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Comparative Nutrient Analysis of Prawn (*Penaeus indicus*), Crab (*Scylla serrata*), and Lobster (*Sagmariasus verreauxi*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author MT conceived the idea of the project and reviewed the manuscript. Author AS performed the experiment in the laboratory, tested the hypothesis, and verified the results. Both authors read and approved the final manuscript.

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ABSTRACT

This paper presents a comprehensive analysis of the proximate composition of three popular crustaceans: Prawns (Penaeus indicus), Crab (Scylla serrata), and Lobster (Sagmariasus verreauxi). This paper aims to find proximate analysis that involves the determination of various components such as moisture content, protein, lipid, carbohydrate, and ash. These findings suggest that prawns, lobster, and crab differ in their nutritional composition, highlighting their potential as diverse sources of essential nutrients. Prawns may be a suitable option for individuals seeking a high-protein seafood choice with a protein content of 20.23g, whereas lobster may provide a richer source of carbohydrates at 1.093g. Crab, with its low fat at 2.2g and high mineral content, could be

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beneficial for individuals aiming to enhance their dietary intake of these nutrients. The findings of this paper conclude that crabs offer a preferable seafood option among crustaceans compared to prawns and lobsters. Further research could explore additional species of prawns, crabs, and lobsters to strengthen our conclusions.

Keywords: Proximate analysis; nutrient analysis; crustaceans; shellfish.

1. INTRODUCTION

Fish is a healthy food. India has a coastline of more than 8000 km including islands of Andaman & Nicobar. However, unlike most South Asian countries the dependency on fish is lower in India. This could largely be due to the vegetarian eating habits of various religious sects in the country. Health food refers to specific food items that not only fulfil basic nutritional needs but also offer positive effects on human health. Fish, for example, is rich in proteins, lipids, minerals, and vitamins, and contains minimal carbohydrates. Its biochemical makeup highlights its significance as a valuable source of protein and essential fatty acids. Compared to plant proteins, animal proteins, like those found in fish, are generally considered superior. The quality of fish proteins is notable due to their higher concentration of myofibrillar proteins and essential amino acids. Furthermore, fish lipids contribute health-promoting omega-3 polyunsaturated fatty acids, such as highly unsaturated fatty acids, which play a crucial role in heart health and are associated with the prevention of various conditions like atherosclerosis, cancer, and Alzheimer's disease [1]. Consuming fish gives energy, protein, and a variety of other nutrients that are essential for good health. An expert panel led by FAO and WHO found that eating seafood provides calories, protein, and essential elements such as long-chain n-3 PUFAs [2,1,3,4].

Shellfish can be categorized into two main groups: crustaceans and molluscs. Crustaceans are invertebrates characterized by segmented bodies shielded by chitinous shells. Examples include shrimp, lobster, crayfish, crab, and krill. Molluscs, on the other hand, are soft-bodied invertebrates divided into foot and visceral sections [2].

Shrimps serve as an excellent protein source while being exceptionally low in fat and calories, rendering them a highly nutritious dietary option [5-7]. Despite their high cholesterol content, shrimps contain minimal saturated fat, the type of fat known to elevate cholesterol levels in the body [8]. *Fenneropenaeus indicus*, formerly known as *Penaeus indicus*, is highly valued as a commercially significant prawn species globally, with a notable presence in India. These prawns typically dwell at depths of 2 to 90 meters, predominantly found at the bottom of estuarine, marine, and brackish waters [9]. This accessibility contributes to their significance as a staple food source in coastal areas, enhancing local dependency on them for sustenance.

Mud crabs (*S. serrata*) are popular and pricey seafood in Asian countries, particularly in Southeast Asia. Crab meat is in high demand in both national and international markets due to its deliciousness and nutritional value. The nutrient substances include amino acids, unsaturated fatty acids, proteins, and minerals like calcium, iron, phosphorus, zinc, and potassium [10].

Sagmariasus verreauxi is the largest spiny lobster (Palinuridae) species and a valuable commercial seafood commodity in the Southern Hemisphere [11-13]. The recent completion of the *S. verreauxi* life cycle in captives, from eggs to adults, has enhanced the species' road to sustainable aquaculture. Optimization of dietary protein is one step to establishing sustainable aquaculture [14].

In recent times, there has been a significant push for increased seafood consumption, primarily driven by its recognized role in promoting a healthy diet [15,16]. This is attributed to its abundance of high-quality protein, low levels of saturated fat, and rich content of omega-3 fatty acids [17]. According to a Times of India report published on Mar 19, 2024, the percentage of individuals consuming fish rose from 66% to 72.1% between 2005-06 and 2019-21, while yearly per person fish intake increased from 4.9kg to 8.9kg from 2005 to 2020. Within the group of fish consumers, individual consumption levels went up from 7.4kg to 12.3kg over the same period [18]. Crustaceans, despite being nutritionally rich sources of protein and minerals, have sometimes been overlooked as healthy food choices due to concerns about their perceived high cholesterol levels [17].

The choice of cooking methods and temperatures significantly impacts nutrient retention. The preparation and cooking techniques employed alter the structure of food components. Cooking renders foods like meat and fish palatable and easier to digest. However, heat exposure can also result in undesirable alterations, such as the loss of nutritional content, primarily due to lipid oxidation, and modifications in certain protein components [19]. Different cooking methods, such as baking and grilling, lead to reduced edible portions due to water loss compared to steaming or poaching. Broiling, as examined in this study, is likely to result in significant water loss [20-22]. The proximate composition analysis reveals that both finfish and shellfish are excellent sources of protein and contain relatively low levels of fat. Protein percentages vary, ranging from approximately 9% in clams and oysters to about 21% in flounder [23]. The higher percentages in the cooked product indicate moisture loss but provide a more accurate representation of the actual composition when consumed. Shellfish exhibit notably higher concentrations of iron, zinc, and manganese, with oysters particularly abundant in these essential micronutrients [24].

2. METHODS AND MATERIALS

2.1 Sample Collection

Healthy adult samples of Prawn (*Penaeus indicus*), Crab (*Scylla serrata*), and Lobster (*Sagmariasus verreauxi*) with intact appendages were collected from the fish landing center Bhaucha Dhakka in Mumbai, India. Six samples each (prawn, crab, and lobster) were collected and segregated. After collection samples were transported in an icebox to the laboratory for further analysis.

2.2 Sample Preparation

Samples were properly cleaned with distilled water to remove any dust particles attached to the tentacles and appendages. After removing the carapace, the flesh content of each sample is weighed and kept for further analysis.

2.3 Sample Analysis

The proximate analysis of prawns, crabs, and lobster was conducted using the AOAC method. Moisture content was assessed by weighing the differences before and after overnight oven drying at 100°C.

Ash content was determined using the dry ashing procedure. 1g of each sample was taken in a porcelain crucible and weighed, then kept in a Muffle furnace for 2 hours. After cooling, the crucible is kept in a Desiccator and weighed.

Protein estimation was performed using the Folin-Lowry method. The sample was treated with Reagent A (2% sodium carbonate and 0.1N sodium hydroxide) and Reagent B (0.5% copper sulfate in 1% potassium sodium tartrate), along with the Folin-Ciocalteau reagent. A standard graph was then used to determine the sample concentration.

Fat content was determined by drying the sample in an oven at 100°C and subsequently extracting fat with diethyl ether in a Soxhlet Extractor for 3 to 4 hours.

Carbohydrates were determined using the Anthrone reagent method. 1g of sample was treated with Anthrone's reagent (Anthrone reagent in concentrated sulphuric acid) and glucose as standard. A standard graph was then used to determine the sample concentration.

3. RESULTS AND DISCUSSION

3.1 Moisture Content

The moisture content of Prawn (*Penaeus indicus*) was 77.84%, Crab (*Scylla serrata*) was 78.74% and Lobster (*Sagmariasus verreauxi*) was 70.67% respectively represented in Fig. 1. In this study, the moisture content of crab was found to be slightly higher than that of prawn, with the lowest moisture content observed in lobster. Similar results were reported for prawn species by Vardi [2]. Other prawn species have shown moisture content ranging from 63.29% to 72.35% [25,26]. Arumugam et al. [24] reported moisture content of 83.52% and 84.35% in *P. homarus* and *P. ornatus* species of spiny lobster, respectively. Lyla et al. [27] found the water content in *S. serrata* to be 82.63%, which does not align with the results of this study. Other crab species, including Callinectes sapidus, Portunus pelagicus, and Cancer pagurus, have shown similar water content to *S. serrata* [24,28,29].

3.2 Ash Content

The ash content in prawn, crab, and lobster is 0.525%, 0.93%, and 1.3%, respectively. There is a significant variation in ash content among the three crustaceans. The ash content in lobster

matches the findings of Arumugam, A. *loc. cit.* However, the ash content in prawns and crabs is lower compared to previous studies [30,28].

3.3 Protein

The protein content in prawn is 20.23g per 100g, which aligns with the findings of Islam et al. [1], making it the highest among the three shellfish. This is followed by lobster with 19.55g of protein and crab with 18.45g of protein. According to Lyla et al. [27], the protein content in *S. serrata* is higher than our study's findings, while *Portunus pelagicus* and *Cancer pagurus* have reported results consistent with our study [29,27,28]. Similar results were observed for the protein content of *S. verreauxi* in [31]. The protein content in other lobster species, such as *P. homarus* and *P. ornatus*, tends to be higher, showing variations compared to the species previously discussed.

3.4 Fat

The fat content of *P. indicus* stands at 4.8g per 100g of body weight, aligning closely with findings documented by Islam. *S. serrata*, on the other hand, exhibits a lower fat content at 2.2g per 100g, as indicated by Lyla et al. [27]. In contrast, *P. pelagicus, C. pagurus*, and *Spiralothelphusa hydrodroma*, as observed in this study, possess significantly lower fat levels than *S. serrata* [32,33]. Conversely, *S. verreauxi* boasts the highest fat content among the three crustaceans, at 5.86g. Similarly, *P. homarus* and *P. ornatus* exhibit slightly elevated fat content, as referenced by Arumugam et al. [24,31]. However, *H. gammarus* and *H. americanus* show notably low-fat content in muscles, with slightly higher levels in the hepatopancreas and gonads, as reported by Barrento [28].

3.5 Carbohydrate

The carbohydrate content varies among the crustaceans, with prawns containing 0.53g, crabs 1.0g, and lobsters 1.093g. The carbohydrate content of *P. indicus* and *M. rosenbergii* fall within similar ranges as reported by Islam and Anthony, respectively [34]. However, *P. notialis* has a significantly higher carbohydrate content compared to our findings, as indicated by Lyla [27]. *S. serrata* shows comparable results, consistent with Lyla's findings. For lobsters, *P. homarus* and *P. ornatus* exhibit notably higher carbohydrate content compared to S. verreauxi in our study, as referenced by Arumugam et al. [24].

Table 1. Proximate analysis of *P. indicus, S. serrata, and S. verreauxi*

Species	Moisture (%)	Ash (%)	Protein (per 100g)	Fat (per 100g)	Carbohydrate (per 100g)
Prawn (Penaeus indicus)	77.84	0.525	20.23	4.8	0.53
Crab (Scylla serrata)	78.84	0.93	18.45	2.2	1.00
Lobster (Sagmariasus verreauxi)	70.67	1.3	19.55	5.86	1.093

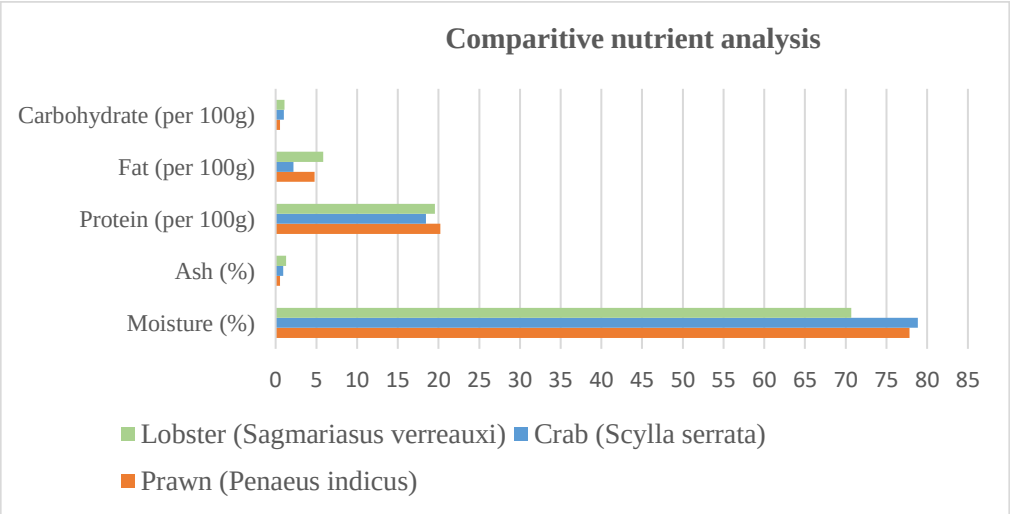

Fig. 1. Comparative nutrient analysis graph

4. CONCLUSION

The proximate composition varies significantly among prawns, crabs, and lobsters, as observed previously. Prawns exhibit higher protein and fat content but lower carbohydrate content compared to crabs and lobsters. Lobsters have lower protein content than prawns and crabs, but they are higher in terms of fats and carbohydrates. On the other hand, crabs have slightly lower protein content than prawns and significantly lower fat content. The carbohydrate content in crabs is higher than in prawns but slightly lower than in lobsters.

From these findings, we can conclude that crabs offer a preferable seafood option among crustaceans compared to prawns and lobsters. However, crabs are economically costlier than prawns and not as readily available. In countries like India, particularly in the Western Ghats region, there is a greater reliance on various species of prawns due to their affordability and versatility in cooking, especially in the Konkan region of Maharashtra where they are considered delicacies. Conversely, in the northern states of India, freshwater prawns are more popular, and the availability of crabs and lobsters is minimal.

Our study aims to identify a superfood among crustaceans in the seafood category for which we selected three commonly available crustaceans in the Mumbai region of Indian prawn (*Penaeus indicus*), crab (*Scylla serrata*), and lobster (*Sagmariasus verreauxi*). Further research could explore additional species of prawns, crabs, and lobsters to strengthen our conclusions.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented and published in the conference: An International Conference on Coastal and Marine Conservation CMC-2024 dated from 1st and 2nd March, 2024 in Mumbai, India. Web Link of the proceeding: https://mithibai.ac.in/wp-content/uploads/2024/02/CMC2024-CONFERENCE-brochure..pdf

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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