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COMPARISON OF PHYSICOCHEMICAL PROPERTIES OF MUSCLE PROTEINS IN CULTURED AND WILD PRAWNS (*PENAEUS (FENNEROPENAEUS) ORIENTALIS* KISHINOUYE, 1918)

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ABSTRACT: Protein physicochemical properties in cultured and wild prawns *(Penaeus (F.) orientalis* Kishinouye, 1918) were studied and compared. Protein fractions were separated into water-soluble, salt-soluble, alkali-soluble, and stroma. The results showed that salt- and alkali-soluble proteins were slightly higher in wild prawns and water-soluble proteins were higher in cultured prawns. There were only slight differences in Ca^{2+}-ATPase, MG^{2+}-ATPase, and ATP sensitivities. The textural values of wild prawns were significantly higher than the cultured ones.

KEY WORDS: Prawn, *Penaeus (Fenneropenaeus) orientalis*, Protein, Texture.

INTRODUCTION

Shrimps and prawns contribute about 20% (by volume) to the world seafood market. They have a high economic value, particularly in China, which has 25% of the world's population but only 6% of the world's arable land. Thus, the cultivation of marine resources, such as shrimps and prawns, are of vital importance.

China's annual output of shrimps and prawns (both wild and cultured) is approximately 200,000 tons. In addition to domestic consumption, large amounts, 20,000 tons, are exported, contributing further to China's economic growth.

Due to the short fishing season for prawns, compounded by a short shelf-life, it is necessary to freeze and process prawns for long-term storage. Unfortunately, this causes changes in texture, color, and size that are unacceptable to consumers. These changes are usually attributed to properties of different muscle proteins. While much information is available on the physicochemical and functional properties of fish proteins, there is little on prawn proteins. Some attempts have been made. Gadavaribai, *et al.*, 1987 and Xue and Xiubai, 1991 studied the flavour components and amino-acid compositions in cultured and wild prawns *(Penaeus (F.) orientalis)*. Kaneisha, H. 1979 looked at the biochemical properties of proteins from Antarctic krill. Papadopoulas *et al.* (1989), investigated muscle ultrastructural changes in the freshwater prawn *Macrobrachium rosenbergi* and Shamasunder and Parakash (1994) elucidated some functional and biochemical properties of proteins from *Metapenaeus dobsoni*. Nothing has been done to compare the different proteins and their properties in cultured and wild prawns. The importance of proteins in storage, stability, and processing necessitates a deeper understanding of the nature of prawn proteins.

In the present work, cultured and wild prawn proteins and their physicochemical properties were studied and compared. This fundamental study could provide informations on the changes in proteins due to storage.

MATERIALS AND METHODS

The prawns used in this study were chinese prawns *(Penaeus (F.) orientalis)*. Live cultured prawns were procured from a commercial farm on the Qingdao coast of China. Wild prawns were also caught off the same coast. Both types were brought to the laboratory in oxygen-packed plastic bags. After being peeled, deheaded, and deveined, they were used for extraction and analysis.

Determination of proximate composition

Moisture, fat, protein, and ash were estimated according to the procedures of AOAC (1984). Carbohydrates were estimated by the Anthrone method. All experiments were done in triplicate and average values reported.

Determination of the protein fractions

Water-soluble, salt-soluble and alkali-soluble proteins from cultured and wild prawns were extracted according to the method of Nobukazu (1987). All operations were performed at 3-4°C as quantitatively as possible. Twenty grams of each muscle were weighed and used for the extraction of proteins. Water-soluble proteins were extracted with 0.05 M KCI phosphate buffer. For salt-soluble fractions, three concentrations (0.25, 0.5, 1.0) were employed. Alkali soluble proteins were isolated with 0.1 N NaOH. Nonprotein nitrogen was determined according to the method of Kaneisha, H. (1979), nitrogen by the micro Kjeldahl method, and protein composition calculated by multiplying N by 6.25.

Ca^{2+}-ATPase activity

To 1 ml of protein solution the following were added in order: 0.5 ml of 0.5M tris-maleate buffer, pH 7.0; 0.5ml of 0.1 M $CaCl_2$; 7.5 ml of water, and 0.5 ml of 20 mM ATP solution, pH 7.0 . The rate of release of inorganic phosphate within 5 minutes of reaction at 25°C was determined after the addition of ATP. Five ml of 15% perchloric acid (PCA) was added to stop the reaction and the inorganic phosphate determined according to the method of Arai and Takashi (1977). Ca^{2+}-ATPase activity was shown as uM of inorganic phosphate liberated by 1 mg of protein within 1 minute of reaction at 25°C.

Mg^{2+}-ATPase activity

To 1 ml of protein solution were added 1 ml of 0.02M $MgCl_2$; 1 ml of 0.2 M tris-maleate buffer, pH 7.0; 5 ml of distilled water; and 1 ml of 20mm ATP solution. The rate of release of inorganic phosphate within 5 minutes of reaction at 25°C was determined after the addition of ATP; 5 ml of 15% PCA was used to stop the reaction and the inorganic phosphate was determined according to the method of Arai and Takashi (1977). The Mg^{2+}-ATPase activity was shown as uM pi/mg/min of reaction at 25°C.

ATP sensitivity

ATP sensitivity was estimated according to the method of Connell (1960) using an Ostwald viscometer at 25±0.1°C.

Determination of texture

Texture was determined in three different regions: the head, abdomen, and tail using OTMS (Ottoawa texture measuring system), a puncture force method.

RESULTS AND DISCUSSION

The proximate composition of wild and cultured prawns is shown in table I. The proteins from both types were very similar. The wild prawn proteins were slightly higher by 0.7%. This may be due to the protein composition of feed and its utilization by the prawn. Nobukazu (1987) extracted protein with different ionic strength solutions and obtained similar results. Table 2 presents the nonprotein nitrogen (NPN) content in different protein fractions. The cultured prawns had a lower NPN content than the wild ones. Perhaps this accounts for the good flavor of wild prawns. Xiubai (1991). The water-soluble proteins in cultured prawns were high because myofibrillar proteins are easily decomposed during extraction. The salt-soluble portion of cultured prawns, 55.5%, was lower than the wild prawns which was 56.3%. It was the same as most fish meat (Connell, 1960). The alkali-soluble fraction and stroma of wild prawns are to be noted as they were significantly higher than in the cultured prawns, and even higher than in most fishes. Perhaps this is why the texture of the wild prawns is tougher compared to the cultured.

Table I. Proximate composition (%) of wild and cultured prawns.

	Total Protein	Lipids	Ash	CHO	Moisture
Cultured	18.96	0.56	1.51	0.22	78.40
Wild	19.10	0.38	1.44	0.25	78.42

Table II. Protein composition (mg N/g muscle) of cultured and wild prawns in different ionic strength solutions.

Protein fractions	Cultured		Wild	
NPN	4.23		4.99	
0.05M KCl	9.63	(31.8)*	8.19	(26.8)
0.25M KCl	2.78	(09.2)	3.42	(11.2)
0.50M KCl	7.28	(24.0)	7.51	(24.2)
1.00M KCl	6.75	(22.2)	6.26	(20.5)
0.10N NaOH	2.63	(08.7)	3.88	(12.7)
STROMA	0.8	(02.8)	1.28	(04.2)

* ( ) Protein percent.

Table III. Ca^{2+}-ATPase and Mg^{2+}-ATPase activities (uM Pi/mg/min) of cultured and wild prawns.

	Ca^{2+}-ATPase	Mg^{2+}-ATPase
Cultured	0.21	0.56
Wild	0.19	0.45

Table IV. ATP sensitivity of cultured and wild prawns.

	0.25M KCI	0.5 M KCI	1.0 KCI
Cultured	3.5	80.3	76.3
Wild	4.9	81.3	85.3

Table V. Textural measurements (Kg/cm^2) of cultured and wild prawns.

	Head	Abdomen	Tail	Average
Cultured	0.60	0.45	0.30	0.45
Wild	0.75	0.52	0.45	0.54

Table 3 presents the Ca^{2+}-ATPase and Mg^{2+}-ATPase activities. Ca^{2+} and Mg^{2+} activities are protein characteristics widely used as indexes to evaluate the stability of muscle proteins (Arai and Takashi, 1977). The ATPase activity of muscular proteins gives an indication of the myosin that binds with other proteins. The Ca^{2+} and Mg^{2+} activities of cultured prawns were higher compared to the wild ones. The Mg^{2+} activity was especially high. The Ca^{2+} activity was similar to that reported by Nobukazu (1987) in krill, but the Mg^{2+} activity was much higher compared to the activity in the krill. Ca^{2+} activates ATPase activity whereas Mg^{2+} deactivates it. However, in low ionic strength solutions, Mg^{2+} increases the activity significantly, perhaps due to phosphorylation of the muscle proteins. This could be the reason for high Mg^{2+} activity.

Table 4 describes the ATP sensitivities of cultured and wild prawns. ATP sensitivity is linked to protein viscosity. In 0.25 KCI, low sensitivity was obtained due to the low levels of myosin. The loss of Ca^{2+} sensitivity is considered to be the result of myofibrill filamentation, and the effect of hydrolysis by proteases (Tokiwa and Matsumiya, 1969). However, according to Seki and Hasegawa (1978), the loss of Ca^{2+} sensitivity of myofibril proteins is an effect of modification of actinomyosin interactions caused by oxidation of SH groups in myosin.

Texture of the muscles is one of the sensory parameters used to assess the quality of prawns. The textural values are given in table 5. Texture was measured in three different regions: head, abdomen and tail. The wild prawns had high textural values compared to the cultured in all the three regions. This may be due to a number of reasons. According to Segars and Johnson (1986), muscle having a low pH has a tough texture. Fluctuations in water, protein, and lipid contents also have a significant impact (Dunajski, 1979). In fishes, texture changes are noticed after migration, spawning or starvation. Perhaps these also account for the hard texture in wild prawns.

REFERENCES

AOAC. 1984. *Official methods of analysis of the association of the official analytical chemists*, 14th Edition. Association of Official Analytical Chemists, Washington, D.C.

Arai, K., 1974. Evaluation of fish quality from the muscle protein studies. *Japanese Society of Scientific Fisheries Koseisha, Tokyo* 55-80.

Arai, K. and R. Takashi. 1977. Studies on muscular protein of Fish. Effect of freezing on determination of actomyosin ATPase from carp muscle. *Bulletin of the Japanese Society of Scientific Fisheries* 43: 533-541.

Connell, J.J. 1960. Studies on the protein of fish skeletal muscle. *Biochemical Journal* 75: 530-538.

Dunajski, E.J. 1979. Texture of fish. *Journal of Texture Studies* 10: 901-918.

Godavaribai, S., V.S. Khabade, and V.J. Prakash, 1987. Effect of freezing and sodium citrate treatment on the association-dissociation of proteins from shrimps. *Food Science and Technology* 24: 243-246.

Kanehisa, H. 1979. Muscle protein composition of sardine and mackerel. *Bulletin of the Japanese Society of Scientific Fisheries* 45(11): 1435-1441.

Nobukazu, S. 1987. Food biochemical studies on the utilization of muscular proteins in Antarctic krill for human consumption. *Bulletin of the Tokai, Regional Fisheries Research Laboratory* 111: 63-136.

Papadopoulas, L.S., S.B., Smith, T.L., Wheeler, and G. Finne 1989. Muscle ultrastructural changes in freshwater prawns during ice storage. *Journal Food Science* 54: 1125-1128.

Segars, R.A. and E.A. Johnson. 1986. Sea food quality determination. *International Symposium on Seafood Quality Determination*. Elsevier, Amsterdam. Pp.49-61.

Seki, N. and E. Hasegawa. 1978. Comparative studies on fish troponins. *Bulletin of the Japanese Society of Scientific Fisheries* 44: 71-78.

Shamasunder, B.A. and V. Prakash. 1994. Physicochemical and functional properties of protein from prawns. *Journal of Agriculture and Food Chemistry* 42: 169-174.

Tokiwa, T. and H. Matsumiya. 1969. Fragmentation of fish myofibrills. Effect of storage condition muscle cathepsin. *Bulletin of the Japan Society of Scientific Fisheries* 35: 1099-1105.

Weber, K. and M. Osborn, 1969. The reliability of molecular weight determination by SDS. *Biochemical Journal* 75: 530-538.

Xue Changhu and Chen Xiubai. 1991. Comparison of flavor components of cultured and wild prawns. *Journal of the Ocean University Qingdao* 21: 89-100.

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