

Amino acid composition of krill protein coagulate

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The nutritional value of the meat of various crustaceans was studied in the VNIRO laboratory of invertebrates and alga. In addition to shrimps, crawfish and lobsters, the meat of which is valued the world over as a long recognized delicacy, we investigated krill (*Euphausia superba*) that provides an important food source for sea mammals and fish.

The meat of large crustaceans (shrimps, crabs, crawfish and lobsters) is freed from the shell manually or using a machine, in most cases after being boiled, because the meat proteins of raw crustaceans are semiliquid.

Krill is a tender and perishable crustacean. Its meat proteins are predominantly semiliquid.

There is only 0.5 g of meat in the krill's ventral shell, which is very difficult to extract. Therefore, until recently krill has not been of interest to the fishing industry.

During the first Antarctic trip of the scientific research ship «Akademik Knipovich» (1964-1965), process engineer M.I. Kruchkova offered an effective method for extracting the krill meat from its shell and preparing a natural protein product from it; she prepared a pinkish-orange paste-like product (without any food additives) with a pleasant sweetish taste, reminiscent of shrimp. It was named «krill protein coagulate».

The protein coagulate was put into glass jars, sterilized and kept at a temperature of 5 – 7 °C. It can be added in salads and other savory dishes.

A batch of the protein coagulate was investigated; its chemical composition was found to be as follows (in %): water – 73.5; fat – 6.9; ash – 1.7; sugars – 1.3; total nitrogen – 2.7; protein (by difference) – 16.6. As one can see, quite a large quantity of sugars is present in the product. It is known that proteins of crustaceans very often are bound with sugars to form glycoproteins, which most likely impart the sweetish taste to the meat. According to Borgstrom [2], lobster protein contains 2.2% of sugars, which are mostly a mixture of glucose (three parts) and fructose (eight parts). Crab protein contains 2.8% of sugars, of which glucose makes up four parts and fructose makes up one part.

The amino acid content of the protein coagulate was determined by using the paper partition chromatography method. This method, which has been described by us previously [1], presupposes that the product under study has been processed with alcohol three or four times in order to prepare a protein-free extract of free amino acids of the product and a protein sample for further investigation; these samples are as free as possible from foreign non-protein substances.

The protein sample prepared from the krill protein coagulate was a dry, light powder of pinkish color. The yield was 17.1% by weight of the protein coagulate. Its chemical composition (%): water – 9.6; fat – 0.4; ash – 5.9; total nitrogen – 13.3; protein (by difference) – 84.1.

In order to determine the amino acid content, the protein specimens were subjected to hydrolysis

with hydrochloric acid.

The hydrolysates obtained and the protein-free extract were analyzed.

Amino acids were partitioned on one-dimensional chromatograms with downward solvent development as described by us in the paper «Amino acid composition of squid proteins» (p. 158 in the present collection of works). 14 spots of amino acids appeared on the chromatograms.

Table 1.

Amino acid content in krill protein coagulate

	In % of pure protein					
			Error			
			Absolute	Relative, %		
Lysine	11.80 – 14.50	12.8	±0.87	6.8	10.74	1.84
Arginine	8.08 – 10.20	9.1	±0.46	5.1	7.63	1.30
Threonine	6.18 – 7.70	7.0	±0.32	4.6	5.87	1.00
Valine	8.36 – 10.80	9.4	±0.75	8.0	7.88	1.35
Leucines	15.40 – 17.05	16.0	±0.59	3.7	13.42	2.29
Phenylalanine	6.62 – 6.98	6.8	±0.16	2.4	5.70	0.97
Alanine	6.14 – 7.25	6.7	±0.35	5.2	5.62	0.96
Glutamine	12.40 – 14.22	13.4	±0.61	4.6	11.25	1.92
Asparagine	11.20 – 11.70	11.5	±0.18	1.6	9.65	1.65
Serine	1.84 – 3.32	2.7	±0.51	18.9	2.26	0.39
Glycine	6.40 – 8.24	7.3	±0.56	7.7	6.12	1.05
Tyrosine	6.44 – 8.12	7.0	±0.58	8.3	5.87	1.00
Cystine	3.39 – 4.09	3.8	±0.20	5.3	3.18	0.54

The results of the quantitative determination of amino acids in the protein specimen prepared from the krill protein coagulate are given in Table 1. The data by Borgstrom [2] on the content of some amino acids in proteins of Bombay and Pacific Ocean shrimps and lobsters and some food products are also presented for comparison (Table 2).

Table 2.

Amino acid content in protein of shrimps, lobsters and some food products

	Bombay	Pacific Ocean	Foodstuffs
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	Shrimps, large	Lobsters	Shrimps, large	Lobsters	Shrimps	Cod	Chicken (white meat)
Lysine	18.5	17.6	9.4	9.5	10.0	10.1	10.1
Arginine	8.3	7.2	9.0	7.4	13.2	12.6	13.9
Threonine	4.6	5.3	4.1	4.4	2.9	3.3	3.4
Valine	4.1	2.9	4.4	4.5	-	-	-
Leucines	19.9	15.6	12.4	12.7	-	-	-
Phenylalanine	14.6	2.7	4.4	4.7	2.5	2.3	2.0
Alanine	-	-	6.0	5.9	-	-	-
Glutamine	-	-	17.5	16.9	-	-	-
Asparagine	-	-	11.7	12.3	-	-	-
Serine	-	-	4.2	4.9	3.3	4.1	3.9
Glycine	-	-	4.7	4.6	-	-	-
Tyrosine	1.0	0.8	4.1	4.1	2.3	2.2	2.1
Cystine	1.4	1.5	1.1	1.3	0.7	0.8	0.6
Methionine	4.6	2.2	2.8	3.2	2.0	2.2	2.0
Histidine	1.6	1.2	1.9	2.1	3.1	3.5	4.0
Tryptophan	0.4	0.2	1.0	0.9	1.1	1.1	1.1
Proline	-	-	3.7	3.4	-	-	-

* In grams/100 g of protein, adjusted to 16% of nitrogen.

As is seen from Tables 1 and 2, the krill protein coagulate is not inferior in amino acid content to highly valuable food products such as cod, chicken and crustaceans (shrimps and lobsters), and as for the content of certain amino acids, for example threonine, valine, phenylalanine, glycine and tyrosine, it is superior to the above products. It should be noted that we did not find methionine and histidine in the krill protein coagulate, and proline was not determined.

The data on the free amino acid content in the protein-free extracts are presented below.

Amino acids	mg/100g
Arginine	186
Lysine	83
Threonine	42
Methionine	10
Valine	33
Leucines	71
Phenylalanine	30
Alanine	71

Glutamine	20
Asparagine	71
Tyrosine	37

In addition to the above amino acids, cystine (a very weak spot), proline (an intensively colored spot) and one unidentified spot were found on the chromatograms. Two amino acids -serine and glycine - correspond to the unidentified spot by their position on the chromatograms.

The high free arginine content in the krill protein coagulate is noteworthy. There is an indication in the literature [2] that the meat of crustaceans (shrimps, lobsters, crabs and crawfish) contains practically no creatine; however, much arginine bound with phosphorus was found therein.

CONCLUSION

Krill protein coagulate is rich in essential amino acids such as arginine, lysine, threonine, leucines and phenylalanine, and is characterized by a high content of the dicarboxylic amino acids glutamine and asparagine. The meat of crustaceans is easily assimilated (better than casein) and is rich in essential trace elements [3].

Based on the results of our investigations and literature data it follows that krill protein coagulate can be considered to be a high-value food product.