Comparative biochemical study of the crab *Charybdis feriatus* from marine and estuarine water

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**Abstract**

The aim of the present study was to compare the biochemical profile of crab (*Charybdis feriatus*) inhabiting both estuarine and marine habitat, and to establish the nutritive value of the crab from different ecosystem. The protein, carbohydrate and lipid contents were found to be (21.8 mg/g, 2.1 mg/g and 0.2g) respectively, in crab inhabiting estuarine habitat and the amount of protein (5.1mg/g), carbohydrate (1.3 mg/g) and lipid (0.4g) was found in crab inhabiting marine habitat. The total lipid and protein estimation results that the nutritive value of marine crab is higher when compared to crab from estuary region, whereas the carbohydrate levels are comparatively higher in crab collected from estuary. The differences found in this study of the two habitats may probably due to the available diet in the different regions and their environmental factors.

**Keyword:** *Charybdis feriatus*, Estuary, Marine, Protein, Carbohydrate.

**INTRODUCTION**

Aquaculture, also known as aqua farming, is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants. Crabs rank third among the edible marine crustaceans of India by virtue of their importance as an esteemed gourmet and the value of fishery they support [1]. Crabs are not only ecologically important as benthic predators, they are also economically important members of marine and brackish communities found in coastal and estuarine waters [2 – 4]. They exhibit complex life histories with stages occurring in both estuarine and fully saline coastal waters [5-6]. The increased demand for the crabs in different markets and the depletion of resources along the coast has necessitated an urgent need for promoting crab culture in India. India is fast developing in crab fishery and there is a vast scope for the crab meat due to its delicacy and nutritional richness. In India, the coastal belt from Tuticorin to Mallipattinam has been proven as the strongest potential of edible sea crabs [7]. Estuaries and backwaters have an important role in the survival of many crustaceans. They provide a permanent habitat for many of them, while many others utilise these areas as their nursery and breeding grounds. Twelve species of edible crabs inhabit marine and contiguous estuarine area that comes under the domain of commercial fishing [8].

Crabs, among numerous other invertebrates are considered as an essential shell fishery product [9]. The use of marine resources for human consumption has improved rapidly worldwide. In general, seafood products, which include crustacean shellfish, have been praised for their health supporting characteristics. Shellfish are nutritionally precious sources of various minerals and high quality protein [10-11].

Majority of these water animals are also found in the tropical water, they also occupy unique position in the agricultural sectors of these sea animals from all sources rose from 580,000 million tons in 1978 [12].

Among the marine crustaceans found along the Indian coast, crab rank third after shrimp and lobsters for their esteemed seafood delicacy and also the value of fishery they support [13]. The commercially important crabs, the genus *Scylla* ranks first followed by the members of the family *Portunidae* [14-16]. The blue swimmer crab, *P. pelagicus* is the most important commercial species of the Indo-Pacific region. Other species of commercial value are *P. sanguinolentus*, *Charybdis to whom correspondence should be addressed: V.Jelin Email:jelin.vilvest@gmail.com
feriatus, C. lucifera and P. vigil. The fishery of P. pelagicus along the South East coast was facing fishing pressure due to increasing demand for the species in the export market. The annual marine crab landings in India have steadily increased from 20,000 to 48,380 tonnes during 1977–2005, of which P. pelagicus contribute about 30 % [17-18].

Due to the technological developments in the marine fishery sector, the exploitation of the fishery is being continuously extended to deeper grounds. As a result, non conventional crustaceans are being added to the inventory of decapods crustaceans every year [19].

Crab of various species may be classified into Callinectes amnicola, Octopode africana, seremaspecie, Sodononates africana, are widely distributed along the Indian coast. C. amnicola is used as food while O. africana is used as baits. The pincers is commonly consumed as food in the main body and as baits for fish. Crabs mostly occur at the mouth of estuaries and in the main river channel [20]. They constitute a nuisance by damaging set nets in water.

Most of the marine crabs occurring along the Indian coast belong to the family Portunidae. Among them P. pelagicus, P. sanguinolentus and C. feriata form schools in inshore waters and are fished by commercial trawlers along with penaeid prawns. Individuals with brood reach the market during the summer months. The seed of these species enter the waters of Cochin, (Kerala, India) from November onwards. The post-monsoon conditions of high salinity and temperature make the backwaters an ideal nursery ground. The crab seed subsisting on the zooplankton grow very fast and remain in the backwaters until the first showers of the southwest monsoon in May–June. The abrupt fall in the temperature and salinity causes the crabs to migrate to inshore areas. By this time the individual crabs attain marketable size [21].

**Charybdis feriatus**

*Charybdis feriatus* (Linnaeus, 1758) commonly known as crucifix crab forms one of the important commercial crabs and the most important species of the genus *Charybdis*. It is widely distributed in the Indo-Pacific region from Japan to China to Australia in the east, to eastern and southern Africa, Gulf of Oman and Arabian Gulf in the west, encompassing Pakistan, India, Sri Lanka and Indonesia [22-26].

It is usually occurs sub – littorally on muddy and sandy bottoms, as well as on rocky and stony coasts including coral reef flats, at depths of approximately 10–60 m. This species of *Charybdis* has a high commercial value being caught in trawl nets, traps and fixed nets, and it is usually sold frozen. However with the recent expansion of live fish markets, this species is now maintained in aquaria and hold-tanks, and exported throughout eastern Asia [26]. The crab has a maximum carapace width of 20 cm with females weighing 150–350 g compared to males, which may reach 1 kg. Its size and quality of meat makes this species a valuable target for aquaculture practices [27].

*Charybdis feriatus* can be easily distinguished with prominent white cross on the median part of the dorsal carapace brownish with purplish tinge and conspicuous yellow markings; chelipeds purplish brown, spotted with yellow, tips light brownish pink and legs and pincers with numerous scattered white spots [28]. Mesogastric, cardiac and mesobranchial regions is convex, mesogastric and meta gastric regions each with a pair of obscure carinae, epibranchial ridge present. Front divided into 6 teeth. Antero - lateral margin cut into 6 teeth; the first truncate and concave in the median of the anterior margin; the last one the smallest, but acuter and more projecting. Chelipeds stout are asymmetrical. Merus armed with 3 strong teeth on the distal half of anterior margin and with granules or denticles on the proximal half [22]. The arm has three enlarged spines on the anterior (inner) border and a spine at the far end of the inferior border, but the posterior border is unarmed. The wrist has the inner angle strongly spicule form and has three spicules and some smooth ridges on the outer surface. In both hands the fingers are strongly toothed, are as long as their palm. In the last pair of legs the merus is about three-fourths as long as broad and has a spine at far end of the posterior border. In the male the 6th tergum is much broader than long and has curved and gradually convergent sides [29]. Male is up to 120 mm (Carapace width) and female up to 110 mm (Carapace width). It prefers to inhabit area of sandy to sandy muddy substrates at depths from 30 to 60 m [26].

The nutritional composition of numerous commercially harvested species of crab has been partially described, shellfish vary widely in their nutrient content [30]. Biochemical studies are very important for studying the nutritional aspects of the animal. The biochemical constituents in animals are
known to vary with season, size of the animal, stage of maturity, temperature and availability of food etc. [31]. The present study was carried out to estimate the biochemical comparison of crab (*Charybdis feriatus*) inhabiting of both marine and estuary.

**MATERIALS AND METHODS**

*Charybdis feriatus* used for this study were purchased from the fisherman who landed at the fish market Kasimedu and estuary crab *C. feriatus* from Pulicat Lake. In the laboratory the specimens were washed thoroughly to exclude contaminants. The flesh and shell of *C. feriatus* were separated. From this 1 g of tissue was taken and it is mixed with 10 ml of Phosphate Buffer Saline (PBS) and the contents were transferred to the centrifuge tube and centrifuged at 10,000 rpm for 7 min at 4 °C the supernatant was transferred into a new tube and it was stored at –20 °C.

The samples were biochemically determined. All determination was performed in duplicates Protein estimation was analysed by the use of Lowry’s method, carbohydrate was determined by Anthrone method. Fat content was analysed by Gravimetry method.

**Estimation of protein by Lowry’s method**

0.5, 1.0, 1.5, 2.0, 2.5 ml of BSA was taken in a concentration of 10 mg/100 ml and added to test tubes respectively. The tubes are marked as S1, S2, S3, S4, S5 respectively.0.1 ml of protein sample was taken from the supernatant. And one test tube is maintained as blank. The above solutions are made up to 3 ml using distilled water.3 ml of distilled water is added to the blank. To all these reaction set up 4.5 ml of Lowry’s reagent is added and incubated for 10 min. Then 0.5 ml of Folin’s reagent is added and incubated at RT for 30–60min. The absorbance is read at 630 nm using *spectrophotometer* for all the samples. The quantity of the unknown protein is calculated by plotting standard graph using BSA.

**Estimation of carbohydrate by Anthrone method**

Tissue samples were then ground with 5 volumes of distilled water. Particulate matters were removed by straining through nylon tissue, followed by centrifugation at 15,000 g for 20 min at 4 °C. The working standard solution was added as 0.4, 0.8, 1.2, 1.6 and 2.0 ml in the series of test tubes and marked as S1, S2, S3, S4, and S5. The unknown solution 0.1 ml was added to the test tube and marked as U1. All the tubes were made up to 1 ml with distilled water. 4 ml of Anthrone reagent was added to all the tubes. The tubes were incubated in a boiling water bath for 10 min. The intensity of the colour developed was read at 630 nm.

**Estimation of lipid by gravimetric technique**

The fat content was measured in duplicates by gravimetric technique with chloroform/methanol/water according to the method described by Kinsella *et al.* (1977). If the estimation of total lipids is not a serious problem with large samples, specific methods are required for small sample size (up to 100 mg). Thus, 10–50 mg are homogenized with 4 ml of a chloroform/methanol mixture (1/1, v/v) in a handheld ground glass homogenizing tube. The homogenate was centrifuged at 3,000 rpm for 5 min, and the supernatant volume recorded. An aliquot (0.25 ml) of the supernatant was transferred to a glass tube, being careful to deposit the sample directly at the bottom to the tube [32-33].

**RESULT**

The result of the present study revealed significant variation in the biochemical constituent of muscle of the marine and estuary crab, *Charybdis feriatus*, as summarized in Tables 1, 2, 3 and 4 & Fig. 1, 2, 3 and 4.

**Protein content**

Table 1, describes the varying levels of protein content in the crab (*Charybdis feriatus*) inhabiting both marine and estuary. Further the data represented graphically in Fig 1. Where, protein content was highest in marine crab than estuary crab 21.8 mg and 5.1mg respectively.

**Carbohydrate content**

The total Carbohydrate forms the second largest biochemical component. Table 2 explains the differences between the carbohydrate content in *Charybdis feriatus* from estuary and marine. It shows that a significant increase of total Carbohydrate level in estuary when (2.1 mg) compared to that of marine crab (1.3 mg). This was further illustrated in Fig 2.

**Lipid content**

The level of Lipid rents the lowest among the quantified biochemical constituents studied.
of protein in the present study are agreement with feeding systems predicted in both areas. Values of variables may be due to the different types of diet geographical variation in the crab sources, other inhabiting estuary (5.1 mg). The difference may due crab inhabiting marine (21.8 mg) than those in crab estuarine (0.2 g). Table 3 and fig. 3.

Biochemical composition of *Charybdis feriatus*

Table 4, describes the varying levels of protein, carbohydrate and lipid content in the crab (*Charybdis feriatus*) inhabiting both marine and estuary. Further the data represented graphically in Fig. 4.

**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 [34]. 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 sea food proteins make it very valuable in combating protein malnutrition, especially in children. Accumulation of energy reserves in species dependent upon unstable food resources has been reported by several authors [35-36]. Even though the protein content is less in crabs than in fishes (8.3–23.8 %) they form a well established food. Proximate chemical composition, energy content and metabolic rates of a large number of pelagic crustaceans and fishes have been studied in temperate and subtropical latitudes. Many authors have revealed that mesopelagic species show variability in proximate composition as a function of depth of occurrence and as a function of regional productivity. Depth and productivity both affect food availability and thus influence chemical composition. In particular, lipid and protein content (% wet weight) both decline and as a result water concentration increases with increasing depth of occurrence [37]. In the present study, protein content was higher in crab inhabiting marine (21.8 mg) than those in crab inhabiting estuary (5.1 mg). The difference may due to geographical variation in the crab sources, other variables may be due to the different types of diet and feeding systems predicted in both areas. Values of protein in the present study are agreement with other studies. The protein values are in *P. vigil* was 15.75–20.16 % [38] and in *C. affinis* was 17.8 %. The protein content of soft shell was found to be 8.33 % and hard shell crab was 14.93 % in *S. serrata* [39]. Balasubramanian and Suseelan (2001) assessed the protein values in *C. smithii* was 59.8–71 % in dry matter basis [40]. In *S. serrata*, the protein content of the body meat and claw meat was 20.11 and 18.54 % respectively. Hence protein is essential in the diets as it is one of the basic building blocks of the body in terms of providing bones and muscles strength, endurance and immunity. Carbohydrates in fishery products contain no dietary fibres but only glucocides, the majority of which consist of glycogen (polysaccharide). They also contain traces of glucose, fructose, sucrose and other mono and disaccharides [41]. Carbohydrate content average between 1.3 and 2.1 mg was obtained in marine as well as estuarine. The higher value recorded by crab in estuarine water. In the present study, carbohydrate constitute only a minor percentage of total biochemical composition of *C. feriatus* has 2.1 mg in estuary crab and 1.3 mg in marine crab. The previous studies were suggested that the carbohydrate in the muscle varied from 0.3 to 0.63 % in *P. Vigil* [36].

In crustaceans, lipids are not only the principle 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. Generally in marine invertebrates, lipid is the most variable fraction. The lipid content varies with season Lipids are highly efficient as sources of energy and they contain more than twice the energy of carbohydrates and proteins [41]. Fat content obtained in the study was found to be low when compared to carbohydrate and protein. It is important to note that they are essentially play a vital role in the structure and biological, functions of the cell and to transport fat soluble vitamin in the body. Lipid values found to be lower in estuary. Than the marine inhabiting crab respectively (0.2 and 0.4 g). Lipid content of the hard shell crab (2.41 %) was higher than soft shell crabs (1.50%). The post-monsoon conditions of high salinity and temperature make the backwaters an ideal nursery ground. The crab seed subsisting on the zooplankton grow very fast and remain in the backwaters until the first showers of the southwest monsoon in May–June. The abrupt fall in the
temperature and salinity causes the crabs to migrate to inshore areas. By this time the individual crabs attain marketable size [21]. Several other workers also reported the lipid values from 6.2 to 7.6% in *C. smithi* [40]. In *P. pelagicus* the lipid value was 3.3–5.6% and *P. sanguinolentus* it was 3.8–5.5% [21].

Table 1. Protein content of *Charybdis feriatus* from Marine and estuary

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sample</th>
<th>Absorbance at 630nm</th>
<th>Average</th>
<th>Protein content (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E₁</td>
<td>0.505</td>
<td>0.6055</td>
<td>5.1</td>
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<tr>
<td></td>
<td>E₂</td>
<td>0.706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M₁</td>
<td>2.744</td>
<td>2.656</td>
<td>21.8</td>
</tr>
<tr>
<td></td>
<td>M₂</td>
<td>2.568</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Carbohydrate content of *Charybdis feriatus* from marine and estuary

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sample</th>
<th>Absorbance at 630nm</th>
<th>Average</th>
<th>Carbohydrate content (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E₁</td>
<td>0.1871</td>
<td>0.2305</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>0.2739</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M₁</td>
<td>0.1317</td>
<td>0.1604</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>M₂</td>
<td>0.1891</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Lipid content of *Charybdis feriatus* from Marine and estuary

<table>
<thead>
<tr>
<th>S. No</th>
<th>Sample</th>
<th>Sample before lipid extraction(mg)</th>
<th>Sample before lipid extraction(mg)</th>
<th>Difference</th>
<th>Average Mass of lipid(mg)</th>
<th>Lipid content(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E₁</td>
<td>1.02</td>
<td>1.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>E₂</td>
<td>1.05</td>
<td>1.03</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M₁</td>
<td>1.03</td>
<td>1.04</td>
<td>0.01</td>
<td>0.01</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>M₂</td>
<td>1.04</td>
<td>1.03</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E₁ & E₂ samples collected from estuarine inhabiting crab; M₁ & M₂ samples collected from marine inhabiting crab

Table 4. Biochemical comparison of Marine and Estuary crab of *Charybdis feriatus*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Sample</th>
<th>Protein (mg)</th>
<th>Carbohydrate (mg)</th>
<th>Lipid (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Estuary</td>
<td>5.1</td>
<td>2.1</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>Marine</td>
<td>21.8</td>
<td>1.3</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Fig 1. Protein content of *Charybdis feriatus* from Marine and estuary

The protein content was maximum in marine than in estuarine crab.

Fig 2. Carbohydrate content of *Charybdis feriatus* from different ecosystem

Carbohydrate content was significantly higher in estuary than in marine crab.
Fig 3. Lipid content of *Charybdis feriatus* from different ecosystem

![Lipid content graph](image)

Total lipid content was maximum in marine than in estuary

Fig 4. Biochemical comparison of Marine and Estuary crab of *charybdis feriatus*

![Biochemical comparison graph](image)

Biochemical comparison *Charybdis feriatus* inhabiting marine and estuarine habitat indicates significant variation.

**CONCLUSION**

The results obtained in the present study have demonstrated that crab inhabiting both marine and estuary water were highly nutritious in terms of protein. Marine crab recorded the highest protein than estuary. Whereas, carbohydrate and lipid were found only minimal concentration when compare to protein. Estuary crab noted remarkable difference with high carbohydrate level when compared to marine with low level. Lipid content of the marine crab was slightly higher than the crab in estuarine waters. The variation is because of their geographical area, the environmental factors and their available food resources. Nutritional point of view it can be inferred that the crab (*Charybdis feriatus*) could be employed as a supplement of protein and carbohydrate. So, that the crab was suggested for balanced diet in human nutrition. Though the values showed minor difference when compare to estuary and marine, it can be recommended as a good source of protein and lipid from marine and carbohydrate in estuary.

**ACKNOWLEDGEMENT**

Nil.

**CONFLICT OF INTEREST**

No Conflict of Interest.

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