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AMINO-ACID PROFILE OF A MACTRIDAE BIVALVE MOLLUSK FROM THE SEA OF JAPAN

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Bivalve mollusks represent one of the most broadly distributed and abundant groups of marine animals with bodies covered by a calciferous bivalve shell. This prominent group of hydrobionts has for a long time attracted interest. They were used since antiquity as food and decoration. Bivalve mollusks are attractive to industry and for food because of their chemical composition and structure and life cycle [1].

Mactra chinensis (Philippi 1846) is a bivalve mollusk of the family Mactridae that inhabits the Seas of Japan and Okhotsk on sandy sediments at depths from 1 to 15 m and temperatures up to 23.5°C. Large specimens reach 80 mm in length and weigh up to 71 g. The mass composition of the raw meaty parts of *M. chinensis* is mantle 3.1–4.6%, muscle-adductor 2.4–3.1%, muscle (leg) 5.4–7.2%, gills 1.8–3.4%, and internals 3.4–6.8%. The relative body mass of *M. chinensis* did not show seasonal variations [2].

Despite the rather detailed data on the morphology and biology of this mollusk, information on the chemical composition, in particular that of proteins, amino acids, lipids, and other classes of compounds from soft parts of *M. chinensis*, is scattered and addresses only motor muscle. The quality of *M. chinensis* proteins and contents of free amino acids in mantle and adductor have not been studied. This limits the incorporation of these soft parts into development and practical use.

The goal of the present work was a comprehensive study of the composition and contents of free amino acids and the amino-acid composition of proteins from soft parts of the Far-East bivalve mollusk *M. chinensis*.

Table 1 presents the composition and contents of free amino acids in soft parts of the mollusk.

The contents of free amino acids in all parts were rather high and did not show significant differences ($p < 0.05$). The dominant amino acids from all parts were taurine (23.64–28.50% of total amino acids) dominating in mantle, glutamic acid (8.90–11.29%) dominating in adductor, and arginine (6.02–8.46% of total amino acids) dominating in muscle. Analogous results were reported by other researchers and indicated that the contents of free amino acids in tissues of bivalve mollusks were rather high and exceeded those in fish [3–5].

The greatest differences in contents of individual amino acids in different parts were found for hydroxylysine and tyrosine (prevalence in adductor over mantle by 3.12 and 2.19 times, respectively); histidine, phosphoserine, and methionine (prevalence in muscle over adductor by 1.86, 1.99, and 1.86 times, respectively); proline and isoleucine (prevalence in muscle over mantle by 2.25 and 1.96 times, respectively), and cysteine (prevalence in mantle over adductor by 1.94 times). The differences in free amino-acid contents of other parts of *M. chinensis* were considered insignificant. The high contents of S-containing amino acids suggested that the studied parts could have antioxidant activity [6].

Table 2 presents the qualitative and quantitative amino-acid compositions of proteins from *M. chinensis* parts.

Proteins from all parts of *M. chinensis* contained identical sets of amino acids. The predominant essential amino acids were leucine and lysine (dominant in adductor). A comparison of the contents of essential amino acids in *M. chinensis* parts showed that they were greatest in adductor (total 33.95 mg/g of wt.), then muscle (total 32.55 mg/g of wt.), and least in mantle (total 28.58 mg/g of wt.). Muscle characteristically had the greatest contents of threonine, tyrosine, phenylalanine, and tryptophan; mantle, methionine and isoleucine; and adductor, cysteine, valine, leucine, and lysine, as compared with the other parts. The contents of conditionally essential amino acids histidine (1.52–2.54 mg/g of wt.) and arginine (6.80–8.66 mg/g of wt.) were significant and dominated in mantle.

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TABLE 1. Composition and Content of Free Amino Acids in *Mactra chinensis*

Amino acid	Muscle		Mantle		Adductor	
	% of total amino acids	mg/g of moist tissue	% of total amino acids	mg/g of moist tissue	% of total amino acids	mg/g of moist tissue
Thr	3.04 ± 0.12	6.30 ± 0.19	2.45 ± 0.09	5.11 ± 0.22	4.09 ± 0.17	8.22 ± 0.36
Val	2.77 ± 0.11	5.81 ± 0.25	3.12 ± 0.14	6.40 ± 0.29	2.11 ± 0.08	4.18 ± 0.17
Hyl	1.43 ± 0.05	3.05 ± 0.12	0.69 ± 0.03	1.44 ± 0.05	2.15 ± 0.09	4.28 ± 0.19
Leu	3.83 ± 0.18	7.92 ± 0.36	3.19 ± 0.14	6.74 ± 0.28	4.40 ± 0.20	8.91 ± 0.38
Glu	10.76 ± 0.46	22.03 ± 0.94	8.90 ± 0.41	17.72 ± 0.70	11.29 ± 0.50	22.70 ± 1.02
Tyr	1.98 ± 0.08	4.07 ± 0.18	1.03 ± 0.04	2.12 ± 0.05	2.56 ± 0.09	5.12 ± 0.19
Phe	3.16 ± 0.10	6.34 ± 0.30	4.05 ± 0.17	8.23 ± 0.26	3.85 ± 0.15	7.75 ± 0.28
Lys	7.30 ± 0.35	14.95 ± 0.59	6.50 ± 0.30	13.15 ± 0.54	7.34 ± 0.31	14.64 ± 0.61
Ser	2.57 ± 0.12	5.13 ± 0.10	3.08 ± 0.13	6.27 ± 0.18	2.97 ± 0.11	6.03 ± 0.19
Asp	7.80 ± 0.34	16.40 ± 0.68	6.71 ± 0.29	13.58 ± 0.51	8.03 ± 0.36	16.07 ± 0.71
Gly	5.19 ± 0.18	10.53 ± 0.42	6.10 ± 0.25	12.46 ± 0.47	4.99 ± 0.21	10.02 ± 0.41
Arg	8.46 ± 0.36	17.02 ± 0.75	6.02 ± 0.27	12.04 ± 0.54	7.08 ± 0.32	14.19 ± 0.63
Orn	2.30 ± 0.10	4.80 ± 0.21	3.65 ± 0.15	7.20 ± 0.30	2.90 ± 0.13	5.84 ± 0.22
Tau	24.87 ± 1.14	51.03 ± 2.12	28.50 ± 1.35	57.90 ± 1.86	23.64 ± 1.02	47.38 ± 1.98
His	1.76 ± 0.05	3.87 ± 0.11	1.12 ± 0.04	2.35 ± 0.08	0.94 ± 0.03	1.99 ± 0.06
Pro	2.18 ± 0.08	4.90 ± 0.21	4.91 ± 0.16	9.95 ± 0.30	3.40 ± 0.15	6.78 ± 0.25
Ala	4.42 ± 0.19	9.34 ± 0.39	3.07 ± 0.11	6.21 ± 0.14	4.01 ± 0.17	8.05 ± 0.32
Cys	1.14 ± 0.04	2.47 ± 0.07	1.75 ± 0.06	3.56 ± 0.09	0.90 ± 0.03	1.81 ± 0.03
Ile	2.06 ± 0.08	4.45 ± 0.19	1.05 ± 0.03	2.25 ± 0.06	1.70 ± 0.06	3.42 ± 0.14
Phosphoserine	0.69 ± 0.02	1.59 ± 0.05	1.13 ± 0.04	2.30 ± 0.07	1.37 ± 0.05	2.76 ± 0.10
Met	1.59 ± 0.07	3.38 ± 0.13	2.12 ± 0.04	4.41 ± 0.15	2.96 ± 0.07	6.01 ± 0.23
Total	99.30 ± 4.51	205.38 ± 9.51	99.14 ± 4.34	201.39 ± 8.90	99.78 ± 4.86	206.15 ± 10.03

TABLE 2. Amino-Acid Composition of Proteins from *Mactra chinensis* Parts

Amino acid	Muscle		Mantle		Adductor	
	mg/g of wt.	mg/g of protein	mg/g of wt.	mg/g of protein	mg/g of wt.	mg/g of protein
Thr	3.71 ± 0.11	32.11 ± 1.09	2.10 ± 0.08	35.04 ± 1.27	3.01 ± 0.10	27.06 ± 0.87
Asp	8.93 ± 0.26	112.00 ± 3.09	10.96 ± 0.38	117.26 ± 4.45	9.45 ± 0.32	108.23 ± 3.98
Ser	3.09 ± 0.09	35.20 ± 1.34	3.78 ± 0.11	31.13 ± 1.10	2.51 ± 0.08	27.12 ± 1.04
Glu	12.37 ± 0.45	148.06 ± 4.54	11.42 ± 0.39	150.64 ± 6.03	10.98 ± 0.28	162.32 ± 6.55
Pro	4.50 ± 0.12	61.22 ± 1.70	6.08 ± 0.25	68.05 ± 3.07	5.84 ± 0.12	46.20 ± 1.88
Gly	9.19 ± 0.29	109.06 ± 3.67	8.86 ± 0.38	102.20 ± 3.95	10.57 ± 0.30	99.15 ± 3.70
Ala	9.01 ± 0.31	93.41 ± 2.95	8.15 ± 0.37	74.31 ± 3.10	10.06 ± 0.27	98.04 ± 3.58
Cys	0.44 ± 0.00	5.59 ± 0.13	0.34 ± 0.00	11.25 ± 0.37	0.69 ± 0.00	16.35 ± 0.50
Val	3.53 ± 0.07	37.16 ± 0.96	4.86 ± 0.19	47.50 ± 2.06	5.08 ± 0.18	36.57 ± 1.26
Met	0.97 ± 0.02	11.29 ± 0.37	1.20 ± 0.02	18.12 ± 0.75	0.85 ± 0.01	9.31 ± 0.25
Ile	3.62 ± 0.07	29.33 ± 0.90	4.49 ± 0.15	35.06 ± 1.18	4.12 ± 0.09	38.60 ± 1.18
Leu	7.16 ± 0.19	80.07 ± 2.74	6.15 ± 0.19	73.17 ± 2.99	8.07 ± 0.27	79.21 ± 3.16
Tyr	2.65 ± 0.10	30.00 ± 1.15	1.42 ± 0.02	28.20 ± 1.04	2.06 ± 0.03	24.29 ± 0.86
Phe	3.00 ± 0.12	27.15 ± 0.89	2.02 ± 0.03	21.09 ± 0.87	2.44 ± 0.05	27.40 ± 1.17
Lys	6.71 ± 0.26	76.61 ± 3.12	5.54 ± 0.17	73.38 ± 3.19	7.03 ± 0.20	83.25 ± 3.11
His	1.85 ± 0.05	23.13 ± 0.95	2.54 ± 0.09	29.03 ± 1.17	1.52 ± 0.02	34.46 ± 1.05
Arg	6.80 ± 0.26	78.55 ± 2.98	8.66 ± 0.30	72.10 ± 3.24	7.57 ± 0.19	75.19 ± 2.95
Trp	0.78 ± 0.01	10.06 ± 0.21	0.46 ± 0.00	9.16 ± 0.28	0.60 ± 0.00	7.25 ± 0.09
Total	88.31 ± 2.78	1.00	89.03 ± 2.91	1.00	92.45 ± 3.11	1.00

Nonessential amino acids in all parts consisted mostly of glutamic acid (10.98–12.37 mg/g of wt.) with predominance in muscle, glycine (8.86–10.57 mg/g of wt.) with predominance in adductor, aspartic acid (8.93–10.96 mg/g of wt.) with predominance in mantle, and alanine (8.15–10.06 mg/g of wt.) with predominance in adductor. The high content of glycine,

a biologically active amino acid that is involved in cholesterol metabolism, gave the mollusk tissues a sweet taste [7]. The high content of proline (4.50–6.08 mg/g of wt.) with predominance in mantle was also noteworthy. This gave it a more rigid structure than the other parts.

Thus, parts of the Far-East mollusk *M. chinensis* were characterized with high contents of free amino acids that were variably localized. Proteins of *M. chinensis* contained 19 amino acids. Their contents differed somewhat in the various parts.

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