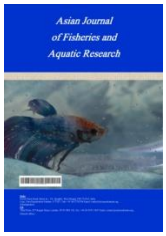

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Proximate Analysis and Mineral Composition of Commercially Important Spiny Lobsters from Visakhapatnam Coast, Andhra Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The research work was carried out to assess the dietary qualities of spiny lobsters collected from Visakhapatnam fishing harbour, situated on the northeast coast of Andhra Pradesh. The species selected were *Panulirus homarus* (Linnaeus, 1758), *P. ornatus* (Fabricius, 1798), *P. versicolor* (Latreille, 1804), and *P. polyphagus* (Herbst, 1793). The species were morphometrically measured, and their tissue was analyzed for the comparative proximate composition (Moisture, Protein, Lipid, and Ash) on a dry weight basis. Protein content was found to be high in all the lobster species. Highest protein content was observed in *P. homarus* (mg/g), followed by *P. ornatus* and *P. versicolor* (mg/g). Moisture percentage was 72.7, 75.7, 76.2, and 74.8% respectively. In addition, four minerals were analysed (Ca, Na, K, and Mg) in the present study. Calcium was observed maximum in all the species, and Magnesium was recorded minimum in all the lobsters.

Keywords: Spiny lobsters; nutritional content; proximate analysis; minerals; Visakhapatnam.

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1. INTRODUCTION

The marine food consumption of human resources has increased rapidly in worldwide. As a whole, food merchandise, together with crustaceans, shellfish are acclaimed for their health-promoting characteristics. The shellfish are nutritionally precious sources of assorted minerals and high protein concentrations to humans. In several nations, seafood has mainly been a component of man's diet and is a vital nutrient supply, particularly extremely edible proteins.

India has an extensive coastline of over 7,516.6 km with aquatic species that are exploitable resources. Indian aquaculture cultivation is promising and has risen to larger heights by mercantilism quality seafood merchandise to major world markets through its seafood industry [1]. Seafood is very highly nutritious, easy to digest, and extremely edible [2].

Lobsters are highly-priced seafood delicacies that are in great demand in international markets. In contrast to alternative vital shellfish and finfish resources that sustain commercial fisheries, lobsters have the excellence of supporting a high-value fishery, generating maybe the highest rates of foreign exchange among all seafood exports. However, the number of lobsters landed worldwide is a very meagre share of the world's marine fish production. Spiny lobsters are nutritionally rich high-value marine fishery resources. Owing to its high demand among domestic also as international market, this resource is heavily fished in India. The Spiny lobsters *Panulirus homarus* are inhabited wide in tropical and subtropical waters of the Indo-West Pacific region and eastern Africa to Japan, Indonesia, and Australia [3]. In India, lobsters are landed on the northwest, southwest, and southeast coasts.

Marine resource utilisation for human consumption has increased rapidly worldwide. As a whole, seafood products, including crustacean shellfish, are lauded for their health-promoting characteristics. Shellfish are nutritionally valuable sources of assorted minerals and high-quality protein [4-8].

Biochemical studies are essential from the nutritional point of view. It is well understood that the biochemical composition of the edible tissues of marine invertebrates is influenced by their dietary habits, age, sex, season, and alternative ecological factors [9,10]. The nutritional value is represented in its biochemical content; the biochemical composition of any edible organism is extremely essential [11]. Generally, the proximate composition suggests that percentage composition of five basic constituents like protein, carbohydrate, lipid, ash, and water. The proximate composition varied widely depending on species, size, sex, maturity, season, and feeding regimes. Information on daily dietary intake of nutrients, particularly cholesterol is sort of vital for particularly those with cardiovascular problems [12,13]. To maintain good health, protein is important and exists in a large quantity as a component of the human body of all nutrients [14]. Lipids are the organic resources of the crustaceans [15].

Minerals are called micronutrients, and the physiological and biochemical mechanisms by which the human body acquires food are assimilated and used to sustain health and function and ensure adequate immune competence and cognitive development [16,17]. Minerals are inorganic compounds needed by the body to shape teeth, bones, and blood cells and regulate body fluids. There are two main categories of essential minerals required for survival. Minerals occurring in appreciable amounts are called microelements, and those found in minute quantities are called trace elements or microelements. Macrominerals include calcium, potassium, sodium, magnesium, chloride, and phosphorus. Humans need a minimum of 100 mg a day.

In skeletal structures such as bones and teeth, minerals are important components. To maintain osmotic pressure, minerals play a crucial role and manage the exchange of water and solutes within the animal body. They serve as structural constituents of soft tissues and are essential for transmitting nerve impulses and muscle contraction. Minerals act as essential components of many enzymes, vitamins, hormones, respiratory pigments, or cofactors in metabolism, catalysts, and enzyme activators. Since the selected lobster species of Visakhapatnam coast have limited information on their distribution, species composition, and their role in proximate composition, which are more important from human health nutritional point of view.

2. MATERIALS AND METHODS

2.1 Collection of Lobsters samples and processing

The healthy lobsters such as *Panulirus homarus* (Linnaeus, 1758), *P. ornatus* (Fabricius, 1798), *P. versicolor* (Latreille, 1804), and *P. polyphagus* (Herbst, 1793), with length and weight ranges of 25.4 cm to 29.2 cm and 158.3 g to 171.8 g were collected from Visakhapatnam fishing harbour (Lat: 17°.729" N and Long: 83°.219" E) during January 2017 to December 2018. The morphometric measurements of the lobsters were shown in table 1. The collected lobsters were transported to the Department of Marine Living Resources, Andhra University, Visakhapatnam, with an icebox in preserved condition.

The lobsters were first properly cleaned in the laboratory. The exoskeleton and head were removed, and the entire body tissue was dried at 80°c in a hot air oven for 24 hours. The oven-dried meat was powdered and packed in air-tight containers. The samples were stored in a refrigerator until use for subsequent chemical analysis.

2.2 Proximate Composition

Triplicate samples of 40 (10 specimens each) spiny lobsters were analyzed. For this study, all the samples were pooled and required amount of the sample was taken. The following parameters were determined, which include crude protein, crude lipid, moisture, and total ash, by using the standard methods [18]. On each chemical analysis, triplicate determinations were performed and reported on a dry weight basis.

2.3 Moisture Content

The amount of moisture in the species was determined according to AOAC (Association of Official Analytical Chemists). In a hot air oven, samples were dried at 60°C until persistent weights have been obtained, cooled, and reweighed in a desiccator. The variance between fresh and dry weights was assumed to be moisture content.

2.4 Lipid Content

Crude lipid was determined by weighing 5 g of each sample wrapped in a filter paper in a Soxhlet apparatus using petroleum ether. This was done each for 4 hours. The extracted materials left after the solvent had evaporated were weighed, and the fat content was calculated.

2.5 Ash Content

Dried samples obtained during the determination of the moisture content process were heated in a muffle furnace at 600°C a few hours long. By subtracting the ash weight from the original weight, the percentage of ash was calculated.

2.6 Crude Protein Content

The Kjeldahl method was analysed for crude protein (AOAC). Using a 6.25 conversion factor to transform total nitrogen to crude protein, the samples went through the three necessary digestion stages: digestion, distillation, and titration. The protein percentage in the samples was determined accordingly.

2.7 Mineral Content

The mineral compositions of the specimen were measured using the Spectrophotometric method of atomic absorption (AOAC, 2005).). The collected muscle tissue from the lobsters 2 g of sample was placed in digestion tubes with concentrated HNO_3 was added and kept for overnight for the estimation of minerals. This was continued with $HClO_4$. The analysis of Na, K, Ca and Mg was performed by flame Atomic Absorption Spectrophotometry (Varian 220 Spectra AAS, Australia Pvt. Ltd).

3. RESULTS

3.1 Morphometric Analysis

The average length, weight of lobsters were recorded as, *P. homarus* 28.7±0.26, 167.2±0.57, *P. versicolor* 27.4±0.28, 163.8±0.49, *P. ornatus* 29.7±0.40, 171.8±0.53 and *P. polyphagus* were 25.8±0.32, 158.8±0.44 respectively (Table 1).

3.2 Proximate Composition

The proximate composition of the collected lobsters has been estimated and listed in table 2, and their graphical presentation was shown in fig. 2. From the present investigation, it is evident that the muscle tissue of lobsters contains a significant amount of nutrients like moisture,

protein, fat, ash. They might play a crucial position in the proper functioning of human beings body to protect the health from illness.

The results revealed the dominance of moisture content in all four lobsters followed by total protein. The percentage composition of total protein in *P. homarus, P. versicolor, P. ornatus, and P. polyphagus* was 22.8±0.41, 23.7±0.32, 22.6±0.49 and 21.8±0.49, respectively. The lipid content of the lobsters was found to be 2.93±0.03 in *P. homarus*; 3.28±0.02 in *P. versicolor*, 3.53±0.37 in *P. ornatus,* and 2.75±0.02 in *P. polyphagus*. It was noticed that the ash content was very low in all and ranges between 1.47±0.04 and 1.67±0.03, respectively.

3.3 Minerals

The results of the mineral compositions of lobsters are shown in table 3. The calcium (Ca) recorded was maximum in *P. ornatus* 242.6±1.79 and minimum in *P. polyphagus* 216.4 ±1.63. Sodium (Na) recorded was maximum in *P. ornatus* 294.7±1.00, and the minimum was recorded in *P. polyphagus* 266.9± 1.86. Potassium (K) was recorded maximum in *P. polyphagus* 159.6±1.99, and the minimum was recorded in *P. ornatus* 139.9±1.45. Magnesium (Mg) recorded was maximum in *P. ornatus* 105.9±1.48, and minimum in *P. versicolor* 85.8±1.31.

4. DISCUSSION

Crustacean groups of animals play a significant role in the food chain cycle as they are consumed in abundant numbers by human beings. Due to their delicious nature, high protein, and good amino acid content, several crustaceans are preferred as foodstuffs for human consumption [19]. The richness in Na, K, Ca, Mg is identified as one of the major qualities of edible seafood [20,21]. In the present study, a high amount of protein content was recorded in *P. versicolor* (23.3±1.26) than the other three lobsters. The amount of protein content was almost similar when comparing with the studies of spiny lobsters [22], *Heterocarpus gibbosus, Plesionika spinipus* [23], *Podopthalmus vigil* [24], lobster (*Thenus orientalis*) [25], *Macrobrachium rosenbergii* [26], *Calappa lophus* [27] and *Portunus pelagicus* [28,29]. Protein is important and thus occurs to preserve life, as a part of the human body, the most significant sum of all nutrients [30].

Table 1. Morphometric measurements of lobsters

Species	Length (cm)	Weight (g)
P. homarus	28.7 ± 0.26	167.2 ± 0.57
P. versicolor	27.4 ± 0.28	163.8 ± 0.49
P. ornatus	29.7 ± 0.40	171.8 ± 0.53
P. polyphagus	25.8 ± 0.32	158.8 ± 0.44

Values were expressed in mean ± S.D

Table 2. Proximate composition of four spiny lobster species (g/100 g on dry weight)

Species	Moisture	Protein	Lipid	Ash
P. homarus	72.7±0.53	22.8±0.41	2.93±0.03	1.47±0.04
P. versicolor	75.7±0.49	23.7±0.32	3.28±0.02	1.64±0.03
P. ornatus	76.7±0.50	22.6±0.49	3.53±0.37	1.67±0.03
P. polyphagus	74.3±0.37	21.8±0.49	2.75±0.02	1.59±0.04

Values are expressed in means ± S.D

Table 3. Mineral composition of four spiny lobster species (mg/100 g on dry weight)

Species	Calcium	Sodium	Potassium	Magnesium
P. homarus	226.9±2.18	285.9±3.55	153.5±0.49	94.1±0.16
P. versicolor	235.5±1.59	276.3±1.24	148.1±1.10	85.8±1.31
P. ornatus	242.6±1.79	294.7±1.00	139.9±1.45	105.9±1.48
P. polyphagus	216.4 ±1.63	266.9±1.86	159.6±1.99	98±1.04

Values are expressed in means ± S.D

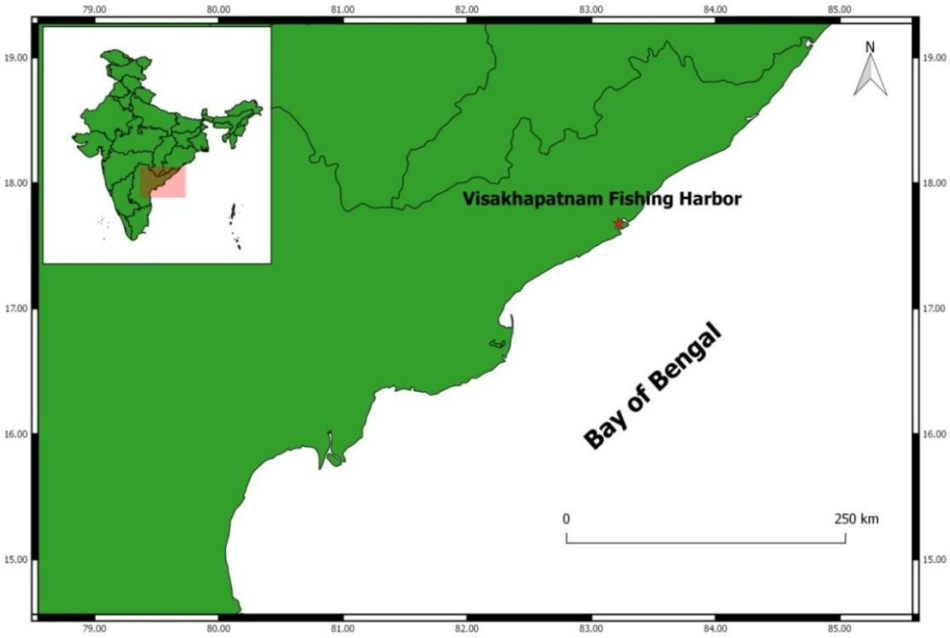

Fig. 1. Map showing sampling station Visakhapatnam fishing harbour

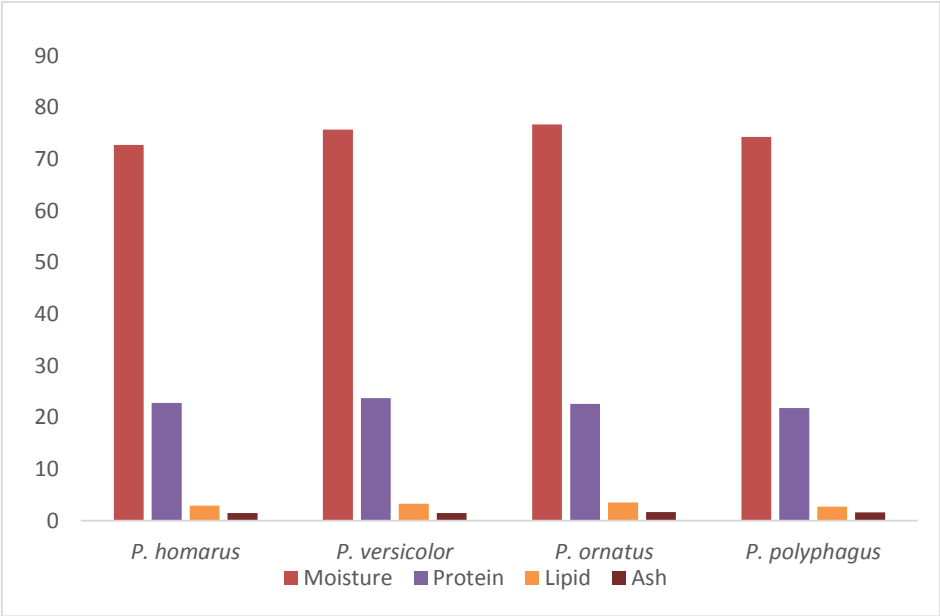

Fig. 2. Graphical presentation of the proximate composition

The moisture content of a sample is a measurement of its water content. The results in table 2 demonstrated variance in the moisture content values obtained with *P. ornatus* having the highest moisture content (76.2±1.23), followed by *P. versicolor* (75.7±1.16) *P. polyphagus* (74.8±1.49), and *P. homarus* (72.7±0.53). For organisms, the high moisture content is good because it will make enzymatic reactions. However, it can be disadvantageous to have high moisture content by making the organism susceptible to microbial spoilage, increasing oxidative degradation of polyunsaturated fatty acids, and consequently reducing the consistency of fatty acids lobsters, thereby reducing its preservation time [31].

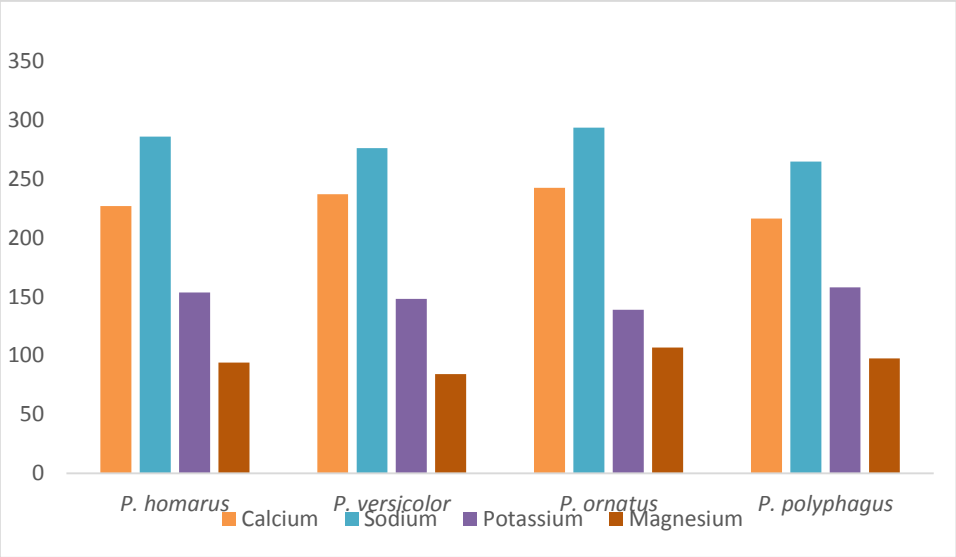

Fig. 3. Graphical presentation of the mineral composition

The mineral content of an organism is measured using ash. It is an inorganic remnant of organic matter that is burnt. The results in table.1 demonstrated the ash content in the four lobsters in the order *P. ornatus* > *P. versicolor* > *P. polyphagus* > *P. homarus*. The differences in the concentration of minerals may be influenced by different factors, including seasonal changes, size, sex, age, and sexual maturity, food source, and availability in each organism's habitat, as well as other considerations such as water chemistry, salinity, temperature, and contaminants [32,33].

Lipids are highly efficient energy sources, and they contain more than twice the energy of carbohydrates and proteins [30]. Lipids are an alternative source of nutrition in times of abstaining and starvation. As shown in table 2, *P. ornatus* had the highest fat content (1.62±0.38), and *P. homarus* had the lowest (1.41±0.32). Fats play an important in the structural and biological functions of the cells. In crustaceans, lipids not only serve as the primary organic reserve and source of metabolic energy but are also indispensable in maintaining cellular integrity. Generally, lipids act as a major food reserve and protein and may fluctuate periodically due to environmental variables like temperature [34].

The main functions of essential minerals include skeletal structure, maintenance of colloidal system and regulation of the acid-base equilibrium [35]. Minerals also constitute important components of hormones, enzymes and enzyme activators. Lobsters their high mineral content is well known. Defects in minerals can inflict serious health harm. Sodium in the walls of the intestine, joints, and gallbladder helps reduce blood clotting, which is important for the operation of the membrane, nerve impulses, and muscle contractions and is the primary cation of body fluids. It's playing a major role in the excretion of carbon dioxide [36]. Maximum sodium content in the present study was obtained in *P. ornatus* (293.7 mg/100 g dry weight) and minimum content in *P. polyphagus* (264.9 mg/100 g dry weight). In the evidence of previous studies, Sodium was reported in *Charybdis smithii* [37], *P. monodon* [38], *P. sanguinolentus* [39], *Metapenaeus affinis* [40]. *Calappa lophus* [27], *P. sanguinolentus* [41], *S. tranquebarica* [42] and *E. sinesnsis* [43].

Potassium is essential for membrane activity, nerve impulses, and muscle contractions. It is considered to be an important cation. Potassium helps maintain the acid-base balance of the body and essential for the cytoplasm, a primary electrolyte, an alkalizer. It attracts oxygen to tissues and eliminates toxins from the body [44]. Potassium is most important for maintaining the pH, storage, and transfer of energy and nucleotide synthesis. The present study shows high Potassium in *P. polyphagus* (157.9 mg/100 g dry weight), whereas low potassium was recorded in *P. ornatus* (139.0mg/ 100 g dry weight). Similar studies were conducted on some other crustacean species. *Calappa lophus* [27], *S. tranquebarica* [42], *P. sanguinolentus* [41] and *E. sinesnsis* [43].

The importance of calcium in humans is well known. It is required to form bones and teeth, clot blood, and control nerve and muscle functions. It serves as an essential cofactor for extracellular enzymes and proteins. The maximum calcium content was found in *P. ornatus* (242.6 mg/100 g dry wt), whereas the minimum content was recorded in *P. polyphagus* (216.4 mg/100 mg dry wt).

Magnesium acts as a cofactor in many enzyme-linked biochemical reactions in different physiological processes. It plays a prominent role in ATP-dependent metabolic reactions, vital for brain and liver function and calm nerves. It helps cell growth, increases tissue elasticity, and performs neuromuscular functions [45,46]. Here in the lobster species, a high magnesium level was observed in *P. ornatus* (106.8 mg/100g dry wt), whereas 84.3 mg/100 g dry wt was observed in *P. versicolor***.**

5. CONCLUSION

Based on the nutritive value of the species derived from this study, Shellfishes are good protein sources, low in carbohydrate and fat contents. The present study revealed that the meat of the spiny lobsters contains a high nutritive value and the great palatability of this species encourage its suitability for being appropriate seafood. Marine organisms form a good sources of minerals. Mineral components are needed for human nutrition. The minerals like Calcium, Potassium, Magnesium and sodium that are essential for normal tissue metabolism and maintenance of health are ample in these species. The quality of the aquatic environment also influenced the physiological and nutritional compositions of these shellfishes. This study reveals that the spiny lobsters ideal diet food and consumption of lobsters may help to prevent nutrition deficiencies in the future. In regard to fishery economics, increase in market demand of these lobsters will result in the landing of the lobsters in fresh and preserved form, thereby increasing the income of the fishermen as well as effectively reducing resource loss due to discarding.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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