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Nutritive Value of Hard and Soft Shell Crabs of *Portunus sanguinolentus* (Herbst)

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Abstract: Iin the present study, biochemical composition (protein, carbohydrate and lipid) including amino acids and minerals were studied both soft and hard shell crabs of *P.sanguinolentus*. The protein, carbohydrate and lipid contents were found to be higher in hard shell crabs than that of soft shell crabs. Totally 10 essential amino acids were reported. Among these, 8 individual essential amino acids are reported in hard shell crabs and 7 amino acids are recorded in soft shell crabs. The hard shell crabs totally contributed maximum amount of essential amino acids (51.096%) and minimum was in soft shell crabs (43.627%).Among 10 nonessential amino acids, 8 amino acids are reported in hard shell crabs and 7 amino acids are recorded in soft shell crabs. Hard shell crabs totally contributed 53.783% of non essential amino acids and soft shell crabs 49.719%. In the present study, totally 5 minerals were reported both hard and soft shell crabs. The hard shell crabs contributed maximum (3.985mg) of minerals and minimum was in soft shell crabs (3.018 mg). The protein, carbohydrate and lipid contents were found to be higher in hard shell crabs than that of soft shell crabs. The individual and total amino acid (essential +non essential) contributions are much higher in hard shell crabs than soft shell crabs. The total contribution of the minerals is higher in hard shell crabs when compared to soft shell crabs. So hard shell crabs are declared superior over soft shell crabs in terms of nutritive value.

Key words: Blue crab, nutritive value, soft shell crabs and amino acids

INTRODUCTION

The crab fishery in India is fast developing and there is a vast scope for the crab meat due to its delicacy and nutritional richness. The commercially important portunid crabs found along Parangipettai coast are *Scylla serrata, S. tranquebarica, Portunus sanguinolentus, P. pelagicus, Podophthalamus vigil, Charbdis feriata, C. lucifera, C. natator, C. granulata* and *C. truncata* (John Samuel *et al*., 2004). In Indian scenario, the consumer mostly prefers large sized mud crabs, *viz*., *S. tranquebarica* and S. *serrata*. They are exported to South East Asian countries under live conditions. Because of their delicacy and larger size, the live mud crabs are always in greater demand and fetch a higher price both national and international markets (Kathirvel 1993). But swimming crabs, both *P. pelagicus* and *P. sanguinolentus* are being exported mostly frozen and canned forms. The natural availability of mud crabs is restricted in some seasons only. However, the blue swimming crabs (*P.sanguinolentus* and *P. pelagicus*) are abundant throughout the year. For each unit of fishing effort, moulted or water crabs are also caught which have no or very low market value. In India, usually the soft shell (water crab) crabs are discarded from the landing centre. Since, there is no much knowledge about the nutritional status of the soft shell crabs. To know the nutritional value of crabs, biochemical studies are very important. Such data on soft shell crabs are not available especially blue swimming crabs. So studies on biochemical composition of soft shell crabs are very much need of the hour to stop the wastage of soft shell crabs. So in the present study, biochemical composition (protein, carbohydrate and lipid) including amino acids and minerals were studied both soft and hard shell crabs of *P. sanguinolentus*.

MATERIALS AND METHODS

Hard and soft shell crabs (newly moulted or water crabs) (weight of 80-120 g and carapace width of 65-84 cm) were purchased from the landing centre of Parangipettai (Lat. 11º 29'N and Long. 79º 46'E). They were brought to the laboratory and acclimatized to the laboratory conditions (Salinity 30-34ppt; dissolved oxygen 5.0-6.0 ppm; temperature 28-30 ºC and pH 7.5-8.5). After acclimatization, both hard and soft shell crabs were dried at 60 ºC in an oven and used for biochemical analysis. The protein, carbohydrate and lipid contents were estimated by adopting the standard methods of Raymont *et al.* (1964), Dubois *et al.* (1956) and Folch *et al.* (1956) respectively. The experimental crab samples were dried at 60ºC for 24 hours in an oven and the dried samples were finely ground for estimating the amino acids in the HPLC (Merck Hitachi L-7400) following the method of Baker and Han (1994). The minerals were estimated both hard and soft shell crabs by following the method of Guzman and Jimeneza (1992).

RESULTS

The protein, carbohydrate and lipid contents were found to be higher in hard shell crabs than that of soft shell crabs (Table 1).

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Table 1: Proximate composition of hard and soft shell crabs of *P. sanguinolentus*.

S.No	Crab	Protein(%)	Carbohydrate (%)	Lipid(%)
1	Hard shell	32.6± 0.9	1.17 ±0.92	2.41± 0.30
2	Soft shell	17.17± 0.48	0.68± 0.15	1.50± 0.7

In hard shell crabs, leucine (8.386%) was maximum followed by arginine (8.385%) and lysine (6.963%). Histidine (4.442%) was minimum when compared to other essential amino acids. In soft shell crabs, leucine (9.242%) and arginine (9.242%) was maximum. Whereas histidine was minimum (3.134%). Tryptophan was totally absent both hard and soft shell crabs. Totally 10 essential amino acids were reported both hard and soft shell crabs. Among these, 8 individual essential amino acids are reported in hard shell crabs (Leucine > arginine > lysine > valine > phenylalanine > isoleucine > threonine > histidine) and 7 amino acids are recorded in soft shell crabs (Leucine >arginine> valine > lysine > threonine> Isoleucine>histidine). As far as total essential amino acids are concerned, hard shell crabs contributed maximum (51.096%) and minimum was in soft shell crabs (43.627%) (Table 2).

In hard shell crabs, aspargine was maximum (12.877%) followed by glutamic acid (11.539%) and serine (9.648%). Tyrosine (1.913%) was minimum and two amino acids are not detectable (Aspartic acid and cystine). Among 10 non essential amino acids, 8 amino acids are reported in hard shell crabs (Aspargine>glutamic acid>serine>proline>taurine>glycine>alanine>tyrosine) and 7 amino acids are recorded in soft shell crabs (glutamic acid> aspargine > serine > glycine > proline > alanine > tyrosine). In soft shell crabs, glutamic acid was maximum (12.383%) followed by aspargine (12.295%) and serine (10.370%). Tyrosine (2.054%) was minimum and three amino acids are not detectable (aspartic acid, cystine and taurine). Hard shell crabs totally contributed 53.783% of non essential amino acids and soft shell crabs 49.719% (Table 3).

In hard shell crabs, calcium (2.028 mg) was maximum and zinc (0.445 mg) was minimum. In soft shell crabs also calcium (1.022 mg) was maximum and zinc was minimum (0.457 mg). Totally 5 minerals were reported in hard (Calcium> sodium >magnesium>potassium>zinc) and soft shell crabs (Calcium>magnesium>sodium>potassium>zinc). The hard shell crabs contributed maximum of 3.985 mg and minimum was in soft shell crabs 3.018 mg (Table 4).

Table 2 : Essential amino acid contents of hard and soft shell crabs of *P. sanguinolentus*

S.No	Amino acids	Hard shell crabs (%)	Soft shell crabs(%)
1	Threonine	4.884	5.259
2	Valine	6.484	6.953
3	Arginine	8.385	9.242
4	Methionine	N.D	N.D
5	Isoleucine	5.407	3.137
6	Leucine	8.386	9.242
7	Lysine	6.963	6.660
8	Phenylalanine	6.145	N.D
9	Histidine	4.442	3.134
10	Tryptophan	NA	NA
	Total	51.096	43.627

ND-Not detected, NA-Not available

Table 3: Nonessential amino acid contents of hard and soft shell crabs of *P. sanguinolentus*.

S.No	Amino acids	Hard shell crabs (%)	Soft Shell crabs (%)
1	Aspartic acid	N.D	N.D
2	Glutamic acid	11.539	12.383
3	Cystine	N.D	N.D
4	Tyrosine	1.913	2.054
5	Taurine	4.884	N.D
6	Alanine	2.936	3.137
7	Aspargine	12.877	12.295
8	Glycine	4.442	4.799
9	Proline	5.544	4.681
10	Serine	9.648	10.370
	Total	53.783	49.719

Table 4: Mineral composition of hard and soft shell crabs of *P. sanguinolentus*

S.No	Minerals	Hard shell crabs (mg/100g)	Soft Shell crabs (mg/100g)
1	Calcium	2.028	1.022
2	Sodium	0.521	0.520
3	Potassium	0.480	0.497
4	Zinc	0.445	0.457
5	Magnesium	0.511	0.522
	Total	3.985	3.018

DISCUSSION

Biochemical studies are very important from the nutritional point of view. The biochemical constituents in animals are known to vary with season, size of the animal, stage of maturity, temperature and availability of food etc. Protein is essential for the sustenance of life and accordingly exists in the largest quantity of all nutrients as a component of the human body (Okuzumi and Fujii, 2000). An increasing demand for good quality animal protein for the exploding population has led to effective and increasing exploitation of the aquatic resources. The acceptability and easy digestibility of fish proteins make it very valuable in combating protein malnutrition, especially in children. The protein of fish has a high biological value with its growth promoting capacity. Fish occupy an important part in the world protein supply, accounting for about 10 % of the total protein supply. About 60% of the population in the developing countries derives 40% or more of their total animal protein supplies from fish. The average protein content of fish approximately ranges from 8 to 23g/100g wet edible protein.

In the present study, protein content was higher in hard shell crabs (32.6%) than those in soft shell crabs (17.17%). Values of protein in the present study are agreement with other studies (Sheen and D'Abramo, 1991; Zafar *et al*., 2004; Murugesan *et al*., 2008). The protein content of soft shell was found to be 8.33% and hard shell crab was 14.93% in *S.ocenica* (Anil and Suseelan, 2001). Balasubramanian and Suseelan (2001) assessed the protein values in *C. smithii* was 59.8 to 71% in dry matter basis. The protein values in *P. vigil* was

15.75 to 20.16 %.(Radhakrishnan and Natarajan, 1979) and in *C. affinins* was 17.8% (Vasconcelos and Braz, 2001). In *S. serrata*, the protein content of the body meat and claw meat was 20.11% and 18.54% respectively (Prasad and Neelakantan, 1989). Anon (1999) reported that the protein value in blue crab was 17.17%. George and Gopakumar (1987) observed the protein content in *S. serrata* with egg (19.16%), without egg (20.92%), body meat (16.8%) and claw meat (16.28%). George *et al.* (1990) noticed the protein values in cooked crab of *S. serrata* ranged from 14.43 to 18.96%. The protein content of *P. pelagicus* and *P. sanguinolentus* was 0.47 to 15.91% and 12.81 to 13.6% respectively (Radhakrishnan, 1979). Zafer *et al.* (2004) reported that the protein values in *S. serrata* male were 17.69% and 19.39% for females. Khan (1992) investigated 11.60% protein in body meat of male and 19.92% protein in females body meat of *S.serrata*. Thirunavukkarasu (2005) recorded the protein values in *S. tranquebarica* from different parts *viz*., body meat (65.48 to 72.24%), claw meat (69.5 to 80.29%) and leg meat (69.47 to 74.7%).

Carbohydrates constitute only a minor percentage of total biochemical composition. Carbohydrates in fishery products contain no dietary fiber but only glucides, the majority of which consist of glycogen. They also contain traces of glucose, fructose, sucrose and other mono and disaccharides (Okuzumi and Fujii, 2000). In the present study, carbohydrate content was higher in hard shell crabs (1.17%) and lower in soft shell crabs (0.68%). The previous studies were suggested that the carbohydrate in the muscle varied from 0.3 to 0.63% in *P. vigil* (Radhakrishnan and Natarajan, 1979), 2.4 to 3.4% in *C. smithii* (Balasubramanian and Suseelan, 2001), 0.17% in body meat, 0.24% in claw meat of *S. serrata* (Prasad and Neelakantan, 1989), 0.16 to 0.55% in *P.pelagicus* and 0.44 to 0.73% in *P. sanguinolentus* (Radhakrishnan, 1979). In *S. tranquebarica*, the carbohydrate values of body meat, claw meat and the leg meat was 0.59 to 2.23%, 0.68 to 2.87% and 0.76 to 2.76% respectively (Thirunavukkarasu, 2005). Recently Murugesan *et al.* (2008) reported that carbohydrate content of hard shell crabs (1.42%) of *C.lucifera* was little bit lower than eyestalk ablated crabs (1.45%).

Lipids are highly efficient as sources of energy and they contain more than twice the energy of carbohydrates and proteins (Okuzumi and Fujii, 2000). In the present study, lipid content of the hard shell crab (2.41%) was higher than soft shell crabs (1.50%). In *P. vigil* the lipid values assessed from 5.13 to 9.73% by Radhakrishnan and Natarajan (1979). Balasubramanian and Suseelan (2001) recorded that the lipid values from 6.2 to 7.6% in *C. smithii.* In *Chaceon affinis,* the lipid values were 0.7% (Vasconcelos and Braz, 2001) and in blue crab it was 1.5% (Anon, 1999). Prasad and Neelakantan (1989) noticed that the lipid content in *S. serrata* from body meat was 1.65% and claw meat was 2.01%. George and Gopakumar (1987) assessed the lipid values in *S. serrata* with egg (0.43%), without egg (0.7%), body meat (1.07%) and claw meat (1.0%). In *P. pelagicus* the lipid value was 3.3 to 5.6% and *P. sanguinolentus* it was 3.8 to 5.5% (Radhakrishnan, 1979). The lipid content of the body meat (0.9 to1.6), claw meat (1.83 to 2.06%) and leg meat (1.58 to 2.08%) was estimated by Thirunavukkarasu (2005). Recently Murugesan *et al.*, (2008) reported that lipid content of hard shell crabs (1.65%) of *C. lucifera* was little bit lower than eyestalk ablated crabs (1.85%). In crustaceans, lipids are not only the principal organic reserve and source of metabolic energy, but also indispensable in maintaining cellular integrity. Lipids as a general rule act as major food reserve along with protein and are subject to periodic fluctuations influenced by environmental variables like temperature (Nagabhushanam and Farooqui, 1982).

Biological value of protein is obviously reflected upon its essential amino acids concentration. In general, the shellfish have a balanced distribution of all essential amino acids required for an adult per day. There are 20 amino acids found in fish proteins. Some of these are listed as essential amino acids (EAA), *i.e.* arginine, histidine, isolucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine because these are not synthesized in the body. The essential amino acids are required for maintenance of life, growth, synthesis of vitamins and reproduction. The lowest level of any one of these essential amino acids in a protein source, which limits the utilization of that protein, makes it the "First limiting amino acid" (Paulraj and Sridhar, 2001). 10 essential amino acids were reported, among these 8 individual essential amino acids are reported in hard shell crabs (Leucine > arginine > lysine > valine> phenylalanine>isoleucine>threonine>histidine) and 7 amino acids are recorded in soft shell crabs (Leucine, arginine>valine>lysine>threonine>isoleucine>histidine). As far as total essential amino acids concerned, hard shell crabs contributed maximum (51.096%) and minimum was in soft shell crabs (43.627%).

The essential amino acid composition in *S. serrata* was reported by Prasad and Neelakandan (1989). Histidine, leucine, thronine and cystine were possessed in higher proportion and the total contribution was 36.82%. Anon (1999) reported arginine, lysine, leucine and isoleucine in blue crab. Thirunavukkarasu (2005) recorded amino acids in the following order: arginine >leucine > lysine > valine> isoleucine >threonine> phenylalanine >methionine >histidine in *S. traquebarica.* The nutritive value of any animal is decided by the presence of essential amino acids. In this sense, individual and total essential amino acid contributions are much higher in hard shell crabs than soft shell crabs of the present study. So hard shell crabs are declared superior over soft shell crabs in terms of nutritive value.

Among 10 non essential amino acids, 8 amino acids are reported in hard shell crabs (Aspargine>glutamic acid>serine>proline>taurine>glycine>alanine>tyrosine) and 7 amino acids are recorded in soft shell crabs (glutamic acid> aspargine > serine > glycine > proline >

alanine > tyrosine). Hard shell crabs totally contributed 53.783% of essential amino acids and soft shell crabs 49.719%.Thirunavukkarasu (2005) reported non essential amino acids in the following order: Glutamic acid > asapartic acid>alanine>glycine>serine in *S.tranquebarica.* In general, the presence of amino acids in the body of the animal is determined by the amount of protein. The protein content of the hard shell crabs are more so the total amino acid contribution is high and it is less because the protein content is less in soft shell crabs of the present study.

Marine organisms form a good source of minerals. Ash is left out after complete combustion of fish meat and gives a measure of the total mineral content. The ash content of fish varies 0.5-2% (Gopakumar, 1997). The fish and shellfish can absorb minerals directly from the aquatic environment through gills and body surfaces. Almost all the elements that occur in seawater are found to some extent in aquatic animals and these include Na,K,Ca,P,Al,Ba,Cd,I,Cr,Pb,Li,Hg,Ag,St and Va.

The mineral serve as components of bones, soft tissues (sulfur aminacids, metalloproteins) and co-factors and and co-activators of various enzymes important in human nutrition. Calcium, phosphorus, magnesium and the electrolytes (sodium and potassium) are considered to be as macro elements and iron, copper, zinc, iodine, chromium, cobalt, manganese, molybdenum and selenium are considered as trace elements that are required for normal functioning, For instance the more soluble minerals such as Ca, P, Na, K and Cl are involved in the maintenance of acid-base balance and membrane potential.

The calcium and phosphorus together account for 70 to 80% of the minerals in the skeleton of fish (Nair and Mathew, 2000). The phosphorous (adenosine polyphosphate) act as a key substance for energy release and present in phospholipids. Sulphur containing amino acids like cystein and methionine are main sources of sulphur in fish. Copper and iron are important minerals found in fish as respiratory pigment, while cobalt is present in vitamin $B_{12.}$

In the present study, totally 5 minerals were reported both hard(Calcium>sodium>magnesium>potassium>zinc) and soft shell crabs (Calcium > magnesium>sodium> potassium>zinc).The hard shell crabs contributed maximum (3.985mg) of minerals and minimum was in soft shell crabs (3.018 mg). Both hard and soft shell crabs of the present study the calcium showed maximum concentration. These are very much comparable with that of blue crab by Anon (1999) and Thirunavukkarasu (2005) in *S.tranquebrica.* Whereas Hagashi *et al.* (1979) reported that in the boiled crabs, sodium and potassium comprised the major part of minerals. In the present investigation, the individual contribution of these minerals is more or less same in both hard and soft shell crabs. But total contribution of these minerals is higher in hard shell crabs when compared to soft shell crabs.

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