УДК 664.955.2
DOI: 10.37493/2307-910X.2023.1.6

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СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ПИЩЕВОЙ ЦЕННОСТИ ИКРЫ ТОЛСТОЛОБИКА, СОМА, САЗАНА И СУДАКА

COMPARATIVE CHARACTERISTICS OF THE NUTRITIONAL VALUE OF BIG CARP, CATFISH, CARP AND PIECE CAVIAR

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Аннотация

Изучение и анализ химического состава и биохимических показателей икорного сырья пресноводных рыб, обитающих в низовьях Волги, подтверждают тот факт, что икорное сырье обладает сравнительно высокой энергетической и биологической эффективностью функционирования и ценностью белковых и липидных комплексов. Биологическая ценность белковых комплексов обусловлена присутствием всего перечня незаменимых аминокислот, общая доля которых выше по сравнению с идеальной белковой субстанцией. Пресноводное, как и морское икорное сырье, является отличным источником липидов, в том числе и фосфолипидов, которые содержат значительное количество длинноцепочечных полиненасыщенных жирных кислот. Поэтому в последних исследованиях, связанных с рыбным сырьем и сопутствующих продуктах, им уделяется большое внимание. В этой статье представлен обзор химического состава и свойств икры четырех видов рыб, икорная составляющая, которой является низко востребованной в нативном и переработанном виде на отечественном рынке рыбопродуктов.

Ключевые слова: пресноводные виды рыб, сом, сазан, толстолобик, судак, химический состав, белки, липиды, пищевая ценность.

Abstract

The study and analysis of the chemical composition and biochemical parameters of caviar raw materials of freshwater fish living in the lower reaches of the Volga confirm the fact that caviar raw materials have a relatively high energy and biological efficiency of functioning and the value of protein and lipid complexes. The biological value of protein complexes is due to the presence of the entire list of essential amino acids, the total proportion of which is higher compared to the ideal protein substance. Freshwater, like marine caviar, is an excellent source of lipids, including phospholipids, which contain a

significant amount of long-chain polyunsaturated fatty acids. Therefore, in recent studies related to fish raw materials and related products, much attention is paid to them. This article provides an overview of the chemical composition and properties of caviar of four species of fish, the caviar component of which is in low demand in native and processed form in the domestic fish products market.

Key words: freshwater fish species, catfish, carp, silver carp, pike perch, chemical composition, proteins, lipids, nutritional value.

Introduction

Raw caviar (RC) is of particular value for the production of a wide range of food materials. The nutritional significance of IS and functional products from it was studied by a number of researchers, in particular, L.S. Abramova, T.P. Kalinichenko, E.A. Akhmerov [1, 2, 3]. It has been substantiated that RC has a relatively high energy and biological efficiency of functioning and the value of protein and lipid complexes, a large proportion of lipid- and water-soluble vitamin complexes, macro- and microelements. These indicators of RC make it possible to use it as a component in the production of a number of fish materials and semi-finished products of relatively high biological significance. The Astrakhan region in terms of rearing and commercial catch, fish of such species as carp, catfish, pike perch and silver carp occupies one of the leading places, and also has prospects for further growth, since there are many inland water bodies in this area, which, with their active use for breeding the necessary for human aquatic biological resources, will lead to an increase in the consumption of protein-containing materials.

Over the past five years, based on an analysis conducted by the Volga-Caspian branch of the Federal State Budget Scientific Institution "VNIRO", commercial fish stocks, including those previously indicated, have increased from 281 to 310 thousand tons. The volumes of the total allowable catch and the recommended catch increased from approximately 62 to 69 thousand tons. The mass of the catch of these fish species as of December 2020 in the Southern Fishery Federal District was slightly below 47 thousand tons. The maximum catch (about 85%) was observed in the Volga-Caspian and North-Caspian fish areas of the Astrakhan region [4], but in the literature there is no complete information on the chemical composition and biochemical parameters of RC, except for silver carp [5]. It should be noted that information about the complex of RC parameters, which has not yet been utilized for food purposes, will determine its use in the field of production of functional food materials.

Objects and purpose of the study

The purpose of this study and analysis was to study the energy and biological efficiency of the functioning and value of protein and lipid complexes of RC of 4 fish species due to its low demand, both in native and processed state in the market sphere of the Russian Federation, in particular, to assess its implementation in the technology of substances of functional orientation. Catfish, carp, zander and silver carp caught in the Lower Volga basin of the Astrakhan region were chosen as objects of study.

To achieve this goal, the following tasks were defined:

– to analyze the literature data on the chemical composition and energy significance of RC of selected fish species;

– to study the amino acid composition of RC protein complexes and to reveal its biological significance;

– to analyze the literature data on the composition of lipid acids, the proportion of specific fractions of phospholipid complexes and to assess the biological effectiveness of the functioning of RC fats of selected fish species.

Research results and discussion

At present, the technologies of functionally oriented food materials are based on information about a set of parameters that determine the energy and biological efficiency of functioning and the value of protein and lipid complexes and other RC components. Literature data on the study of the indicated factors [1, 2, 3, 5, 6] speak in favor of the fact that,

according to the chemical composition, RC can be classified as a high-protein and lipid substance (Table 1). The composition of the RC of the indicated objects of analysis does not contradict the data of early studies of the RC of hydrobionts of both freshwater and marine origin.

Table 1 - Chemical composition of RC [5, 6]

caviar raw materials from	Mass content, % in the total composition				Energy value, kcal/100 g
	Water	Lipids	Protein complexes	Ash	
silver carp	63.45	10.27	25.05	1.25	180.40
carp	65.50	2.8	27	1.80	137.60
zander	69.80	5.6	22.70	1.50	133.10
catfish	65.70	3.5	27.30	1.90	139.60

The biological significance of protein complexes is due to the quantitative and qualitative amino acid composition, the correlation of the proportion of amino acids with it in an ideal protein substance (Table 2).

The data on the study of the amino acid composition in fish protein complexes, shown in Table 2, indicate that, according to the proportion of individual essential amino acid substances, such as leucine, isoleucine, valine, lysine, threonine, the composition of phenylalanine and tyrosine, the protein complexes of RC of many fish freshwater origin prevail in comparison with the "ideal" protein substance [7, 8]. The limiting amino acid complexes are tryptophan, valine and isoleucine. Among the nonessential amino acid complexes, glutamic acid predominates, which significantly affects nitrogen metabolism and functions as a neurotransmitter [9].

The biological effect of the functioning of fats is primarily due to the specifics of their fatty acid composition [5].

Table 3 shows the degree of correlation of the fatty acid composition of RC, the studied fish species, according to the normative indicators of their consumption. The study of the lipid-acid composition of lipid acids leads to the conclusion that the total amount of saturated and monounsaturated lipid acids prevails in the RC of fish of freshwater origin, with the first being in the first position, the second in the second, and the polyunsaturated in the third.

Table 2 - Amino acid composition of RC protein complexes [5, 7]

Name of amino acids	Ideal protein	Amino acid content, g/100g of protein							
		In the calf of a silver carp	Speed, %	In carp caviar	Speed, %	In zander caviar	Speed, %	Catfish in caviar	Speed, %
Irreplaceable, incl.	36.0	44.83	124.5	37.52	104.2	46.25	128.5	44.28	123.0
Valine	5.0	4.49	89.8	3.30	66.0	5.6	112.0	5.3	106.0
Isoleucine	4.0	3.94	98.5	3.17	79.25	5.4	135.0	4.72	118.0
Leucine	7.0	11.34	162.0	7.82	111.7	8.1	115.7	8.32	118.9
Lysine	5.5	7.28	132.4	4.34	78.9	9.4	116.4	9.4	170.9
Methionine + cysteine	3.5	3.95	112.9	5.28	150.9	4.6	131.4	4.1	117.1
Threonine	4.0	5.04	126.0	4.29	107.3	4.6	115.0	4.5	112.5
tryptophan	1.0	0.91	91.0	-	-	1.1	110.0	1.14	114.0
Phenylalanine + Tyrosine	6.0	7.88	131.3	9.32	155.3	7.45	124.2	6.8	113.3
Replaceable, incl.	-	55.31	-	54.4	-	-	-	-	-
Arginine	-	5.17	-	5.70	-	-	-	-	-
Histidine	-	2.55	-	8.40	-	-	-	-	-
Serene	-	6.14	-	7.76	-	-	-	-	-
Glutamic acid	-	16.0	-	15.09	-	-	-	-	-
Aspartic acid	-	7.03	-	1.81	-	-	-	-	-

Proline	-	5.10	-	6.6	-	-	-	-	-
Glycine	-	4.01	-	3.28	-	-	-	-	-
Alanine	-	9.31	-	6.30	-	-	-	-	-

The total number of types of lipid acids is higher than the recommended standards [5, 10]. In the series of saturated lipid acids, palmitic acid prevails, which improves the procedures for the synthesis of lipoproteins and the fall in blood cholesterol levels [5].

Table 3 - Evaluation of the fatty acid content of RC [5, 8, 12,13]

Name lipid acids	Mass content of fatty acids, % of their total amount			
	IC silver carp	IS carp	IS zander	IP catfish
Saturated, incl.	**42**	**34.59**	**17.40**	**32.35**
Lauric (From $_{12:0}$)	0.06	0.02	-	-
Myristic (FROM $_{14:0}$)	1.4	0.58	-	0.8
Pentadecanoic (C $_{15:0}$)	0.36	0.34	4	3.3
Palmitic (From $_{16:0}$)	27.54	24.38	8.60	16.4
Heptadecanoic(C $_{17:0}$)	1.1	0.55	-	0.5
Stearic (FROM $_{18:0}$)	9.85	7.29	3.80	6.68
Arakhinovaya (From $_{20:0}$)	0.14	0.12	0.3	-
Geneicosanovaya (C $_{21:0}$)	0.26	1.02	-	-
Begenovaya (From $_{22:0}$)	0.64	0.24	0.7	-
Lignoceric (C $_{24:0}$)	0.67	-	-	-
Monounsaturated, incl.	**36.8**	**33.02**	**22.20**	**41.8**
Myristolenic (From $_{14:1}$)	0.07	0.03	-	-
Pentadecene (C $_{15:1}$)	0.19	-	-	-
Palmitooleic (C $_{16:1}$)	11.64	5.9	0.2	2.74
Heptadecenoic (C $_{17:1}$)	0.57	0.27	-	-
Oleic (FROM $_{18:1}$)	21.93	24.77	22	38.74
Gondovaya (From $_{20:1}$)	0.95	1.77	-	0.35
Nervonovaya (From $_{24:1}$)	1.46	0.28	-	-
Polyunsaturated, incl.	21.17	**26.8**	**60.4**	**25.85**
Hexadecadiene (C $_{16:2}$) ω6	0.37	0.38	2.8	0.19
Linoleic (C $_{18:2}$) ω6	1.48	5.57	55.6	23.51
Linolenic (C $_{18:3}$) ω3	1.52	0.67	2.0	0.51
Eicosodiene (C $_{20:2}$) ω6	0.12	0.07	-	0.20
Eicosotriene (C $_{20:2}$) ω6	0.74	0.12	-	-
Arachidon (C $_{20:4}$) ω6	2.40	7.81	-	0.27
Eicosopentaenoic (C $_{20:5}$) ω3	4.21	1.54	-	-
Docosapentaenoic (C $_{22:5}$) ω3	0.34	-	-	-
Docosahexanoic (C $_{22:6}$) ω3	9.99	10.66	-	-
Not identified	0.07	2.67	-	

Basically, oleic acid, which takes part in the phenomena of biosynthesis of low molecular weight bioregulators, can be reckoned among the types of monounsaturated lipids [11, 12]. It has been substantiated that monounsaturated lipid acid complexes serve as an energy source and are included in the cell membrane structure, and also increase the elastic parameters of arteries and skin.

The main parameter in the formation of pasty and emulsion substances is the proportion of phosphatidylcholine, which, as is known, exhibits emulsifying properties [2, 5]. Unfortunately, data on the content of phosphatidylcholine were established only for silver carp roe [5] and are given in Table 4.

Table 4 - Fractional distribution of phospholipids of silver carp RC [5]

Name of phospholipids	Mass content of fractions, % of the total mass of phospholipids
	RC of silver carp
Phosphatidylcholine	88.23
Phosphtidylethanolamine	6.2

Phosphatidylserine	1.44
Sphingomyelin	3.52
Lysophosphatidylcholine	0.61

The fractional scatter of the proportions of phospholipid complexes in the RC of silver carp is due to the predominance of phosphatidylcholine. In addition, its mass content in the composition of RC fats determines its high emulsifying ability, which allows it to be used in the production of pasty materials. In addition, phosphatidylcholine is included in the structure of biological membrane elements and determines their structural, mechanical and functional parameters [5]. Thus, silver carp RC is a natural composition of biologically active components.

Conclusion

The information indicated in the publication on useful indicators of RC, such as the proportion of protein, lipid, vitamin and mineral complexes, energy significance and, in addition, the amino acid composition of the protein component and the fatty acid composition of fats, speaks in favor of the high nutritional significance of RC.

Since the results on the content of phosphatidylcholine were established only for silver carp caviar, it is advisable, in view of their biological significance, to identify this parameter for other fish species, which will contribute to the development of new and improvement of existing methods for processing RC in order to expand the range of food products, and it also has a functional orientation.

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Дата поступления в редакцию: 12.12.2022
После рецензирования: 13.02.2023
Дата принятия к публикации: 07.03.2023