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Nutritional Status of Edible Palaemonid Prawn Macrobrachium Scabriculum (Heller, 1862)

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Abstract: The south Indian rivers are known for freshwater fisheries and *M. scabriculum* is one of the most common palaemonids. The prawn, *M. scabriculum* is dominant in the Vellar estuary during October-December. The local communities are eating *M. scabriculum* during the above period without knowing its nutritive value. There is no information available on the biochemical composition during different phase of growth in non-penaeid prawns in general and *M. scabriculum* in particular. So in the present study, proximate composition (protein, carbohydrate, lipid, ash and moisture) and fatty acids were studied in different size groups and sexes of *M. scabriculum*. In general the protein, carbohydrate, and lipid contents were higher in younger ones than in adults. Among various saturated fatty acids recorded, the amount of palmitic acid in both sexes was more. As in saturated fatty acids the total amount of monounsaturated fatty acid also shows maximum in males rather than females. The total amount of polyunsaturated fatty acids of *M. scabriculam* is minimum than monounsaturated fatty acid and saturated fatty acids. Considering the above results from the nutritive point of view, *M. scabriculum* can be very well used as food and perhaps as a candidate species in future for culture.

Key words: *Macrobrachium scariculum* · Protein · Carbohydrate · Lipid · Ash · Palmitic acid

INTRODUCTION

In India, millions of people suffering from malnutrition. Protein deficiency may be minimized for some extent by making available cheaper fish meal items which are available to local communities. Prawn has become one of the source of animal protein to the low income earners due to its low price and availability [1]. Among known 150 species of freshwater prawns, *M. rosenbergii, M. americana,* and *M. carcinus* are identified as the largest species. The natural availability of *M. rosenbergii* in Parangipattai area is very limited. However, other species *viz., M. malcolmsonii, M .idella idella, M.idae and M. scabriculum* are naturally distributed [2]. Even though *M. scabriculum* are considered to be small and not exported it is still consumed by local population atleast some months of the year. But in general there is no information available on the biochemical composition during different phase of growth in non-penaeid prawns except a brief report by Sriraman [3] on *M. idae*. Since, there is no much knowledge about the nutritional status of the *M. scabriculum.* The present study is carried out to evaluate the nutritional status of *M. scabriculum* at different size groups and sexes. This is very helpful and to know which size will be adequate and advantageous for consumption from the nutritional point of view.

MATERIALS AND METHODS

The prawn, *M. scabriculum* was collected from freshwater areas of Ponanthittu (Lat.11°28’50.50°N; Long. 79°45’28.23°E) which is located 2 km south to Parangipettai and the water source finally connected with Vellar estuary. Totally 220 specimens size ranging from 30-70 mm in length were collected and transported to the laboratory in live condition and washed with distilled water to remove dust and algal particles and eventually ice killed. Then they were separated in to three groups *viz*. male, female and berried. Further grades were made according to the size and each group was placed in to eight size groups at 5mm intervals. After grading, the exoskeleton was pealed out and homogenized with pestle and mortar. The grounded samples were then freeze dried and powdered and stored in refrigerator for further analysis.

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The protein, carbohydrate and lipid contents were estimated by adopting the standard methods of Raymont *et al.* [4], Dubois *et al.* [5] and Folch *et al.* [6] respectively.The difference in weight between wet and dried tissue represented the weight of water in the body tissue, which is expressed as percentage. Ash was estimated by incinerating the pre-weighed test material (1gm dry weight in a mettle turn ace at 560°C for a period of 5 hours). The residue was weighed and the percentage was calculated.The fatty and methyl esters of the sample was injected into the gas chromatography (GC-6890) capillary column coated with 5% phenyl silicone at a temperature from 170°C to 300°C for 23.33 minutes. Flame ionization time, the different fatty acid samples were identified. Triplicate was maintained for each experiment.

RESULTS

Statistical Analysis: To know the statistical significance one way ANOVA was carried out between sexes and size groups.

The proximate composition of different sexes and size groups of *M. scabriculum* are presented in Table 1.

Protein: The protein content was maximum in males (59.15%) in the size groups of 36-40mm. While minimum was (48.77%) recorded in 51-55mm size groups. The protein content in berried females was ranged from 37.16 to 47.95% in corresponding size groups of 56-60mm and 51-55mm respectively. The females showed highest protein content (56.75%) in the size groups of 30-35mm and lowest protein value (47.61%) was in the size groups of 56-60mm.

Carbohydrate: In males, the carbohydrate values varied between 1.89% in 36-40mm and 2.62% in 66-70mm size groups. In berried females it ranged from 1.69% in 60-62mm to 2.17in 46-50mm size groups. Like wise in females, it fluctuated between 1.72% in 41-45mm and 2.32% in 56-60mm size groups.

Lipid: The lipid content was maximum in males (5.20%) in the size groups of 56-60mm. and minimum was (3.25%) in the size groups of 66-70 mm. The lipid content in berried females was ranged from 2.86% to 3.86 % in 36-40mm and 30-35mm size groups respectively. The females showed highest lipid content of 5.45% in 56-60mm size groups and lowest lipid values (3.86%) was in 41-45mm size groups.

Ash: In general the ash content showed an increasing trend from young ones to adult both in males and females. The maximum ash content was recorded in males (6.40%) with the size groups of 61-65mm, while the minimum ash content was (4.22%) recorded in30-35 mm size groups.

Table 1: Biochemical composition in the muscle tissues of *M. scabriculum* (Values expressed in % on dry weight basis except moisture)

S:No	Size groups	Length (mm)	Protein (%)	Carbohydrate (%)	Lipid (%)	Ash (%)	Moisture (%)
1	Male		58.23±0.36	2.01±0.05	4.02±0.21	4.22±0.06	78.08±0.23
	Female	30-35	56.75±0.26	2.21±0.2	4.54±0.05	4.06±0.03	74.59±0.62
	Berried		55.23±0.42	1.86.±0.23	3.86±0.42	4.12±0.18	74.22±0.56
2	Male		59.15±0.79	1.89±0.12	3.84±0.34	4.79±0.30	75.02±0.32
	Female	36-40	49.27±0.70	2.11±0.23	4.23±0.08	4.85±0.18	74.54±0.45
	Berried		42.59±0.68	1.93±0.12	2.86±0.54	4.92±0.39	76.88±0.24
3	Male		55.79±0.24	2.45±0.1	4.92±0.45	5.53±0.33	79.01±0.44
	Female	41-45	56.22±0.38	1.72±0.14	3.86±0.32	5.16±0.14	78.55±0.23
	Berried		39.90±0.21	2.16±0.22	3.65±0.16	6.03±0.18	78.82±0.32
4	Male		50.11±0.63	1.99±0.24	5.02±0.32	5.75±0.23	76.99±0.08
	Female	46-50	52.16±0.44	1.73±0.11	4.97±0.22	5.65±0.22	73.78±0.22
	Berried		44.24±0.52	2.17±0.21	3.62±0.42	5.70±0.28	77.08±0.18
5	Male		48.77±0.24	2.34±0.08	5.14 ±0.42	5.64±0.42	78.06±0.21
	Female	51-55	52.78±0.30	2.06±0.31	4.02±0.32	5.71±0.32	76.38±0.24
	Berried		47.95±0.27	2.15±0.22	2.97±0.14	5.92±0.23	79.66±0.06
6	Male		50.66±0.43	2.15±0.14	5.20 ±0.21	5.89±0.19	79.99±0.14
	Female	56-60	47.61±0.95	2.32±0.23	5.45 ±0.26	6.12±0.45	77.05±0.34
	Berried		37.16±0.33	2.08±0.21	3.74±0.24	6.05±0.12	80.01±0.26
7	Male	61-65	53.35±0.81	2.42±0.12	3.83±0.54	6.40±0.15	80.46±0.18
	Female	61-62	54.24±0.54	2.04±0.62	4.28±0.82	6.05±0.12	79.06±0.46
	Berried	61-62	46.74±0.23	1.69±0.32	3.76±0.66	6.42 ±0.22	81.02±0.16
8	Male		56.82±0.45	2.62±0.05	3.25±0.46	6.38±0.13	80.06±0.22
	Female	66-70	……	….	…..	…..	…
	Berried		….	….	….	…..	…

Table 2: Saturated fatty acids in females and males (%) of *M. scabriculum*

Fatty Acids	Name	Female 55-60(mm)	Male 65-70(mm)
C12:0	Lauric acid	0.83	0.91
C14:0	Myristic	3.81	3.06
C15:0	Pentadecyclic	1.55	1.18
C16:0	Palmitic	27.64	17.34
C17:0	Margaric	1.51	1.09
C18:0	Stearic	9.67	6.42
C20:0	Arachidic	0.82	0.40
Total		45.83	30.4

Table 3: Monounsaturated fatty acids in females and males (%) of *M. scabriculum*

Fatty Acids	Name	Female 55-60(mm)	Male 65-70(mm)
C16:1w5c	Ambrettolic	0.56	-
C17:1w8c	-	0.85	0.53
C18:1w9c	Oleic	21.04	14.46
C18:1w7c	Octadecenoic	4.81	3.87
Total		27.26	18.86

Table 4: Polyunsaturated fatty acids in females and males (%) of *M. scabriculum*

Fatty Acids	Name	Female 55-60 (mm)	Male 65-70 (mm)
C18w6c	Γ-Linolenic	-	0.39
C20:4w6c	Arachidonic	4.75	4.84
Total		4.75	5.23

Table 5: Branched fatty acids in females and males (%) of *M. scabriculum*

Fatty Acids	Female 55-60 (mm)	Male 65-70 (mm)
C11:0Ante	0.38	1.27
C13:0Ante	0.61	2.70
C14:0Ante	0.68	3.60
C15:0Ante	0.97	3.81
C16:0Ante	0.58	1.96
C17:0Ante	0.71	2.14
C18:0Ante	7.04	9.17
C17:1AnteB	0.83	1.22
Total	11.8	25.87

Table 6: Branched fatty acids in females and males (%) of *M. scabriculum*

Fatty Acids	Female 55-60 (mm)	Male 65-70 (mm)
C15:0 ISO	0.44	1.03
C17:0 ISO	0.41	-
C20:0 ISO	-	0.33
C18:1 ISO H	0.34	-
C19:1 ISO I	2.11	2.50
C15:1 ISO G	-	0.97
C15:0 ISO 2OH	6.79	3.59
C10:0 3OH	-	0.40
C12:0 3OH	-	-
C15:0 2OH	-	0.34
C12:1 3OH	0.25	0.62
C16:0N Alcohol	-	0.55
Total	10.34	10.33

The ash content in berried females was ranged from 4.12% to 6.42% in 30-35mm and 61-62 mm size groups respectively. The females, showed highest level of ash content (6.12%) in the size groups of 56-60 mm and lowest ash values (4.06%) was in 30-35mm size groups.

Moisture: The moisture content in males was ranged from 75.02% to 80.46% in 36-40mm and 61-65 mm size groups respectively. Berried females exhibit a minimum water content of 74.22% in 30-35 mm size groups and maximum values of 81.02% in the size groups of 61-62 mm.

Table 7: One way ANOVA for the biochemical composition between different sexes

		Sum of Squares	df	Mean Square	F	Sig.
Protein						
Between Groups	887.656	2	443.828	2.035	NS	
Within Groups	4579.068	21	218.051			
Total	5466.724	23				
Carbohydrate						
Between Groups	1.176	2	.588	1.524	NS	
Within Groups	8.106	21	.386			
Total	9.282	23				
Lipid						
Between Groups	7.426	2	3.713	2.225	NS	
Within Groups	35.047	21	1.669			
Total	42.473	23				
Ash						
Between Groups	3.376	2	1.688	.557	NS	
Within Groups	63.621	21	3.030			
Total	66.997	23				
Moisture						
Between Groups	640.466	2	320.233	.639	NS	
Within Groups	10529.078	21	501.385			
Total	11169.543	23				

Table 8: One way ANOVA for the biochemical composition between different size groups

		Sum of Squares	df	Mean Square	F	Sig.
Protein						
Between Groups	2817.066	7	402.438	2.430	NS	
Within Groups	2649.657	16	165.604			
Total	5466.724	23				
Carbohydrate						
Between Groups	3.911	7	.559	1.664	NS	
Within Groups	5.371	16	.336			
Total	9.282	23				
Lipid						
Between Groups	27.773	7	3.968	4.318	P<.01	
Within Groups	14.700	16	.919			
Total	42.473	23				
Ash						
Between Groups	39.296	7	5.614	3.242	P<.05	
Within Groups	27.701	16	1.731			
Total	66.997	23				
Moisture						
Between Groups	6863.947	7	980.564	3.644	P<.05	
Within Groups	4305.596	16	269.100			
Total	11169.543	23				

The females showed higher water content of 79.06% in 61-62mm size groups and lower water content of 73.78% in the size groups of 46-50 mm. The results of one way analysis of variance showed that protein, carbohydrate, lipid, ash and moisture did not varied significantly between males, females and berried females (Table 7). However, lipid, ash and moisture varied significantly between different size groups except protein and carbohydrate (Table 8).

Fatty Acids: For fatty acid analysis only bigger sized males (65-70mm) and females (55-60mm) were taken into consideration. The total amount of saturated fatty acids present in males was found to be 30.4% and females it was 45.83%. Among total 7 individual saturated fatty acids reported, the Palmitic acid was maximum in both females (27.64%) and males (17.34%). However, Arachidic acid was minimum in both males and females (Table 2). The total amount of monounsaturated fatty acids was

maximum in females (27.26%) Where as in males it was minimum (18.86%). Oleic fatty acid was found to be maximum than any other monounsaturated fatty acid in both males and females. But it was dominated in females (21.04%) than in males (14.46%) (Table 3).The total amount of polyunsaturated fatty acid was recorded maximum in males (5.23%) than in females (4.75%). However Y-Linolenic was absent in females but present in males (Table 4). The total amount of Anteiso branched fatty acids were maximum in males (25.87%) and minimum in females (11.8%) (Table 5). But Iso-Branched fatty acids did not show significant variation between males and females (Table 6).

DISCUSSION

Biochemical composition of organisms are know to vary with season, size of animal, stages of maturity and availability of food, temperature etc. Protein is the most prominent biochemical components of crustaceans from eggs to adult and is strikingly dominant in younger phases. The quantity of protein in shrimps is largely influenced by the extent of fat and water content [7]. In the present study, males were found to have more protein than females. The fall in protein content, which is very well pronounced in females suggested that the protein in the muscle may be mobilized for the gonadal development. The same trend was observed by Sriraman [3] in shrimp, *Penaeus merguiensis* and in fresh water prawn, *M. idae.* In contrary, females of *P.indicus* and *Metapenaeus monoceros* were increasingly proteinacious than in males. Garg *et al*. [8] reported that the protein content in *Squilla* was varied from 70.09 to 75.46% and in Jawla prawn from 61.93 to 72.64%. Nair and Prabhu [9] showed that protein content in *M.dobsoni* was 65.25% and in *Acetes sp*. was 66.98%. According to Sambhu and Jayaprakash [10] the protein level in *P.indicus* was varied from 44.62 to 80.87%. *M.idae* showed greater variation in protein [3] with regard to size group, protein content was higher in younger organisms than in adults. The high protein content in the younger size groups may be attributed to increased protein synthesis during the active growth phase as it has been observed elsewhere in shrimps and mantis shrimps [11-13]. In the present study also showed higher protein content in younger ones than in adults. Among females, non-berried females showed higher value than berried females. This is mainly due to the intake of protein for the development of eggs in berried females. Protein fluctuation was also noticed among size groups, both in males and females but it was not statistically significant.

Carbohydrates constitute a meager percentage of total biochemical make up in *M. scabriculum* muscle when compared to protein and ash contents. Carbohydrate content exhibited an inverse relationship with protein content. Similar findings were recorded by Sriraman [3], Nair and Prabhu [9], Reddy and Shanbhogue [14], Sambhu and Jayaprakash [10] and Ravichandran [15]. The raise in carbohydrate content was gradual among the size groups and the peak value was observed in the bigger size group, which may be due to more synthesis and accumulation of carbohydrates in the higher size group organisms than in the younger ones. Various factor like gonad development in addition to starvation, feeding, rest, exercise and other physiological states changes the carbohydrate level. Presently the higher values encountered in larger organisms might be due to storage and senility in them. No distinguished trend in carbohydrate fluctuation was noticed among the size groups of many shrimps studied by Achuthan Kutty and Paruhekar [11] and Ajit kumar [12]. In the present study, males generally showed higher carbohydrate values than females and among females, non-berried females showed higher carbohydrates, which is in agreement with Ajith kumar [12]. However the variations of carbohydrate between sexes and size groups are not statistically significant.

In general, lipid act as major food reserves along with protein and subjected to periodic fluctuations influenced by environmental variables like temperature [16]. The inverse relationship between lipids and protein was earlier reported by George and Patel [17], Pillay and Nair [18], Sriraman [3], Radhakrishnan [19], Nair and Prabhu [9] and Ravichandran [15]. Pillai and Nair [18] marked an inverse relationship between lipids and moisture content. But this does not affect the lipid composition of muscle tissue to any great extend. Shaikhmahmud and Magar [20] obtained higher lipid content in mature females of *Parapanaeopsis stylifera* when compared to immature ones. Gopakumar and Nair [21] did not find any variation in the lipid content of muscle tissue of five species of penaeid shrimps studied. Achathan Kutty and Parulekar [11] also did not find any consistency to suggest that maturity condition influnces the lipid composition of muscle tissue. In the present study also there is no regularity in fat values among the size groups in males and females. Berried females showed lesser lipid values than non-berried females and the non-berried females showed, higher fat values than males. But lipid was significantly varied among different size groups.

Ash is one of the least studied biochemical constituents of crustaceans in general and *M. scabriculum* in particular. Sriraman and Reddy [22]

observed slight increase in ash content with increase in size of juveniles of *P.monodon*. In the present study also signals a marginal and gradual rise in the ash composition of muscle regardless of sex. Similar marginal increases in ash during growth were also reported by Achuthan Kutty and Parulekar [11] in *P.stylifera* and *M.affinis* and Ajithkumar [12] in *M. idella* which support the present results. Nair and Prabhu [9] reported that ash composition in *M. dobsoni* was 15.79% and in Jawla prawn (*Acetes sp)* was17.11%. In the present study reflected that increased ash content was noticed in increased size groups, regardless of sex. The differences of ash content among males berried and non-berried females is also noticed and this differences is statistically significant.

In the present study, the total values of saturated fatty acids are maximum in females (45.83%) than in males (30.4%). Among various saturated fatty acids recorded, the amount of palmitic acid in both sexes was more. But when compared with males (17.34%) the females had more (27.64%). Murugesan [23] also reported maximum amount of palmitic acid (20.09%) in the crab, *Charybdis lucifera.*

As in saturated fatty acids the total amount of monounsaturated fatty acid also shows maximum in females rather than male. Among monounsaturated fatty acids studied, Oleic acid was higher in females (21.04%) than in males (14.46%). Comparatively the total amount of polyunsaturated fatty acids of *M. scabriculam* is minimum than monounsaturated fatty acid and saturated fatty acids. In the present study the fatty acids having carbon atoms above 20 could not be identified by the instrument. So the rest of the fatty acids in the *M. scabriculum* were not detected. Further detailed study on fatty acid profile using advanced and versatile instrument is suggested. From the present observation, it could be conformed that *M. scabriculum* is not inferior in terms of nutritive value of already studied decapods crustacean. So *M. scabriculum* is considered to be candidate species for aquaculture.

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