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Effect of seasonal changes on the biological composition of *Charybdis feriatus*

A. Murali Shankar, E. Srikarnasekar, T. Santhosh Kumar and P. Soundarapandian

Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai-608502, Tamil Nadu, India.
Corresponding author: @srikarna11199@gmail.com

Abstract

The seasonal variation of protein content of the *C.feriatus* fluctuated between 16.21± 1.32 % - 25.28±1.39 %. The higher level of protein contents was observed during post monsoon seasons with 25.28 ±1.39 % in female and 21.62±1.42 % in male. The carbohydrate content was higher in males at post monsoon (0.17±0.05 %) and lesser in females at summer (0.12±0.08 %). The maximum lipid contents of 1.21 ±0.24 % and 1.13±0.15 % were detected in female and male respectively during post monsoon seasons. The saturated fatty acids were ranging seasonal wise from 29.17 to 36.69 %. All saturated fatty acids were uniformly shown higher values in females at post monsoon (36.69±1.51 %) followed by males (34.35±1.43 %). The monounsaturated fatty acids were ranging seasonal wise from 25.92 to 28.39 %. Oleic Acid (C18: 1n9) was the most abundant fatty acid. The seasonal variation of PUFA content of the C.feriatus fluctuated between 27.63±3.11 - 34.40±2.56 %. Totally 9 essential amino acids and 8 non-essential amino acids were recorded in the present study. The result of the present study revealed that the percentage of non-essential amino acid (73.54±4.39 mg/g to 90.36±4.11 mg/g) was more than that of essential amino acid (70.71±5.82 mg/g to 95.63±4.81 mg/g). All minerals were reported in both sexes at post monsoon. Sodium was maximum and copper was minimum in both sexes. Cadmium, mercury and arsenic were available in trace amount in both sexes. The present study, clearly depicts that the C. feiatus has the ability to holds its nutrient levels even after cooking by boiling and steaming. Steaming method is an added advantage to hold the nutrients of major protein, amino acids and fatty acids.

Keywords: Charybdis feriatus, biological composition, seasonal crabs,Myristic acid, pentadecylic acid, palmitic acid, margaric acid, steartic acid, lauric acid

1. Introduction

Crabs contain high level of protein which is essential in the development of muscle growth. The common minerals present are Omega 3 fatty acids, vitamin B12, seleniun. These nutritive elements help to enrich our body conditions and also avert long term diseases. Crucifix crabs are available throughout the Indo-Pacific regions and countries such as Japan and Australia. They are also present in subtropical and tropical climates.

The maximum size is about 20cm in length. They are economically important in Eastern Asia. They are commonly found at a depth of 30-60 meters at sandy and muddy substrates. These crabs are found in sub-littoral environment and at reef flats ranging from 10-60m in depth. They inhabit in estuarine areas and offshore regions. The young ones are found in sandy and intertidal habitats but the adults live in deeper muddy areas. The juveniles live in symbiotic relationship below the bells of jelly fish. Very limited information is available on the biochemical composition of *C. feriataus* from the Southeast coast of India and the changes in their biochemical composition with respect to their seasonal variations. Hence present study focused on biochemical composition with respect to their seasonal variations and various cooking methods.

2. Materials and Methods

2.1. Sample collection

The male and females of *C. feriatus* were collected from Annankoil (*Lat*.11°24′ *N*; *Long*. 79°464′ *E*) landing center. After reaching the laboratory they were washed carefully with distilled water to remove the dust and algal particles and ice killed. The carapace of the crabs was opened and the edible parts of muscle tissues were removed with sharp forceps. The removed muscle tissues were homogenized with pestle and mortar. The grounded muscles were then freeze dried and powdered and eventually stored in refrigerator for further analysis.

2.2. Edible yield and proximate composition

The meat yield, hepatosomatic index (HSI), gonadsomatic index (GSI) and the total edible yield of the crab was calculated using the following formulas:

Meat yield (%) = 100 x meat wet weight/body wet weight,

HSI (%) = 100 x hepatopancreas wet weight/body wet weight,

GSI (%) = 100 x gonad wet weight/body wet weight, Total edible yield (%) = meat yield + HSI + GSI.

2.3. Sample preparation for cooking process

In each season, crabs were divided in 3 groups: raw (control; 10 animals), boiled (10 animals) and steamed (10 animals). The animals were measured, weighed and subjected to culinary treatments following the traditional household methods. Boiling consisted in cooking each crab during 15 min in water with salt (2%), and steaming was performed at 105℃ for 15 min. The edible tissues of raw and cooked crabs (muscle) were homogenized and stored at -20 C until further analyses.

2.4. Biochemical composition

Various biochemical parameters were analyzed for the total protein content was folin-Ciocalten phenol method of Lowry *et al.* (1951), total carbohydrate content Dubois *et al.* (1956), lipid estimation was chloroform -methanol extraction procedure of Folch *et al.* (1956), the moisture and ash content was estimated by AOAC, (2005).

2.5. Fatty acids

The samples were oven dried at 70°C for 24 hrs until no more weight reduction was observed. After that the samples were grounded with mortar and pestle. To the 100-200 mg of finely ground tissue samples 1:1 ratio of chloroform: methanol (2ml) was added and kept for 30 seconds. The residual matter was removed by filtering through Whatman No. 1 filter paper (125mm). This was washed with 1 ml of chloroform: methonol (2:1 vol) to remove the inorganic substances from the combined extract by partition and treated with chloroform: methanol: water (8:4:3) where the lower phase evaporated to dryness. The dried matter was subjected in a sealed test tube with 3% Methanolic HCL at 80°C for 18hrs. To this 2ml of hexane was added to extract the fatty acid methyl esters obtained from methanol phase in Hexane. Top 1 ml of the hexane phase was collected in a micro vial. The residual fraction was dissolved in 10:1 of ethyl acetate and injected 1:1 aliquot into a gas chromatograph equipped with flame identification detector and column (Hp ULTRA – 225m, 0.2mm ID) by GC (Kashiwagi *et al.* 1997).

2.6. Amino acids

The amino acids were determined by an automatic amino acid in HPLC analyzer (Lachromehitachi). Five micro liter of amino acid standards mixture sample were injected into the column (DENALIC 18 5 MICROMM 4.6 mm x 150mm). The flow rate was about 1 ml per minute, ambient temperature of 23°C was maintained and sample was detected at 254 nm by following the method of Baker and Han (1994).

2.7. Mineral compositions

To the 5g of wet crab tissue samples, mixture of hydrochloric acid, nitric acid and perchloric acid at a ratio of 10:5:1 was added for digestion at 30 ºC. The digests were filtered suitably and aspirated in digital flame photometer (Modal No.CL 22D, Elicopvt, India); the obtained values were expressed in mg/100g (Guzman and Jimeneza, 1992).

3. Results and Discussion

3.1. Edible yield and proximate composition

Meat yield, Hepatosomatic index (HSI), Gonasomatic index (GSI) and total edible yield of both female and male *C.feriatus* crab are presented in Fig.1. Meat yields of about 33 % were found for both female and male crabs. However, the female and males crabs had substantially different GSI of 9.38 % and 0.94 %, respectively, which also resulted in a significantly higher total edible yield of the females and male respectively (45.90 %, 37.17 %) .

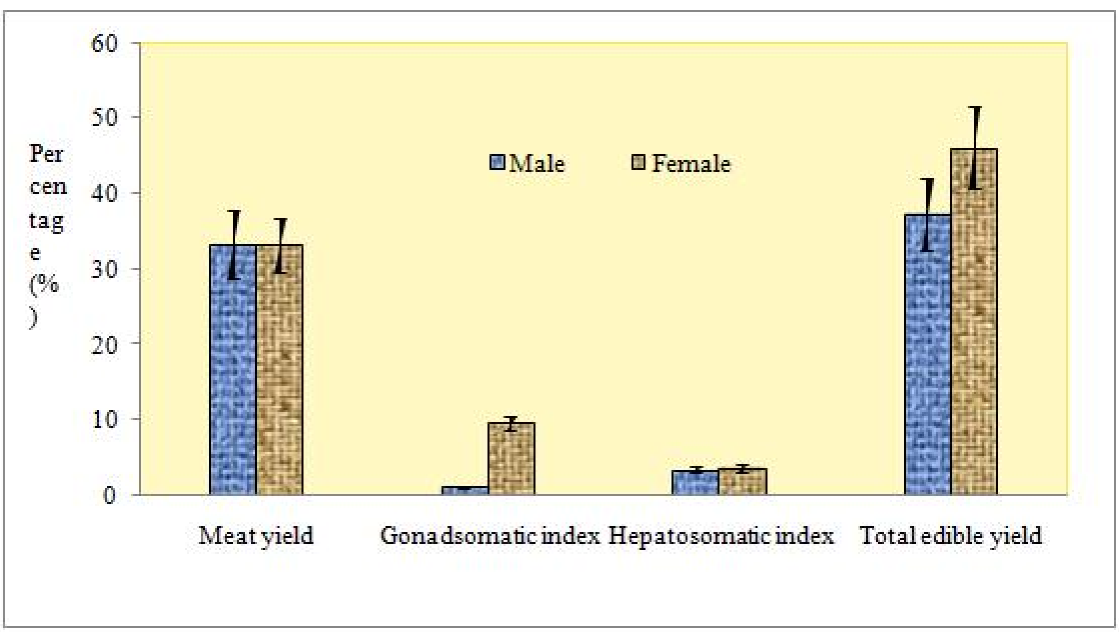

Fig.1 Meat yield, HSI, GSI and total edible yield of *C.feriatus*

3.2. Biochemical composition

The nutritive compositions of male, female were evaluated in four different seasons and cooked muscles. The biochemical composition *viz.*, proximate, amino acid, fatty acid and minerals of *C.feriatus* were represented in Table 1- 4 respectively.

The seasonal variation of protein content of the *C. feriatus* fluctuated between 16.21±1.32 - 25.28±1.39 %. The higher level of protein contents were observed during post monsoon seasons with 25.28 ±1.39 % in female and 21.62±1.42 % in male. Lower values were recorded in summer seasons with 16.21±1.32 % in male and 16.43 ±1.87 % in female (Table 1).

The carbohydrate content of *C. feriatus* different between were ranging from 0.12 ± 0.05 % to 0.17±0.05 % study period. The carbohydrate content was higher in males at post monsoon (0.17±0.05 %) and lesser in females at summer (0.12±0.08 %) (Table 1).

The lipid content of the *C. feriatus* varied between was ranging from 0.69 ± 0.17 % to 1.21 ±0.24 % during the study period. The maximum lipid contents of 1.21 ±0.24 % and 1.13±0.15 % were detected in female and male respectively during post monsoon seasons. The minimum lipid contents of 0.69 ±0.17 %, 5.15 % and % were recorded in female and male respectively during summer seasons (Table 1).

The ash content of the *C .feriatus* different between were ranging from 4.11± 0.49 % to 4.97 ±0.08 % during the period. Ash content was maximum in females at post monsoon (4.97±0.08 %) and males at summer (4.55±0.27 %) than males at post monsoon (4.46±0.78 %) (Table1).

The seasonal variation of moisture content of the *C .feriatus* fluctuated between 69.23 ± 1.23 % - 78.24±2.89 %. The moisture content was maximum in males at summer (78.24±2.89 %) followed by females at summer (74.17±2.79 %). The moisture content was minimum in females at post monsoon (69.23 ±1.23 %) followed by males at post monsoon (71.13±2.11 %) (Table1).

3.3. Fatty acids profile

The fatty acid profiles in the muscle tissues of the *C.feriata* are presented in table 2. The saturated fatty acids were ranging seasonal wise from 29.17 to 36.69 %.Six saturated fatty acids were reported in the present study, Myristic acid(C 14:0); Pentadecylic acid (C 15:0); Palmitic acid (C 16:0); Margaric acid (C 17:0); Stearic acid (C 18:0); Lauric acid (C 20:0) were recorded in the present study. Among major fatty acids palmitic acid (18.12±0.57 %) contribution was maximum at post monsoon followed by stearic acid (10.87±0.61 %) and margaric Acid (6.01±0.21 %). All saturated fatty acids were uniformly shown higher values in females at post monsoon (36.69±1.51%) followed by males (34.35±1.43%) (Table2). Six monounsaturated fatty acids were reported in the present study, Tetradecenoic acid(C 14:1n7); Palmitoleic acid (C16:1n7); Palmitvaccenic acid (C 16:1n5); Oleic acid (C 18:1n9); Gondoic acid (C 20:1n9); Paullinic acid (C 20:1n7) were recorded in the present study. The monounsaturated fatty acids were ranging seasonal wise from 25.92 to 28.39 %.Oleic Acid (C18: 1n9) was the most abundant fatty acid.

Nine polyunsaturated fatty acids were recorded in *C. feriatus*. Sebaleic acid 5,8-Octadecadienoic acid 18:2(n-10) Linoleic acid (C 18:2n6); α-Linolenic acid (C 18:3n3); Dihomolinoleic acid (C 20:2n6); Dihomo-α-linolenic acid (C 20:3n3); Timnodonic acid (EPA) (C20:5n3); Arachidonic acid (C 20:4n6); Clupanodonic acid (C22:5n3); Cervonic acid (DHA) (C22:6n3) were recorded in the present study. Timnodonic acid (EPA) (C20:5n3) were abundant in male and females followed by Dihomo-α-linolenic acid (C 20:3n3). The seasonal variation of PUFA content of the *C. feriatus* fluctuated between 27.63±3.11 - 34.40±2.56 %. All polyunsaturated fatty acids were uniformly shown higher values in males at post monsoon (34.40±2.56 %) minimum in females at summer (27.63±3.11 %) (Table 2).

Table 1. Proximate composition in the muscle tissues of male and female *C.feriatus*with respect to Seasonal variations and cooked muscle (Values are expressed in % on dry weight basis except moisture (Values are mean of three values ± SD).

Contents	Male							Female						
	Seasonal variations (Raw)				Cooked muscle			Seasonal variations (Raw)				Cooked muscle		
	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled
Protein	19.14± 1.86	20.62± 1.14	21.62± 1.42	14.21±1.32	22.15 ±1.12	20.16 ±1.14	16.97 ±0.97	21.61± 1.64	23.21± 1.36	25.28 ±1.39	16.43 ±1.87	25.89 ±1.12	23.82 ±1.85	19.08 ±1.22
Carbohydrate	0.15± 0.09	0.16± 0.06	0.17± 0.05	0.12 ±0.05	0.18 ±0.09	0.16± 0.06	0.15 ±0.08	0.16± 0.03	0.17 ±0.05	0.14 ±0.07	0.12 ±0.08	0.15 ±0.08	0.14 ±0.03	0.13 ±0.08
Lipid	0.97± 0.19	1.06± 0.36	1.13± 0.15	0.87 ±0.25	1.18 ±0.19	1.16± 0.12	1.04 ±0.14	0.73± 0.12	0.87 ±0.11	1.21 ±0.24	0.69 ±0.17	1.24 ±0.81	1.29 ±0.51	1.00 ±0.18
Ash	4.23± 0.42	4.28± 0.06	4.46± 0.78	4.55 ±0.27	4.39 ±0.87	4.01± 0.56	3.95 ±0.79	4.11± 0.49	4.12 ±0.58	4.97 ±0.08	4.19 ±0.44	4.95 ±0.87	4.61 ±0.54	4.55 ±0.27
Moisture	73.11± 2.36	74.11± 2.45	71.13± 2.11	78.24±2.89	71.78 ±2.18	69.78± 2.65	66.12 ±1.98	71.23± 3.11	72.23 ±2.47	69.23 ±1.23	74.17 ±2.79	68.90 ±1.22	66.89 ±2.97	65.59 ±2.44

Pre. M: Pre Monsoon, Mon: Monsoon, Pos. M: Post Monsoon, Sum: Summer

Table 2. Fatty acid profile (%) of *C. feriatus* (Values are mean of three values ± SD)

Fatty acids	Male							Female						
	Seasonal variations (Raw)				Cooked muscle			Seasonal variations (Raw)				Cooked muscle		
	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled
C 14:0	0.34±0.07	0.36±0.04	0.42±0.06	0.26±0.03	0.41±0.04	0.39±0.05	0.35±0.07	0.36±0.09	0.39±0.04	0.43±0.02	0.31±0.05	0.42±0.04	0.40±0.08	0.37±0.04
C 15:0	0.6±0.02	0.5±0.02	0.9±0.03	0.4±0.02	0.8±0.03	0.6±0.01	0.5±0.01	0.79±0.16	0.76±0.05	0.82±0.07	0.61±0.04	0.81±0.09	0.77±0.06	0.72±0.03
C 16:0	16.56±0.30	15.10±0.25	16.96±0.40	15.16±0.63	16.78±0.52	16.67±0.48	16.53±0.23	18.79±0.19	17.93±0.35	18.12±0.57	17.12±0.37	18.19±0.62	17.39±0.14	17.04±0.19
C 17:0	5.26±0.49	5.21±0.67	5.69±0.42	4.12±0.49	5.35±0.28	5.16±0.24	4.76±0.54	5.11±0.43	5.99±0.32	6.01±0.21	5.61±0.31	6.18±0.21	6.02±0.73	5.92±0.53
C 18:0	9.14±0.67	9.02±0.53	9.97±0.47	8.97±0.72	9.86±0.56	9.17±0.32	8.91±0.32	10.07±0.86	9.60±0.62	10.87±0.61	9.08±0.36	10.74±0.81	10.01±0.86	9.42±0.36
C 20:0	0.34±0.08	0.30±0.01	0.41±0.05	0.26±0.02	0.40±0.04	0.38±0.04	0.34±0.06	0.39±0.05	0.31±0.02	0.44±0.03	0.30±0.06	0.43±0.06	0.39±0.07	0.33±0.02
SFA	**32.24±1.53**	**32.26±1.52**	**34.35±1.43**	**29.17±1.91**	**33.06±1.47**	**32.37±1.14**	**31.9±1.23**	**35.51±1.78**	**34.98±1.40**	**36.69±1.51**	**33.03±1.19**	**36.77±1.83**	**34.98±1.94**	**33.80±1.17**
C 14:1n7	0.19±0.03	0.18±0.04	0.20±0.04	0.16±0.02	0.21±0.02	0.19±0.03	0.19±0.04	0.21±0.03	0.19±0.04	0.20±0.05	0.19±0.04	0.20±0.06	0.16±0.03	0.13±0.01
C16:1n7	6.38±0.26	6.48±0.32	6.86±0.29	6.02±0.76	6.84±0.62	6.21±0.89	5.76±0.87	6.24±0.39	5.87±0.57	6.78±0.47	6.04±0.51	6.28±0.44	6.21±0.31	5.84±0.92
C 16:1n5	0.97±0.05	0.94±0.05	1.07±0.15	0.97±0.07	1.05±0.18	0.93±0.02	0.91±0.05	0.92±0.07	0.92±0.07	0.92±0.07	0.92±0.07	0.92±0.07	0.92±0.07	0.92±0.07
C 18:1n9	18.34±1.09	18.44±1.12	18.87±1.23	18.04±1.12	18.67±1.23	18.61±1.21	18.67±1.23	19.29±1.08	19.32±1.06	19.68±1.08	19.16±1.30	19.69±1.13	19.21±1.15	19.09±1.00
C 20:1n9	0.43±0.07	0.49±0.09	0.49±0.05	0.41±0.07	0.49±0.03	0.46±0.04	0.44±0.03	0.39±0.08	0.38±0.02	0.43±0.03	0.39±0.06	0.42±0.13	0.33±0.08	0.31±0.06
C 20:1n7	0.38±0.06	0.39±0.05	0.39±0.07	0.32±0.06	0.40±0.05	0.38±0.06	0.37±0.05	0.29±0.04	0.31±0.06	0.38±0.09	0.25±0.04	0.34±0.06	0.29±0.03	0.26±0.05
MUFA	**26.69±1.56**	**26.92±1.65**	**27.88±1.82**	**25.92±2.10**	**27.66±2.13**	**26.78±2.25**	**26.34±2.27**	**27.34±1.69**	**26.99±1.82**	**28.39±1.79**	**27.31±2.02**	**27.85±1.76**	**27.12±1.67**	**26.55±2.11**
C 18:2n6	2.13±0.15	2.14±0.16	2.57±0.11	2.11±0.17	2.61±0.19	2.04±0.18	1.95±0.13	1.29±0.09	1.22±0.04	1.35±0.07	1.18±0.04	1.36±0.12	1.39±0.12	1.29±0.07
C 18:3n3	0.59±0.09	0.53±0.05	0.53±0.07	0.51±0.03	0.60±0.10	0.57±0.12	0.55±0.13	0.67±0.05	0.65±0.06	0.72±0.13	0.59±0.05	0.71±0.08	0.74±0.05	0.68±0.09
C 20:2n6	0.46±0.04	0.46±0.04	0.46±0.04	0.46±0.04	0.46±0.04	0.46±0.04	0.46±0.04	0.38±0.06	0.39±0.08	0.42±0.04	0.36±0.06	0.42±0.07	0.41±0.06	0.38±0.09

C 20:3n3	5.67±0.38	5.68±0.27	5.89±0.29	4.85±0.21	5.74±0.28	5.61±0.42	5.57±0.61	5.35±0.84	5.39±0.75	5.85±0.81	5.22±0.73	5.91±0.86	5.98±0.64	4.93±0.69
C20:5n3	11.35±0.86	11.47±0.92	11.93±0.67	10.83±0.81	11.95±0.49	11.83±0.89	11.31±0.72	10.37±0.93	10.41±1.07	11.62±1.32	10.21±0.95	10.97±0.98	10.64±0.85	10.35±0.74
C 20:4n6	0.57±0.08	0.59±0.05	0.63±0.07	0.52±0.05	0.67±0.07	0.58±0.12	0.51±0.11	0.35±0.04	0.32±0.08	0.34±0.08	0.35±0.06	0.35±0.09	0.35±0.49	0.33±0.02
C 22:2n6	1.87±0.67	1.74±0.72	1.94±0.62	1.64±0.53	1.91±0.68	1.92±0.62	1.85±0.48	1.32±0.11	1.45±0.18	1.53±0.16	1.22±0.13	1.56±0.18	1.54±0.31	1.12±0.25
C 22:5n3	0.76±0.08	0.77±0.15	0.76±0.08	0.78±0.06	0.75±0.12	0.76±0.14	0.72±0.13	0.81±0.05	0.81±0.14	0.89±0.05	0.69±0.13	0.89±0.15	0.82±0.22	0.72±0.08
C22:6n3	9.25±0.68	9.28±0.52	9.69±0.61	8.92±0.49	9.65±0.58	9.27±0.31	9.23±0.51	8.11±0.56	8.21±0.72	8.94±0.62	7.81±0.96	8.81±0.57	8.64±0.18	8.33±0.78
PUFA	**32.65±3.03**	**32.66±2.88**	**34.40±2.56**	**30.62±2.39**	**34.34±2.55**	**33.04±2.84**	**32.15±3.86**	**28.65±2.73**	**28.85±3.12**	**31.66±3.28**	**27.63±3.11**	**30.98±3.10**	**30.51±2.94**	**28.13±2.81**
n-3PUFA	27.62±2.09	27.73±1.91	28.83±1.72	25.89±1.60	28.69±1.57	28.04±1.88	27.73±2.09	25.31±2.43	25.47±2.74	28.02±2.93	24.52±2.82	27.29±2.64	26.82±1.94	25.01±2.38
n-6PUFA	5.03±0.94	4.92±0.97	5.60±0.84	4.73±0.79	5.65±0.98	5.00±0.96	4.77±0.76	3.34±0.87	3.38±0.38	3.64±0.35	3.11±0.29	3.69±0.46	3.69±0.98	3.07±0.43
n-3/n-6	1.86±0.64	2.05±0.35	1.97±0.63	4.48±0.58	1.48±0.36	3.25±0.41	2.47±0.85	2.54±0.35	2.86±0.93	2.21±0.67	3.42±0.58	2.41±0.72	2.67±0.82	2.38±0.74
EPA+DHA	19.62±1.49	20.75±1.44	21.62±1.28	19.72±1.30	21.60±1.07	21.09±1.20	20.54±1.23	19.48±0.17	18.62±1.79	20.56±1.94	18.02±1.91	19.78±1.55	19.28±1.03	18.68±1.52
Unidentified	8.51±2.47	8.16±1.64	7.31±2.53	9.23±2.34	7.62±2.69	7.81±1.96	10.12±2.43	8.39±1.89	8.47±2.63	7.68±3.26	9.37±3.69	7.86±2.74	7.87±2.63	9.63±2.65

[Myristic acid(C 14:0); Pentadecylic acid (C 15:0); Palmitic acid (C 16:0); Margaric acid (C 17:0); Stearic acid (C 18:0); Lauric acid (C 20:0); Tetradecenoic acid(C 14:1n7); Palmitoleic acid (C16:1n7); Palmitvaccenic acid (C 16:1n5); Oleic acid (C 18:1n9); Gondoic acid (C 20:1n9); Paullinic acid (C 20:1n7); Sebaleic acid 5,8-Octadecadienoic acid 18:2(n-10) Linoleic acid (C 18:2n6); α-Linolenic acid (C 18:3n3); Dihomolinoleic acid (C 20:2n6); Dihomo-αlinolenic acid (C 20:3n3); Timnodonic acid (EPA) (C20:5n3); Arachidonic acid (C 20:4n6); Clupanodonic acid (C 22:5n3); Cervonic acid (DHA) (C22:6n3)] Pre. M: Pre Monsoon, Mon: Monsoon, Pos. M: Post Monsoon, Sum: Summer

3.4. Amino acid profile

The seasonal changes in amino acid content of *C.feriatus* are depicted in Table 3. Totally 9 essential amino acids and 8 non-essential amino acids were recorded in the present study. The result of the present study revealed that the percentage of non-Essential amino acid (73.54±4.39 mg/g to 90.36±4.11 mg/g) was more than that of Essential amino acid (70.71±5.82 mg/g to 95.63±4.81 mg/g). In general lysine was abundant and tryptophan was minimum in the present study. Total essential amino acids were maximum in females at post monsoon (95.63±4.81 mg) followed by males (83.92±5.52 mg). Arginine was uniformly maximum in all seasons. However, Cystine was minimum in all animals irrespective of the both sex and seasons. Total non-essential amino acids were maximum in females at post monsoon (90.36±4.11 mg) rather than males (84.26±4.91 mg). The present study showed higher concentration of amino acids in post monsoon followed by monsoon and pre monsoon seasons while lower concentrations were observed in summer.

3.5. Minerals

The seasonal changes in mineral content of *C. feriatus*maleandfemale are depicted in Table 4.. Totally 11 minerals are reported in the present study.(Sodium> Potassium >Magnesium >Calcium> Iron > Strontium > Manganese >Zinc > Bromine > Copper > Cadmium > Mercury > Arsenic). All minerals were reported in both sexes at post monsoon. Sodium was maximum and copper was minimum in both sexes. Cadmium, mercury and arsenic were available in trace amount in both sexes. The present study showed maximum content of mineral in pre monsoon followed by monsoon, post monsoon and the minimum content was recorded during summer season.

3.6. Biochemical composition in cooked muscle

The present study clearly depicts that the *C. feiatus*has the ability to holds its nutrient levels even after cooking by boiling and steaming. Steaming method is an added advantage to hold the nutrients of major protein, amino acids, fatty acids and minerals even contents after cooking. Hence Steaming method is advisable for better consumption (Table 1-4).

4. Discussion

The swimmer crab *C .feriatus* had a higher meat yield and total edible yield than other crab species with compatible yield data, such as the green crab, *Carcinusmaenas* (Naczk*et al.,* 2004), Chinese mitten crab, *Eriocheirsinensis* (Chen *et al.*, 2007; Wu *et al.,* 2007b) and blue swimmer crab, *Portunuspelagicus* (Wu *et al.*, 2010).

In general, biochemical composition of the whole body indicates the quality of fish. It has been reported that the maximum values of the principle constituents *viz.,* moisture an average 78.93%, protein 74.33%-88.35% and lipids 3.82%-4.07% in crabs (Chen *et al.,* 2007; Maulvault*et al.*, 2012).

Carbohydrate was found to form a minor percentage of the total composition of the muscle. In the present study, the variations found in the seasonal composition of carbohydrates ranged from 0.12 ±0.05 % - 0.17±0.05 % and was in negligible quantity. In the present investigation, the enhanced amount of carbohydrates were observed in the monsoon and this was correlated with the findings made by Ansari *et al*. (1981) who reported that the carbohydrates of many sea animals are mainly composed of glycogen and changes in the carbohydrate level may be due to the accumulation of glycogen at different stages.

Table 3. Amino acids (mg/g) in male and females of *C. feriatus* (Values are mean of three values ± SD)

Amino acids	Male							Female						
	Seasonal variations (Raw)				Cooked muscle			Seasonal variations (Raw)				Cooked muscle		
	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled
Alanine	9.42±0.15	9.73±0.29	10.61±0.41	9.31±0.24	10.84±0.37	10.21±0.65	9.54±0.41	10.34±0.65	10.72±0.43	11.08±0.82	9.92±0.81	11.39±0.60	11.48±0.67	10.94±0.70
Arginine	16.75±0.89	16.36±0.75	17.32±0.80	15.63±0.72	17.48±0.84	16.95±0.70	16.71±0.52	16.84±0.87	17.46±0.80	18.86±0.70	16.48±0.59	18.84±0.93	18.76±0.58	17.91±0.69
Aspartic acid	12.43±0.51	12.82±0.58	13.07±0.94	12.11±0.59	13.85±0.62	13.22±0.71	12.08±0.69	13.47±0.55	14.07±0.76	14.55±0.51	13.96±0.72	14.49±0.72	14.43±0.45	13.89±0.58
Cystine	1.63±0.14	1.78±0.19	2.31±0.15	1.12±0.17	2.67±0.14	2.43±0.31	1.82±0.64	1.84±0.64	1.89±0.54	2.07±0.62	1.54±0.71	2.24±0.41	2.10±0.47	1.56±0.37
Glutamic acid	20.03±0.43	20.45±0.52	22.40±0.67	19.71±0.71	22.85±0.79	22.08±0.85	20.38±0.63	22.49±0.65	22.81±0.66	24.69±0.63	21.06±0.58	24.63±0.71	24.08±0.78	22.30±0.68
Histidine	4.62±0.84	4.81±0.90	4.62±0.54	4.23±0.79	4.79±0.44	4.58±0.87	4.03±0.34	3.34±0.19	3.21±0.27	3.67±0.24	3.02±0.12	3.73±0.24	3.62±0.18	3.20±0.17
Proline	5.73±0.39	5.29±0.51	6.85±0.76	5.54±0.65	6.79±0.89	5.92±0.49	5.53±0.22	6.24±0.63	6.45±0.59	8.35±0.51	6.00±0.63	8.29±0.70	7.94±0.70	6.29±0.70
Serine	6.08±0.31	6.52±0.54	7.08±0.64	5.89±0.52	7.21±0.58	7.05±0.52	6.83±0.41	5.84±0.37	5.95±0.43	7.09±0.08	5.52±0.61	7.14±0.32	7.23±0.33	6.56±0.86
NEAA	**76.69±3.66**	**77.76±4.28**	**84.26±4.91**	**73.54±4.39**	**86.48±4.67**	**82.44±5.01**	**76.69±3.86**	**80.40±4.55**	**82.00±4.48**	**90.36±4.11**	**77.50±4.55**	**90.75±4.51**	**89.64±4.16**	**82.65±4.75**
Tyrosine	6.90±0.22	6.87±0.35	8.37±0.46	6.07±0.53	8.02±0.34	7.93±0.52	7.15±0.44	7.37±0.37	7.53±0.47	8.35±0.68	7.11±0.46	8.37±0.52	8.27±0.46	7.90±0.32
Isoleucine	7.43±0.64	7.46±0.71	9.05±0.81	6.97±0.82	8.91±0.61	8.72±0.68	7.96±0.78	8.36±0.47	8.40±0.61	9.64±0.81	8.21±0.59	9.82±0.68	9.67±0.55	8.70±0.67
Leucine	13.06±0.54	13.36±0.68	13.98±0.73	13.06±0.54	13.93±0.47	13.59±0.67	13.18±0.41	17.24±0.52	17.64±0.69	19.82±0.47	16.74±0.93	19.94±0.88	19.24±0.82	18.04±0.84
Lysine	13.87±0.58	13.60±0.56	14.89±0.78	13.90±0.50	14.66±0.98	13.81±0.59	13.80±0.75	16.26±0.29	16.32±0.34	16.87±0.27	16.07±0.34	16.86±0.57	16.68±0.63	16.27±0.38
Methionine	5.23±0.62	5.27±0.78	6.29±0.67	5.25±0.45	6.27±0.63	6.31±0.42	5.08±0.21	5.44±0.49	5.48±0.53	5.95±0.31	5.21±0.48	5.97±0.40	5.43±0.38	4.94±0.39
Phenylalanine	7.09±0.62	7.24±0.35	8.07±0.63	6.90±0.57	8.09±0.72	8.00±0.29	7.89±0.71	8.37±0.78	8.58±0.67	9.96±0.75	8.28±0.66	9.78±0.59	9.73±0.89	8.90±0.08
Threonine	7.51±0.49	7.49±0.38	9.05±0.56	6.59±0.38	9.18±0.49	9.10±0.42	8.81±0.46	7.35±0.73	7.78±0.80	8.85±0.70	7.74±0.09	8.78±0.84	8.65±0.82	8.05±0.79
Tryptophan	2.13±0.25	2.16±0.29	2.47±0.40	1.93±0.21	2.39±0.24	2.30±0.22	2.11±0.29	2.36±0.64	2.42±0.71	2.94±0.25	2.05±0.79	2.96±0.82	2.81±0.54	2.26±0.53
Valine	10.22±0.54	10.42±0.70	11.75±0.48	10.04±0.82	11.72±0.53	11.15±0.58	10.68±0.59	11.25±0.59	11.69±0.74	13.25±0.57	11.07±0.42	13.29±0.61	13.00±0.45	12.64±0.62
EAA	**73.44±4.50**	**73.87±4.50**	**83.92±5.52**	**70.71±5.82**	**83.17±5.01**	**80.91±4.39**	**76.66±4.64**	**84.00±5.17**	**85.84±5.56**	**95.63±4.81**	**82.48±4.76**	**95.77±5.91**	**93.48±5.54**	**87.70±4.62**
TAA	**150.1±8.1**	**151.6±8.7**	**168.1±10.4**	**144.2±10.2**	**169.6±9.6**	**163.3±9.4**	**150.1±8.1**	**164.4±9.7**	**167.8±10.0**	**185.9±8.9**	**159.9±9.3**	**186.5±10.4**	**183.1±9.7**	**170.3±9.3**
EAA/ TAA	**0.58±0.04**	**0.61±0.07**	**0.43±0.06**	**0.57±0.08**	**0.39±0.07**	**0.56±0.05**	**0.68±0.11**	**0.46±0.08**	**0.62±0.06**	**0.73±0.06**	**0.42±0.08**	**0.49±0.05**	**0.53±0.06**	**0.44±0.06**

Pre. M: Pre Monsoon, Mon: Monsoon, Pos. M: Post Monsoon, Sum: Summer

Table 4. Minerals composition (mg/100g) in male and female of *C.feriatus*(Values are mean of three values ± SD)

Minerals	Male							Female						
	Seasonal variations (Raw)				Cooked muscle			Seasonal variations (Raw)				Cooked muscle		
	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled	Pre.M.	Mon.	Pos.M.	Sum.	Control Raw (Pos.M.)	Steamed	Boiled
Calcium (Ca)	10.38±0.69	10.42±0.87	10.18±0.86	11.31±0.67	10.25±0.85	9.89±0.64	9.63±0.87	11.32±1.60	11.35±0.95	10.18±0.63	12.35±0.58	10.24±0.67	10.17±0.72	10.12±0.68
Iron (Fe)	1.73±0.26	1.82±0.64	1.64±0.26	1.85±0.26	1.64±0.26	1.37±0.31	1.31±0.43	1.98±0.29	1.71±0.24	1.33±0.16	1.22±0.29	1.38±0.15	1.36±0.14	1.33±0.26
Magnesium (Mg)	14.42±1.31	14.53±1.52	15.94±1.83	16.42±1.31	15.86±1.57	15.97±1.35	15.42±1.71	14.89±1.20	13.52±1.73	14.41±1.42	16.72±1.36	14.85±1.49	14.61±1.85	14.91±1.37
Potassium (K)	24.49±1.38	23.85±1.61	25.73±1.47	24.19±1.49	25.53±1.56	25.83±1.42	25.21±1.58	25.31±1.52	25.97±1.43	24.31±1.22	26.19±1.31	24.86±1.52	24.21±1.34	24.01±1.41
Sodium (Na)	32.18±2.52	31.18±1.61	31.28±2.04	37.18±2.48	31.56±2.61	31.22±2.00	31.18±2.31	33.16±2.42	33.18±2.57	30.36±2.50	35.19±3.36	31.46±2.72	30.96±2.32	29.32±2.72
Zinc (Zn)	0.32±0.09	0.28±0.07	0.32±0.12	0.26±0.08	0.33±0.11	0.31±0.16	0.24±0.14	0.33±0.08	0.32±0.09	0.34±0.07	0.39±0.05	0.36±0.08	0.34±0.06	0.31±0.05
Copper (Cu)	0.15±0.06	0.16±0.08	0.16±0.08	0.14±0.06	0.17±0.07	0.17±0.06	0.15±0.08	0.18±0.05	0.17±0.06	0.18±0.05	0.15±0.07	0.20±0.06	0.19±0.05	0.16±0.04
Manganese (Mn)	1.37±0.16	1.42±0.22	1.39±0.18	1.27±0.32	1.52±0.24	1.32±0.26	1.21±0.17	1.89±0.18	1.67±0.14	1.50±0.17	1.72±0.32	1.55±0.19	1.52±0.16	1.46±0.03
Bromine (Br)	0.36±0.07	0.48±0.04	0.23±0.05	0.21±0.06	0.21±0.08	0.33±0.15	0.13±0.05	0.46±0.05	0.45±0.07	0.46±0.08	0.38±0.09	0.48±0.06	0.49±0.08	0.41±0.09
Strontium (Sr)	1.74±0.35	1.79±0.48	1.62±0.29	1.81±0.37	1.72±0.21	1.42±0.23	1.28±0.20	1.78±0.65	1.74±0.31	1.00±0.46	1.81±0.32	1.08±0.47	1.00±0.36	1.00±0.17
Selenium (Se)	0.08±0.02	0.07±0.03	0.03±0.02	0.08±0.02	0.02±0.01	0.03±0.01	0.02±0.01	0.04±0.02	0.06±0.02	0.07±0.02	0.09±0.02	0.07±0.03	0.08±0.03	0.05±0.02
Mercury (Hg)	--	--	--	--	--	--	--	--	--	--	0.03±0.02	--	--	--
Cadmium (Cd)	0.07±0.04	--	--	0.04±0.02	--	--	--	0.06±0.02	0.07±0.04	0.05±0.03	0.05±0.02	0.06±0.02	0.06±0.03	0.05±0.01
Arsenic (As)	--	--	--	--	--	--	--	--	--	--	0.03±0.02	--	--	--

-- : Not present, Pre. M: Pre Monsoon, Mon: Monsoon, Pos. M: Post Monsoon, Sum: Summer

The proteins content of the *C. feriatus* diversified between16.21 - 25.28 %. This high content was due to its food habits since it mainly feeds on fishes and crustaceans. Identical results were reported in *C. natator* by Sivasubramanian, (2011). Protein are mainly present in muscle, that forms the mechanical tissue intended for mobility and do not participate in metabolism. The maximum protein content was observed in post monsoon season. This may due to the increased availability and consumption of the food. This result was correlated with the report given by Correia *et al*. (2003) in conger eel. The minimum content of protein was recorded in summer and this may be due to the depletion in muscle protein owing to spawning activity. In the present study, the moisture content of *C. feriatus* ranged from 69.23 % - 78.24 %. This was in same line with that of report in *P. sanguinolentus*, *C.natator* and *P. vigil* given by Sudhakar *et al.* (2009); Sivasubramanian, (2011); Soundarapandian *et al.*, (2013a). This quantity is fairly high and is actually related to the high content of lysine and glutamic acid which hold water that results in high elasticity of the flesh of the fish in general (Price, 1971). The maximum moisture content was recorded in summer, which coincided with increase in water salinity. This result was more or less similar with the report in eight species of marine fishes by Abdulrahman and D'Souza (2008).

The present study showed higher concentration of amino acids in post monsoon followed by monsoon and pre monsoon seasons and this result was concurrent with the report of Antunes *et al.*, 2010 in ghost crab *Ocypode quadrata*. Minimum content of amino acids were recorded in summer and after spawning (pre monsoon) amino acids were found to be increased and this report was more or less similar to the report of Antunes*et al.* (2010) in ghost crab *Ocypode quadrata*.

Lipid content is a high-quality index of future survival in some species (Simpkins *et al*., 2003). In the present study, fatty acid concentrations were found to be highest in post monsoon. The fatty acid profile is thus characterized by a dominance of SFA and MUFA, representing 60-70 % of the total fatty acids. SFA and MUFA were recorded in higher concentration in the muscles of marine crab *C. feriatus*. This report was in agreement with the findings of Celik *et al.*, (2004). There was decrease in the amount of total lipid and fatty acid in the muscle tissues during the summer and our result was justified with the report of Castell *et al* .(1972) who suggested that storage of lipids vary during reproduction and nutrition periods since the lipids mobilize from muscles to the gonads for its development.

This result lies parallel with previous studies on fatty acids of marine crabs (Wu *et al.,* 2010). Oleic acid is well known for exhibiting a physiological effect to prevent cancer, autoimmunity and inflammatory diseases, in addition to its ability to facilitate wound healing (Campos *et al*., 2013). Palmitoleic acid was the second major MUFA in the present study. Saglik and Imre (2001) found similar result for European anchovy. The seasonal changes of total PUFA had a considerable effect on the variation of unsaturated fatty acid content, from season to season. Among which the

DHA was found in higher concentration followed by EPA and Arachidonic acid. Both DHA and EPA possess high therapeutic importance (Montori*et al*., 2002).

The total PUFAs were highest in monsoon and lowest in summer. This result was correlated with report of Antunes*et al.* (2010) who found highest level of PUFA in ghost crab *Ocypode quadrata*. *C. feriatus* is thus, a good source of high protein, as well as omega - 3 fatty acids particularly EPA and DHA.

Totally 11 minerals are reported in the present study. (Sodium> Potassium >Magnesium >Calcium> Iron > Strontium > Manganese >Zinc > Bromine > Copper > Cadmium > Mercury > Arsenic). All minerals were reported in both sexes at post monsoon. Sodium was maximum and copper was minimum in both sexes. Cadmium, mercury and arsenic were available in trace amount in both sexes. The present study showed maximum content of mineral in pre monsoon followed by monsoon, post monsoon and the minimum content was recorded during summer season. Previous reports in *C. pagurus* also revealed variations in elemental composition between seasons and different tissues (Barrento *et al.*, 2009b). Moreov er, this species has been highlighted as an important source of Cl, K, Ca, and trace elements such as Fe, Cu, Zn and Se (Barrento *et al.,* 2009b).

During the pre-spawning (post monsoon season), the fatty acid composition was very high because the fish was ready to spawn and also due to increase in nutrients. In the summer season, the content of fatty acid found to have decreased during the generation period. After spawning season there was rise in fatty acid content during the study period, this report was correlated with the result of Kandimer and Polat (2007) in Rainbow trout.

The present study, evaluate the change in nutritional compositional of the crab seasonally and to estimate the healthier cooking method so that it could be better utilized. Consumption of this kinds of crab *C. feriatus* not only harbors a high nutritional value but also indirectly prevent the over exploitation of shell fishes and can conserve the stock for future generations. George *et al*. (1990) noticed that the protein values in cooked crab of *S. serrata* were ranged from 14.43 to 18.96%. The n3/n-6 ratio of boiled crab muscle was generally higher from those observed in raw crabs, as well as lower in PUFA/SFA ratio. Since long-chain fatty acid are often extremely susceptible to oxidation, during the culinary procedures, crabs were exposed to high temperatures, which might have been responsible for the decrease of PUFA content in both cooking treatments (Gladyshev *et al*., 2006).

References

Abdulrahman O. Musaiger and Reshma D‘Souza 2008. The effects of different methods of cooking on proximate, mineral and heavy metal composition of fish and shrimps consumed in the Arabian Gulf. Archivoslatinoamericanos de nutricion 58(1):103- 109.

An, J.Y., S.J. Sim, J.S. Lee and B.K. Kim, 2003. Hydrocarbon production from secondarily treated piggery wastewater by the green algae Botryococcus braunii. Journal of Applied Phycology, 15: 185–191.

Anasri, A., Parulekar, A.H., Motondkar, S.G.D. 1981. Seasonal changes in meat weight and biochemical compositon in the black clam, Villorita cyprinoides (grey). Indian J. Marine Sci., 10: 12– 137.

AOAC , 2005. Official Methods of Analysis.18th Edition, Printed in the United States of America.

Baker, D. H. and Y. Han. 1994. Ideal amino acid profile for broiler chicks during first three weeks post hatching. Poult. Sci. 73:1441-1447.

Banerjee, A., R.S. Harma, Y. Chisti and U.C. Banerjee, 2002. Botryococcus braunii: A renewable source of hydrocarbons and other chemicals. Crit. Rev. Biotechnol., 22: 245-279.

Barnwal, B.K. and M.P. Sharma, 2005. Prospects of biodiesel production from vegetables oils in India. Renew Sustain Energy Rev., 9: 363-378.

Campos H. S., , P. R. Souza , B. Peghini, J. Silva and C. Ribeiro Cardoso, 2013. An Overview of the Modulatory Effects of Oleic Acid in Health and Disease, Mini-Reviews in Medicinal Chemistry, 13(2):1-10.

Castell, J.D., Sinnhuber, R.O., Wales, J.H. and Lee, D.J. 1972. Essential fatty acids in the diet of rainbow trout (Salmo gairdnerii): Growth, feed conversion and some gross deficiency symptoms. J. Nutr., 102: 77-86.

Celik, L., A. Tekeli and O. Öztürkcan. 2004. The effects of supplemental L-carnitine in drinking water on performance and egg quality of laying hens exposed to a high ambient temperature. J. Anim. Physiol. Anim. Nutr. 88:229-233.

Chen, H.P., M. Zhang and S. Shrestha, 2007. Compositional characteristics and nutritional quality of Chinese mitten crab (*Eriocheir sinensis*). Food Chem., 103: 1343-1349.

Correia, A.T., Antunes, C., Isidro, E.J., Coimbra, J., 2003. Changes in otolith microstructure and microchemistry during the larval development of the European conger eel (Conger conger). Mar. Biol. 142, 777–789.

Dubois, M., K. A. Gilles, J. K. Hamilton, P. A. Rebers, F. Smith, 1956. Colorimetric method for determination of sugars and related substances. Anal. Chem., 28, 350–356.

Folch J., Lees M., Sloane-Stanley G.H. (1957): A simple method for the isolation and purification of total lipides from animal tissues. J. Biol. Chem. 226: 497-509.

George, C., K. Gopakumar and P.A. Perigreen, 1990. Frozen storage characteristics of raw and cooked crab (*Scylla serrata*) segments, body meat and shell on claws. J. Mar. Biol. Ass. India. 32(1&2): 193-197.

Gladyshev, M. I., Sushchik, N. N., Gubanenko, G. A., Demirchieva, S. M., & Kalachova, G. S. (2006). Effect of way of cooking on content of essential polyunsaturated fatty acids in muscle tissue of humpback salmon (*Oncorhynchus gorbuscha*). Food Chemistry, 96, 446–451.

Guzman, H.M., Jimenez, C.E., 1992. Contamination of coral reefs by heavy metals along the Caribbean Coast of Central America (Costa Rica and Panama). Marine Pollution Bulletin 24, 554–561.

Kandemir, S. and N. Polat, 2007. Seasonal Variation of Total Lipid and Total Fatty Acid in Muscle and Liver of Rainbow Trout (*Oncorhynchus mykiss* W., 1792) Reared in Derbent Dam Lake. Turkish J. Fisheries Aquatic Sci., 7: 27–31.

Kashiwagi, T.; Kunishima, N.; Suzuki, C.; Tsuchiya, F.; Nikkumi, S.; Arata, Y & Morikawa, K. (1997), The novel acidophilic structure of the killer toxin from halotolerant yeast demonstrates with a fungal killer toxin. Structure .5, 81-94.

Lowry, O.H., N.J. Rosebrough, A.L. Farr, and R.J. Randall (1951) Protein Measurement with the Folin Phenol Reagent. J. Biol. Chem. 193:265-275.

Montori, V. M., Farmer, A., Wollan, P. C. and Dinneen, S. F., 2002. Fish oil supplementation in type 2 diabetes: a quantitative systematic review. Diabetic Care, 23(9), 1407-1415.

Naczk, M., J. Williams, K. Brennam, Liyanaspathiramma and F. Shahidi, 2007. Compositional characteristics of green crab (*Carcinus sapidus*). Food Chem., 88: 429-434.

Price, J.H., 1971. The science of meat and meat products. Ed. Freeman and cy. san Francisco. Fish Technol., 19: 31-41.

Saglik, S. and Imre, S. 2001. n-3-Fatty Acids in some Fish Species from Turkey. Journal of Food Science, 66(2): 210-212.

Sivasubramanian, C., 2011. Nutritional status of commercially important crab Charybdis natator (Herbst, 1794). Ph.D., Thesis, Kuppam University, India, 1-132.

Soundarapandian, P., S. Ravichandran and D. Varadhrajan, 2013. Biochemical composition of edible crab *Podophthalmus vigil* (Fabricius). J. Mar.Sci. Res. Dev., 3(1): 1-4.

Sudhakar, M., K. Manivannan and P. Soundarapandian, 2009. Nutritive value of hard and soft shell crabs of *Portunus sanguinolentus* (Herbst). Internat. J. Ani. Vet. Adv.,1(2): 44-48.

Wu, H.J., L.B. Sun, C.B. Li, Z.Z. Li, Z. Zhang, X.B. Wen, Z. Hu, Y.L. Zhang and S.K. Li, 2014. Enhancement of the immune response and protection against *Vibrio parahaemolyticus* by indigenous probiotic Bacillus strains in mud crab (*Scylla paramamosain*). Fish and Shellfish Immunology, 41: 156-162.

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