



Proximate composition of fresh meat and exoskeleton of marine crab *Portunus pelagicus* (Linnaeus, 1758)

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Manuscript details:

Received: 05.05.2020
Accepted: 07.06.2020
Published: 29.06.2020

Cite this article as:

Vigneshwari S and Gokula V (2020) Proximate composition of fresh meat and exoskeleton of marine crab *Portunus pelagicus* (Linnaeus, 1758). *Int. J. of Life Sciences*, Volume 8(2): 383-390.

Available online on <http://www.ijlsci.in>
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)



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ABSTRACT

Blue swimmer crab *Portunus pelagicus* is an economically valuable species found along the southeast coast of India. The present study examines the proximate composition analysis (total protein, carbohydrate, lipid, moisture and ash content) of fresh meat found in body, claw, and leg and the exoskeleton (carapace) for male, female, berried crabs separately collected from Mimisal coast, Tamil Nadu, India. The meat yield was the highest in male body (12.13%) and lowest in berried leg (2.53%). The nutrients were generally found more in body meat followed by claw meat, and leg meat. Among the macronutrients, protein was found maximum in male body meat (47.05%) while lipid was in berried body meat (10.02%). Carbohydrates and ash were found maximum in female body meat (3.58% and 13.2% respectively). Moisture content was more in male body meat (80.5%). Similarly, in the exoskeleton carapace, protein was found more in male (10.41%) while lipids in berried crabs (7.20%). Ash and carbohydrate were more in female (3.1% and 2.06% respectively), while moisture was more in male (36.1%). There were significant differences among male, female and berried crabs in the proximate composition of fresh meat and exoskeleton. Hence, it may be concluded that in terms of nutritional value, male and female crabs may be considered more suitable than the berried for consumers.

Key words: Fresh meat, claw, exoskeleton, macronutrients, moisture, ash

INTRODUCTION

Seafood is highly nutritious and easily digestible palatable food (Sugumar *et al.* 2012; Ali *et al.* 2017). Crab meat is a famous and versatile kind of seafood, which is healthy owing to its protein content, unsaturated fatty acids and mineral composition (Skonberg and Perkins, 2002; Sudhakar *et al.* 2011). Crabmeat is well known for the exceptional and scrumptious taste when compared to fish and molluscs (Sudha Devi and Smiji, 2013) and they have high demand in countries like USA, United Kingdom, Japan, France, Hong Kong and Malaysia. It has become a favourite food for many people replacing

red meat and chicken due to the presence of high nutritive elements. It is noteworthy that crab meat contains lower calories than beef, pork and poultry (Jimmy and Arazu, 2012). It is particularly rich in Omega-3 fatty acids, which are necessary to lower triglycerides and blood pressure, thereby reducing the risk of heart disease (Martinez *et al.* 2009; Williams *et al.* 2016). It is also an excellent source of many vitamins (B2, B3, B12 and C) and minerals like iron, calcium, potassium, phosphorus and zinc, which aids in reducing oxidative damage to cells and tissues and acts as an antioxidant by cancelling out the carcinogenic effects (Kucukgulmez *et al.* 2006; Kaya *et al.* 2009; Soundarapandian *et al.* 2014). The blue swimmer crab *P. pelagicus* (Linnaeus, 1758) is distributed from the eastern Mediterranean to east Africa in the Indian Ocean and up to Japan and Tahiti in the Western and South Pacific Ocean (Khoei *et al.* 2012). It also occurs in the Indo-West Pacific Ocean from Africa to India, Southeast Asia and Australia both in tropical and temperate coastal waters (Johnson *et al.* 2010). In India, the species is available all along the coast, prominently in the southeast and the south-west regions and breeds all round the year (Bhat *et al.* 2011; Ravi and Manisseri, 2013) though large proportions are caught from Palk Bay and the Gulf of Mannar region (Samuel and Soundarapandian, 2009). Owing to the fact that it is caught abundantly along the entire southeast coast of Tamil Nadu for high commercial value. The nutritive value of any edible organism can be evaluated from its macro and micro nutrients. Several researchers have reported on the proximate composition of fresh *P. pelagicus* collected from southeast coast of Tamil Nadu (Ameer Hamsa, 1978; Soundarapandian and Singh, 2008; Ramesh Kumar *et al.* 2009; Sugumar *et al.* 2012). However, attempts to understand the proximate composition of fresh crabs in Mimisal coast is very meagre. Hence, the present study aims to analyze the proximate

composition of fresh meat and exoskeleton of blue swimming crab *P. pelagicus* of Mimisal coast.

MATERIALS AND METHODS

Live (20 males, 20 females and 20 berried individuals) crabs were collected from Mimisal landing centre (9.9202 E and 79.1528 N) in the month of December, 2014 (Fig. 1). The crabs were washed to remove the sand particles and weighed in the collection point. Carapace was removed carefully from each animal and meat (found in body, claw and leg) were taken separately using forceps. The separated meat and carapaces were collected in ziplock covers, labelled and brought to the college laboratory in an icebox. The meat was homogenized using mortar and pestle, centrifuged at 25,000 rpm for 20 min and taken for the analysis (Lowry *et al.* 1951). The carapaces were dried, ground to fine powder and used for further analyses. Proximate analyses were done on these fresh meat and fresh carapaces (Fig. 2).

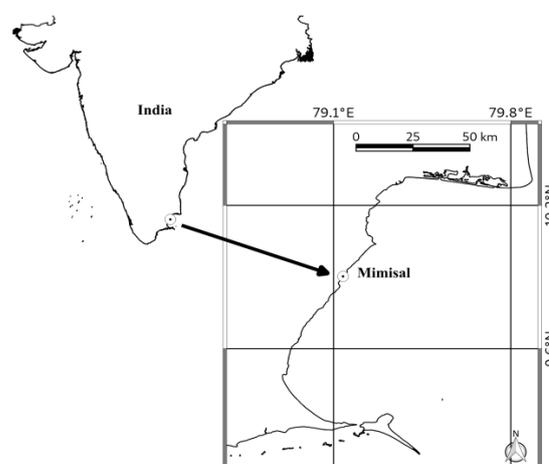


Fig 1. Mimisal – sample collection point

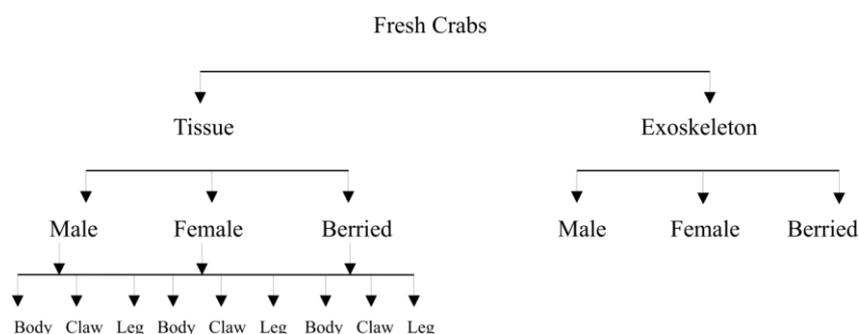


Fig 2: Grouping of crabs

Meat content was estimated following AOAC (2007). Total Protein was estimated following Lowry et al. (1951); Total Carbohydrates content was estimated following Roe (1955); Total lipid was estimated following Folch et al. (1957); Moisture content was determined using hot air oven following AOAC (1995); Total ash was estimated by incinerating the pre-weighed samples in the muffle furnace at 560°C for a

period of 5-8 hours following the method of AOAC (1995).

Statistical Analysis

The data were subjected to analysis of variance (one way ANOVA) and significant differences (if $P < 0.05$) between the means were compared with Turkey's post hoc test using PAST 3.09 version.

$$\text{Meat content (\%)} = \frac{\text{Wet meat weight (g)}}{\text{Total weight (g)}} \times 100 = \text{Yield \%}$$

$$\text{Protein (\%)} = \frac{\text{OD of the Sample}}{\text{OD of the Standard}} \times \frac{\text{Concentration of the Standard}}{\text{Volume of the Sample}} \times 100 = \text{mg\%}$$

$$\text{Carbohydrates} = \frac{\text{OD of the Sample}}{\text{OD of the Standard}} \times \frac{\text{Concentration of the Standard}}{\text{Volume of the Sample}} \times 100 = \text{mg\%}$$

$$\text{Lipids (\%)} = \frac{\text{OD of the Sample}}{\text{OD of the Standard}} \times \frac{\text{Concentration of the Standard}}{\text{Volume of the sample}} \times 100 = \text{mg\%}$$

$$\text{Moisture (\%)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Wet weight}} \times 100$$

$$\text{Ash (\%)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Wet weight}} \times 100$$

RESULTS

The morphometric measurements of the collected crabs were shown in Table 1. The results revealed significant variations in the biochemical constituents of body meat, claw meat, and leg meat and also in the exoskeleton of male, female and berried *P. pelagicus* (Table 2 and 3). The results are expressed on dry meat weight basis. Meat yield of body, claw and leg significantly differed among male, female and berried crabs (Table 2). Macronutrients viz protein, carbohydrates and lipid content of body, claw and leg significantly differed among male, female and berried

crabs (Table 2). These macronutrients content of cooked exoskeleton also significantly differed among male, female and berried crabs (Table 3). The total protein content forms the highest biochemical component followed by lipid (second) and carbohydrate (third) component in the meat of the crabs. The moisture and ash content of body, claw and leg meat significantly differed among male, female and berried crabs (Table 2). In the exoskeleton, moisture content was significantly different while ash content was not significantly different among male, female and berried crabs (Table 3). Moisture content was the highest in males while ash was the highest in females.

Table 1: Morphometric data of male, female and berried *Portunus pelagicus* crabs.

Groups	Range			Mean & S.D		
	Male	Female	Berried	Male	Female	Berried
Body Weight	130 - 230 g	130 - 230 g	160 - 210 g	165.96 ± 15.87	175.87 ± 17.15	183.14 ± 14.09
Carapace Width	10.4 - 14.9 cm	10.6 - 16.2 cm	11.9 - 14.1 cm	12.81 ± 0.80	13.26 ± 0.72	13.10 ± 0.71
Carapace Length	5.1 - 7.5 cm	4.9 - 7.6 cm	5.9 - 7.4 cm	6.25 ± 0.50	6.50 ± 0.53	6.48 ± 0.51

Table 2: Proximate analysis of fresh tissues of *Portunus pelagicus* from male, female and berried crabs.

Proximate analysis		Body	F Value Significant Level P<0.05)	Claw	F Value Significant Level P<0.05)	Leg	F Value Significant Level P<0.05)
Meat content (%)	FM	12.13	F = 56.06	8.10	F = 82.89	4.18	F = 62.82
	FF	10.45		5.81		2.53	
	FB	10.56		6.41		3.26	
Protein (mg%)	FM	47.05	F = 3357	26.71	F = 21.52	11.88	F = 549.8
	FF	40.65		23.00		9.65	
	FB	38.12		20.47		7.71	
Carbohydrates (mg%)	FM	2.92	F = 758.5	2.34	F = 488.7	2.13	F = 117.2
	FF	3.58		3.03		2.44	
	FB	3.21		2.73		2.29	
Lipid (mg%)	FM	7.76	F = 1717	5.0	F = 5607	3.92	F = 4510
	FF	8.87		6.86		5.49	
	FB	10.02		9.69		7.51	
Moisture (%)	FM	80.5	F = 159.7	75.8	F = 95.68	71.6	F = 82.24
	FF	78.8		73.9		70.2	
	FB	76.3		72.5		68.5	
Ash (%)	FM	10.6	F = 58.24	7.5	F = 41.43	3.5	F = 30.8
	FF	13.2		9.8		5.2	
	FB	11.4		8.4		4.8	

FM – Fresh Male; FF – Fresh Female; FB – Fresh Berried crabs

Df Value: Between Groups – 2; Within Groups – 21 (Meat content)

Between Groups – 2; Within Groups – 15.

Table 3: Proximate analysis of fresh exoskeleton of *Portunus pelagicus* from male, female and berried crabs.

Proximate analysis	Groups	Exoskeleton	F Value Significant Level P<0.05)
Protein (mg%)	Male	10.41	F = 490.9
	Female	8.24	
	Berried	6.35	
Carbohydrates (mg%)	Male	2.06	F = 220.2
	Female	2.66	
	Berried	2.52	
Lipid (mg%)	Male	4.08	F = 2511
	Female	5.16	
	Berried	7.20	
Moisture (%)	Male	36.1	F = 1363
	Female	34.8	
	Berried	27.7	
Ash (%)	Male	2.0	F = 7.825
	Female	3.1	
	Berried	2.7	

Df Value: Between Groups – 2; Within Groups – 1

DISCUSSION

The proximate composition means the percentage composition of five basic constituents such as water, protein, lipid, carbohydrate and ash (Pushparajan *et al.* 2012). Seafood contains high levels of energy yielding macronutrients like protein and lipids (Van Ruth *et al.* 2014)]. Large variations occur in the proximate composition of any organism as several factors like species, habitat, diet, water temperature, and seasons often influence the proximate composition (Bilgin and Fidanbas, 2011; Langer *et al.* 2013). Even slight variations occur in the proximate composition within the same species due to several factors sex, sexual maturity and spawning (Ayas and Ozogul, 2011). Nutrient and mineral composition of fresh meat of marine crabs have been investigated in different parts of the world (Abdel-Salam, 2013; Elegbede and Fashina Bombata, 2013; Zotti *et al.* 2016; Hamdi, 2011) while no work have been recorded from Mimisal, southeast coast of India.

In general, consumers select species with more meat content and high nutritive value. In the present study, meat yield was observed in the following order: Male>Female>Berried. More meat yield was seen in male crabs than in female crabs of *Callinectes sapidus* species (Ayas and Ozogul, 2011) *Ucides cordatus* (Pinheiro *et al.* 2015) and of *P. pelagicus* (Ameer Hamsa, 1978). In general higher proportion of meat yield was seen in males than in females because they have bigger claws when compared with female crabs. It helps the male crabs to grasp and feed on a wider variety of food items than females (Erickson *et al.* 2008). Proteins act as biological catalysts in the form of enzymes, hormones, immune molecules and forms structural parts of organisms. It participates in cell signalling and recognition; transmit nerve impulses, transports nutrients, balancing water content and acts as protective molecules of immunity (Fredrick *et al.* 2013). In the present study, protein content was observed in the following order Male>Female>Berried. Protein content in the body meat of male *P. pelagicus* was found to be more in female crabs collected from Karachi coast (Akbar *et al.* 1998). They also reported more protein content in the trashes of males than in females. However, *C. sapidus* and *Podophthalmus vigil* crabs showed more protein content in females than in males (Ayas and Ozogul, 2011; Soundarapandian *et al.* 2013). Protein content of shell wastes of male and female *P. pelagicus* found in Rea Sea showed that

protein content was more in males than in females (Abdel-Salam, 2013). In general, animal based protein sources deliver all the essential amino acids while plant based protein lack one or more essential amino acids (Millward, 1999). Proteins are recurrently used for growth and repair of tissues caused by moulting in crustaceans (Mente, 2006). Males recorded higher protein content than females and berried crabs as they moult many times while females cease to moult after mating. Moreover, male reproductive system has more protein in the seminal plasma and spermatophores (Jeyalectumie and Subramoniam, 1991). Male crabs have more muscles and thus they have more proteins than the female and berried crabs.

Carbohydrates are the essential part of human diet, which forms primarily a source of immediate energy for all body cells. This macronutrient will be in minimum quantities in animal meat in the form of glycogen with more molecular branching. Glycogen content in various edible tissues of bivalves in West Japan showed significant decrease with sexual maturity (Yurimoto, 2015). In the present study, carbohydrate content was higher in the following order: Berried>Female>Male. Carbohydrate content was higher in hard shell crabs than soft shell crabs (Sudhakar *et al.* 2009). In *P. pelagicus*, more glycogen in body and claw meat of males than in female crabs (Akbar *et al.* 1998). Proximate composition of *Callinectes amnicola* showed more carbohydrate content in crunchy chest followed by in walking legs and in tissues (Moronkola *et al.* 2011). But elevated levels of carbohydrates in berried than males and females of *P. vigil* crabs were also recorded (Soundarapandian *et al.* 2013). Reproduction and moulting are the two major physiological events in crustaceans life cycle, thus females have recorded higher carbohydrate composition followed by berried crabs when compared with male crabs.

Lipids tend to be saturated and packed tightly in living organisms and they are the main biochemical constituents of membranes in all cells to help in storage and acts as intermediates in signalling pathways by maintaining cellular integrity. They act as major reserve food along with protein and are subject to periodic fluctuations influenced by environmental variables (Nagabhushanam and Farooqui, 1982). Our results are in agreement with (Soundarapandian *et al.* 2013) in *P. vigil* crabs, (Sarower *et al.* 2013) in the meat of *Scylla serrata*, (Sallam and Gaballa, 2009) in

Charybdis natator, (Wu and Wang, 2017) in Chinese mitten crab (*Eriocheir sinensis*). The biochemical composition of eggs of *P. pelagicus* showed more lipid content (Khoei *et al.* 2012). During embryonic development in decapods, eggs utilize more fat than protein (Hamid *et al.* 2015). Hence, berried crabs may have more lipids to nourish the developing eggs than female and male crabs.

Moisture content is an important indicator in determining the shelf life of food items. It also influences the taste, texture and weight of the food. In the present study, moisture content was higher in the following order: Male>Female>Berried (Ayas and Ozogul, 2011; Sarower *et al.* 2013). However, more water content in berried females followed by males and females in *P. vigil* was also reported (Soundarapandian *et al.* 2013). Low moisture contents in organisms reveals that they have long shelf life periods. They are maintained in good conditions in packed food and sealed cans during export to foreign countries. The ash content is an inorganic residue obtained by burning away all organic content within the food. It gives the total amount of minerals present in a food. Ash is one of the least studied biochemical constituents in crustaceans (Devi *et al.* 2015). Ash content was found more in female than others (Akbar *et al.* 1998; Soundarapandian *et al.* 2013). However, more ash in males than in females was also reported (Ameer Hamsa, 1978). More ash content in walking legs than in tissues and crunchy chest of *C. amnicola* was also reported (Moronkola *et al.* 2011). Fresh food ash content rarely exceeds 5%. The higher value recorded in the present study could be due the presence of rich minerals.

CONCLUSION

The present study revealed that the meat of male and female crabs contain higher macronutrients and ash content than the berried crabs. The high nutritive value and great palatability of this species encourage its suitability for being appropriate seafood. The exoskeleton of this species also showed high proximate components and thus it may also be given as additive for animal feeds besides extracting chitin, chitosan and carotenoids.

ACKNOWLEDGEMENT

Authors are thankful to the Principal and the Management, National College (Autonomous), Trichy - 620 001 for providing the necessary facilities.

Conflict of Interest

The author declares that there is no conflict of interest.

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