changes, a little. Therefore, it became necessary to find the optimal value of the added MMF additive, which ensures the high biological value of the fish pasty products. To get the aim there was a mathematical treatment of the results of the study carried out using the MATHCAD application software package and the equations of dependencies of the content of amino acids and mineral substances on the amount of the MMF additive were determined.

Figure 3 presents graphic representations of the equations of these dependencies of the main limiting amino acids valine and isoleucine, as well as the most deficient mineral substances: calcium and iron.

$$Y_1(x) = 0.0008x^2 + 0.0148x + 0.8872 \quad Y_2(x) = 0.0006x^2 + 0.0658x + 2.2727$$

$$Z_1(x) = 0.0001x^2 - 0.0367x + 3.6099 \quad Z_2(x) = 0.0002x^2 - 0.0430x + 3.6051$$

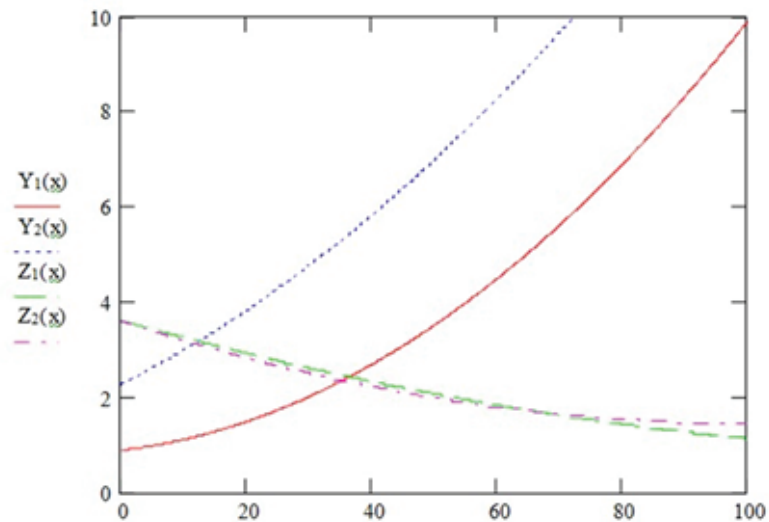


Figure 3: Approximated dependences of calcium content (Y_1); iron (Y_2); valine (Z_1); isoleucine (Z_2) from the content of the MMF additive.

The addition of MMF of 16–38 % to the pastes allows creating products balanced in content of protein and mineral substances. At the same time, there is no noticeable deterioration in the quantitative and qualitative indicators of protein, and an increase in the content of those mineral substances, the lack of which is often perceived by the human body: calcium, magnesium, iron, fluorine, zinc, manganese, cobalt, and lipids containing more than 30 % polyunsaturated fatty acids. It is also important that the introduction of MMF of 16–38 % to pastes allows obtaining the recommended ratio of calcium and phosphorus.

4. Conclusion

Based on the conducted research, it is possible to use the MMF additive as a component of the main raw material of pasty products. There are favorable changes in the balance of essential minerals necessary for normal vital activity of the human body, ensuring an optimal ratio of calcium and phosphorus.

The increase in the content of mineral substances using natural forms of the raw material is an important fact, since the entire system of digestion, active transport, and

the assimilation of the human body is focused on the consumption of organically linked micro and macro elements.

The role of fats in the diet is not limited to their energy value. They are a necessary component of many cellular structures, especially membranes of cells; perform various plastic, physiological and biochemical functions. Of great importance is the chemical composition of consumed fats, especially the content of polyunsaturated fatty acids with a certain position of double bonds and configuration.

Conflict of Interest

The authors have no conflict of interest to declare.

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