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Analysis of dietary value of the soft tissue of the freshwater crab Travancoriana schirnerae

KEYWORDS: Dietary value, proximate composition, Travancoriana schirnerae.

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ABSTRACT *The present study determined the nutritional status of claw and body meat in adult male and female of the freshwater crab, Travancoriana schirnerae with respect to the proximate composition, free amino acids (FAA) and cholesterol contents. Biochemical analyses were done in pentaplicate samples of the homogenate and the data obtained were analyzed using Student's t-test and correlation analysis. The mean protein, oligo and polysaccharides, moisture, lipid, FAA and cholesterol contents of crab meat were found to be 19.39%, 0.38%, 0.51%, 83.02%, 369.5 mg, 1469 mg and 21.3 mg/100 g respectively. Only the fat content showed significant differences between the body parts analyzed. Furthermore, female crab meat had significantly higher levels of protein, carbohydrate and FAA than males indicating females are better than males nutritionally. This study revealed that T. schirnerae meat being low in fat, yet high in protein, is an excellent option to include in a healthy diet.*

Introduction
Edible crustaceans such as crabs, prawns, shrimps, crayfishes and lobsters comprise one of the major sources of nutritious food for human beings. The nutritive value of crustaceans depends on their biochemical constituents such as proteins, carbohydrates, lipids, amino acids, vitamins and minerals. Crabs have exceptional and scrumptious taste as compared to fish and mollusc and rank third after shrimps and lobsters for their revered delicacy and the value of fishery they support (Savad and Raghavan, 2001). Crab meat contains many nutrients and is an excellent source of high quality proteins, vitamins and minerals. Many curative properties are attributed to crab meat in view of the fact that it is used to treat asthma and chronic fever (Raja, 1981). It has been reported that large numbers of potamids and parathelphusids are consumed in Thailand. Yeo et al. (2008) reported that potamids are consumed by the natives of South America to improve health, to treat digestive disorders and to cure physical injuries.

Crab fishery in India is fast developing and there is immense scope for crab meat due to its delicacy and nutritional richness. Because of their delicacy and larger size, crabs are in greater demand and gain lofty price in both national and international markets. In India, a total of 12 marine/brackish water species belonging to six genera, viz., *Scylla, Portunus, Charybdis, Matuta, Varuna* and *Podophthalmus* are of commercial value.

Proximate composition, amino acid and cholesterol contents have been extensively studied in marine crabs from India (Srinivasagam, 1979; Sudhakar et al., 2009; Sudhakar et al., 2011) and abroad (Kucukgulmez et al., 2006; Dima et al., 2009; Jimmy and Arazu, 2012). However, limited research has focused on freshwater crabs (Sayyad et al., 2008; Sengul and Zeliha, 2011).

The freshwater crab, *Travancoriana schirnerae* (Bott, 1969), abundant in the wetlands of Wayanad, Kerala, India, forms a cheap source of animal protein to the poor, malnourished tribes. The natives consume the ovary alone during the breeding season. In spite of abundance and commercial value, no studies have been conducted to determine its nutrient value. The knowledge of the biochemical composition of any edible organism is extremely important since the nutritive value is reflected in biochemical contents as stated by Nagabhushanam and Mane (1978). In the present study, an attempt has been made to evaluate the nutritive value of claw and body meat of adult male and female *T. schirnerae*, thereby to encourage its large scale production and consumption.

Materials and Methods
Adult intermoult males (n=15) and females (n=15) (carapace width 5.5-6 cm) were collected from the paddy fields near the College campus, Mananthavady during April 2010-June 2011. The collected specimens were brought immediately to the laboratory. Their carapace widths (CW) and wet weights were recorded. Meat from the body and claw portions of crabs was removed manually, weighed and analyzed fresh. Care was taken not to desiccate the tissue during dissection. All analyses were conducted on pentaplicate samples of tissue homogenates.

Total protein content was determined by Lowry et al. (1951) method. The oligo and polysaccharide fractions were extracted following the procedure of Johnston and Davies (1972) and estimated by phenol-sulphuric acid method (Dubois et al., 1956). The green colour developed on addition of phenol and sulphuric acid was read at 490 nm in a UV-Vis spectrophotometer-117 (Systronics). Lee and Takahashi (1966) method was adopted for the determination of total free amino acids (FAA). The absorbance of the bluish-purple colour developed was read at 570 nm spectrophotometrically within one hour. The total lipid was extracted following Folch et al. (1957) and estimated by the Sulphovanillin method (Frings et al., 1972). Zlatkis et al. (1953) method was adopted for the estimation of cholesterol.

Moisture analysis
For determination of the moisture content, fresh tissues of claw and body meat were weighed and kept in an oven heated to 105^{0}C. The tissues were taken out and weighed at regular intervals until constant weights were reached. Moisture content was calculated as the difference between wet weight and dry weight of the tissue and this difference has been expressed as percentage of the wet weight of the tissue.

Statistical analysis
The recorded data were subjected to Student's t-test and correlation analysis. Significant differences between means were determined by Student's t-test. Correlation analysis was conducted to find out the relation between protein, carbohydrate, lipid and moisture values.

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Results

The results of the proximate composition, free amino acid and cholesterol analyses are given in Tables 1-2. The protein content of meat varied from 12.80-26.35% (Table 1). The mean protein content on a wet weight basis was 19.39±0.78% (that of male crab meat 18.84±0.76% and female crab meat 19.95±0.43%) (Table 2). The average protein content recorded for claw meat in male was 18.30±3.58% and 20.26±3.34% in females (Table 1). The body meat protein content averaged 19.37±5.29% in males and 19.65±3.21% in females (Table 1). Student's t-test showed no significant difference in protein concentration neither between the sexes (t=0.665, P>0.05) nor between claw and body meat (t=0.134, P>0.05).

Carbohydrates (oligo plus polysaccharides) constituted only a minor percentage (0.50-1.44%) of the total biochemical composition. The oligosaccharide values varied from 0.15-0.47% in males and from 0.31-0.89% in females (Table 1). The mean oligosaccharide values registered for claw and body meat were comparable in both the sexes and displayed no significance statistically (P>0.05). However, Student's t-test confirmed a significant difference in the oligosaccharide fraction between the sexes (P<0.05).

In the present study, the polysaccharide fraction ranged from 0.33-0.63% in males and 0.55-0.78% in females (Table 1). The claw meat polysaccharide fraction averaged 0.37±0.03% and 0.61±0.09% while that of body meat averaged 0.42±0.13% and 0.63±0.02% in males and females respectively (Table 1). The polysaccharide content was significantly greater in females than males (P<0.05) but no significant difference was observed in the polysaccharide level between claw and body meat (P>0.05). Correlation analysis indicated that the carbohydrate content is negatively correlated with protein in *T. schirnerae* (r= -0.964).

Fat content obtained in this study was found to be low (188-580 mg/100 g) in the body parts analyzed for both the sexes (Table 1). The mean lipid values obtained for male (386.5±159.09 mg/100 g) and female crab meat (352.5±198.69 mg/100 g) were comparable and the difference recorded was found statistically insignificant (Table 2). However, the claw meat possessed a substantial higher fat content (491.5±2.1 mg/100 g) than that reported for body meat (241.0±46.6 mg/100 g) (Table 2). Student's t-test established significant difference in lipid levels between claw and body meat (P<0.05). Correlation analysis indicated that the fat content is positively related to protein in *T. schirnerae* (r=0.811).

The percentage moisture content in *T. schirnerae* meat ranged between 76.0 and 88.0% (Table 1). The moisture value reported was comparatively higher in the male crab meat (84.29±3.17%) than the female crab meat (81.33±3.01%); found greater in the body meat portion (84.11±2.47%) than the claw meat portion (81.93±3.92%) (Table 2). However, the differences recorded in moisture levels between the sexes and the body parts were not significant statistically (P>0.05). The water content in *T. schirnerae* marked a negative correlation with protein content (r= -0.531).

The total FAA content was significantly low in male specimens (1197±342 mg/100 g) compared to female specimens (1794±729 mg/100 g) (t=2.380, P<0.05) (Table 2). The FAA content in male claw meat amounted to 1249±183 mg/100 g and body meat 1144±466 mg/100 g whereas the level of total FAA in female claw meat averaged 1656±820 mg/100 g and body meat 1933±689 mg/100 g (Table 1). The body meat had a higher FAA content (1502±684 mg/100g) than the claw meat (1434±575 mg/100 g), but not at significant levels (t=0.254, P>0.05) (Table 2).

The mean cholesterol content reported for *T. schirnerae* meat ranged from 18.0±3.2 mg/100 g in males to 23.6±5.7 mg/100 g in females while more less equal values were obtained for claw (21.0±5.5 mg/100g) and body meat (21.7±6.0 mg/100g) cholesterol (Table 2). Statistically, cholesterol values revealed no significant differences from each other neither between claw and body meat nor between the sexes (P>0.05).

Discussion

The present study estimated the proximate composition, free amino acids and cholesterol contents in claw and body meat of adult male and female *T. schirnerae*. The protein content of the body parts analyzed showed that it is high when compared with other nutrient composition. The average values of protein obtained in this study are in agreement with those of other crab species (Adeyeye, 2002; Chen et al., 2007; Kaya et al., 2009; Sudhakar et al., 2011) but higher than those observed for many marine species (Anonymous, 1999; Radhakrishnan, 2000; Nackzk et al., 2004; Cherif et al., 2008). Only *S. tranquebarica* meat recorded (Thirunavukkarasu, 2005) higher protein values than *T. schirnerae* meat.

The results obtained in this study revealed that the concentration of protein was found greater in the female crab meat than the male. Similar differences between sexes have been noticed in the mud crab *S. serrata* (Khan, 1992; Zafar et al., 2004). Ozogul et al. (2010) reported that there were variations in protein contents of both male and female crab meat in *Callinectes sapidus*. Meanwhile, in freshwater crabs like *Sudanonautes africanus africanus* (Adeyeye, 2002) and *Potamon potamios* (Sengul and Zeliha, 2011), the protein values recorded for female crab meat were low in comparison to male.

The protein values obtained for body meat in *T. schirnerae* was higher than those reported for claw meat. Thirunavukkarasu (2005) recorded greater values for protein in *S. tranquebarica* claw meat than body meat. In *C. sapidus* female, differences were found between protein values of claw and body meat, with a higher value for claw than body meat (Kuley et al., 2008). Protein is vital for normal function, growth and maintenance of body tissues. The content of protein is considered as an important mean for assessing the physiological standard of an organism (Diana, 1982). Shell fish meat provides high quality protein with all the dietary essential amino acids for the growth and maintenance of the body (FNB, 2007).

Results of this study recorded considerably low carbohydrate contents in T. schirnerae meat. Prasad and Neelakantan (1989) documented comparable values for carbohydrates in claw and body meat of S. serrata whereas Khan (1992) and Srinivasagam (1979) reported noticeably low carbohydrate contents in the blue swimmer crab P. pelagicus and in blood spotted swimming crab P. sanguinolentus. Sudhakar et al. (2011) analyzed the carbohydrate contents of long-eyed swimming crab P. vigil muscle and found them to be within the range recorded for T. schirnerae. On the other hand, elevated values for carbohydrates were noticed in C. smithii (Balasubramanian and Suseelan, 2001), S. tranquebarica claw and body meat (Thirunavukkarasu, 2005) and in the warty crab Eriphia verrucosa meat (Altinelataman and Dincer, 2007).

In *T. schirnerae*, the concentration of carbohydrates (oligo and polysaccharides) was significantly higher in females than males, which are in agreement with the previous findings (Zafar et al., 2004). Bhavan et al. (2010) reported that the carbohydrates in the muscle showed some differences when compared between male and female in the freshwater prawn *Macrobrachium rosenbergii*. The carbohydrate content showed negative correlation with protein in both male and female *T. schirnerae* as documented for *S. serrata* (Zafar et al., 2004). Carbohydrates are considered to be foremost among organic nutrients to be consumed to generate energy (Heath, 1987). Carbohydrates in fishery products include no dietary fibres but only glucides, bulk of which contained the

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polysaccharide glycogen. Carbohydrates also include traces of glucose, fructose, sucrose and other mono and disaccharides (Okuzumi and Fujii, 2000). They serve as precursors for the synthesis of non-essential amino acids and some nutrients, which are metabolic intermediates necessary for growth (NRC, 1993). They exist both in free (as glycogen) and bound states (as protein bound sugars). The stored glycogen is utilized in moulting, adaptation to hypoxia or anoxia (Chang and O'Connor, 1983).

Results of this study showed that *T. schirnerae* meat is low in fat when compared to the lipid values assessed for marine crabs (Radhakrishnan, 1979; Radhakrishnan and Natarajan, 1979; Balasubramanian and Suseelan, 2001). Freshwater crab meat is generally low in fat, which is good for health (Adeyeye, 2002). Like *S. tranquebarica* (Thirunavukkarasu, 2005), the fat content in *T. schirnerae* did not show so notable variation with sex but marked significantly greater amounts in claw than body meat. George and Gopakumar (1987) reported lower lipid levels in *S. serrata* claw than body meat.

Generally, the muscles of crabs and prawns contained lesser quantity of lipid (Bhavan, 2009). Therefore, crabs and prawns are preferred by the consumer. Lipids are highly efficient as sources of energy and contained more than double the energy of carbohydrates and proteins (Okuzumi and Fujii, 2000). They are vital in maintaining structural and physiological integrity of cellular and subcellular membranes. They supply a source of essential nutrients and act as transporters of certain non-fat nutrients particularly the fat-soluble vitamins like A, D, E and K (New, 1986). Besides, lipids also serve as precursors of steroid hormones.

The average moisture content recorded in the present study was higher than that reported for marine and intertidal crabs (George and Gopakumar, 1987; Skonberg and Perkins, 2002; Musaiger and Al-Rumaidh, 2005; Kucukgulmez et al., 2006). The moisture content obtained for the soft shelled crab meat of *P. potamios* (Benjakul and Sutthipan, 2009) is very close to the values obtained in the present analysis.

In this study, the water content was found to be slightly higher in males than females. Similar observation was made in *S. serrata* meat by Srinivasagam (1979). It has been reported that the muscles of male prawns (Bhavan et al., 2010) and fish (Nargis, 2006) generally contained higher levels of water than females. On the contrary, Kuley et al. (2008) reported that male blue crab meat had lower moisture content than female crab meat. The higher percentage of moisture noticed in body meat than the claw meat and the negative correlation observed between water content and protein concentration of *T. schirnerae* are in agreement with the observations made for *S. serrata* (Zafar et al., 2004). According to Bassey et al. (2011), knowledge of the moisture content of food stuff serves as a useful index of their keeping qualities and susceptibility to fungal infection.

The average FAA content was low in *T. schirnerae* meat when compared to marine or brackish water species (Konosu et al., 1978; Chiou and Huang, 2003). Camien et al. (1951) have revealed that the FAA content is generally greater in marine species than freshwater species. The recorded data indicates that sex has a role in the meat quality of *T. schirnerae*. The concentration of FAA is found lower in the male, while the female has higher concentration which implies the unique physiology of females. Nevertheless, the results obtained in the freshwater field crab *Parathelphusa sp.* (Padmanabhanaidu and Ramamurthy, 1961) and in the ghost crab *Ocypode platytarsis* (Siva Sankar and Yogamoorthi, 2012) revealed that lower FAA concentrations were found in females than males. In *T. schirnerae*, total FAA was moderately higher in body meat than claw meat. On the contrary, in the male snow crab *Chionoecetes opilio*, it has been reported that the total FAA was lower in the body muscle (Miyagawa et al., 1979) than the leg muscle (Miyagawa et al., 1990).

The nutritive value of animal meat is decided by its free amino acid content. Crustacean muscles contain high concentrations of free amino acids such as arginine, glycine, proline, glutamine and alanine (Cobb et al., 1975). Konosu and Yamaguchi (1982) have pointed out that the FAA content in crustaceans is higher than those in fish and mollusc. High levels of taurine, proline, glycine, alanine and arginine are characteristic for crustaceans. Free amino acids such as alanine, glutamine and glycine are responsible for the unique flavor and taste of crab meat.

The mean cholesterol values in the present study were considerably lower than those reported for marine species (Ackman and McLeod, 1988; Skonberg and Perkins, 2002; Kaya et al., 2009). Freshwater crab meat is low in cholesterol when compared to marine and brackish water species (Sinha and Ahmed, 2011). In this study, the mean cholesterol content reported for claw and body meats were more or less equal. Cholesterol is essential for the synthesis of bile acids, sex hormones and vitamin D. Cells make about two-thirds of the cholesterol requirement of the body, remaining one-third comes through diet (Byrd-Bredbenner et al., 2009).

To conclude, the meat of *T. schirnerae* is low in fat, high in protein and is a moderate source of free amino acids. The values of protein, free amino acid and moisture contents are on par with or greater than those of other freshwater, marine and brackish water crabs. Moreover, the proportion of total protein, free amino acids, carbohydrate was found to be higher in females than males which suggest their nutritional value over males. This study reveals that freshwater crabs are ideal diet foods and consumption of crabs may help to prevent nutrition deficiencies in the future.

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Table 1: Proximate composition, free amino acid and cholesterol contents of claw and body meat of adult male and female *Travancoriana schirnerae.*

Parameters	Male		Female	
	Claw	Body	Claw	Body
Protein	12.80-21.44	14.04-26.35	16.33-24.82	17.28-25.00
	18.30±3.58	19.37±5.29	20.26±3.34	19.65±3.21
Oligo	0.15-0.47	0.19-0.25	0.31-0.89	0.43-0.58
	0.26±0.12	0.23±0.02	0.51±0.22	0.80±0.06
Poly	0.34-0.40	0.33-0.63	0.55-0.78	0.59-0.65
	0.37±0.03	0.42±0.13	0.61±0.09	0.63±0.02
Lipid	401.0-580.0	264.0-284.0	406.0-580.0	188.0-232.0
	490.5±126.5	274.0±14.14	493.0±123.0	212.0±22.27
Moisture	80.0-88.0	81.0-87.75	76.0-82.0	82.0-84.0
	83.87±3.56	84.70±3.21	79.33±3.05	83.33±1.15
FAA	1034-1499	702-1882	682-2689	750-2429
	1249±183.0	1144±466.0	1656±820.0	1933±689.0
Cholesterol	15.3-22.7	17.1-17.2	16.7-29.3	17.8-29.0
	19.0±5.2	17.15±0.001	22.4±6.3	24.8±6.10

Protein - (%); Oligo (Oligosaccharides) - (%); Poly (Polysaccharides) - (%); Lipid - (mg/100 g); Moisture - (%); FAA (Free amino acids) - (mg/100 g); Cholesterol- (mg/100 g)

Values are expressed as range and Mean±SD

Table 2: Nutritional status of claw and body meat of adult male and female *Travancoriana schirnerae.*

Parameters	Claw	Body	Male	Female	Crab
Protein	19.28±1.38	19.51±0.19	18.84±0.76	19.95±0.43	19.39±0.78
Oligo	0.39±0.17	0.36±0.19	0.24±0.02	0.50±0.01	0.38±0.18
Poly	0.49±0.17	0.52±0.14	0.39±0.03	0.62±0.01	0.51±0.16
Lipid	491.5±2.1	241.0±46.6	386.5±159.09	352.5±198.69	369.5±148.2
Moisture	81.93±3.92	84.11±2.47	84.29±3.17	81.33±3.01	83.02±3.34
FAA	1434±575.0	1502±684.0	1197±342.0	1794±729.0	1469±617.8
Cholesterol	21.0±5.5	21.7±6.0	18.0±3.2	23.6±5.7	21.3±5.4

Protein - (%); Oligo (Oligosaccharides) - (%); Poly (Polysaccharides) - (%); Lipid - (mg/100 g); Moisture - (%); FAA (Free amino acids) - (mg/100 g); Cholesterol - (mg/100 g)

Values are expressed as Mean±SD

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