Fishery Technology 60 (2023) : 254 - 261

Comparative Study of Biochemical Composition and Nutrient Profile of Four Species of Penaeid Shrimps

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Abstract

The biochemical composition and nutrient profile of flower tail shrimp (*Metapenaeus dobsoni)*, brown shrimp (*Metapenaeus monoceros)*, jinga shrimp (*Metapenaeus affinis)* and kiddi shrimp *(Parapenaeopsis stylifera)* were evaluated. Significantly higher ($p<0.05$) content of crude protein in *M. affinis* (17.84 %) and crude fat in *M. monoceros* (1.78 %) and ash in *P. stylifera* (1.84 %) were observed. Glutamic acid (19.45 to 20.45 %) was the predominant amino acid. Ratio of essential to non-essential amino acids (EAA/NEAA) was 0.74 to 0.89 with highest in case of *M. dobsoni*. Palmitic acid was the abundant fatty acid in all the four species (15.04 to 21.99 %). The content of eicosapentaenoic acid (13.37 to 14.85 %) and docosahexaenoic acid (8.65 to 16.99 %) were significantly higher. The ratio of n-3 and n-6 fatty acids ranged from 0.52 to 1.05. The ratio of polyunsaturated to saturated fatty acids (PUFA/SFA) was highest in *P. stylifera* (1.14), while in the *Metapenaeus* spp. it ranged from 0.54 to 0.82. Atherogenicity index (AI) and thrombogenicity index (TI) were lower, AI values range from 0.53 to 0.68 in *Metapenaeus* spp. and 0.39 in case of *P. stylifera.* TI values of *Metapenaeus* spp. ranged from 0.46 to 0.53 and in case of *P. stylifera* TI value was 0.25. The mineral profile showed rich content of potassium, sodium, calcium and magnesium.

Keywords: Shrimp, fatty acids, amino acids, minerals

Introduction

Shellfishes especially shrimps belong to the larger group of crustaceans form a major share of delicacy among seafood products. Studies indicate the occurrence of 437 species of shrimps and prawns in Indian waters (Radhakrishnan et al., 2012). In case of seafood, shrimp is a heavily traded commodity and contributes second in export in terms of value. The traded price of this commodity has increased over the past years (FAO, 2018). Shrimp landing in India in 2018 includes 1,92,154 tonnes of penaeid prawns and 1,94,011 tonnes of non-penaeid prawns which contribute to 11.1 % of the total landings in India in 2018 (FRAD, CMFRI, 2019) and forms an economically important constituent.

The important species contributing to the fishery of Indian marine waters includes *Metapenaeus dobsoni* (Miers, 1878) commonly known as flower tail shrimp or kadal shrimp, *Metapenaeus monoceros* (Fabricius, 1798) commonly known as brown shrimp or speckled shrimp, *Metapenaeus affinis* (H. Milne Edwards, 1837) commonly known as jinga shrimp and *Parapenaeopsis stylifera* (H. Milne Edwards, 1837) commonly known as kiddi shrimp. *M. dobsoni* is a dominating major species among prawn fishery of southwest and southeast coast of India. *M. monoceros* is a commercially important species captured from backwaters, estuaries and also from 100 m depth of sea. *M. monoceros* is possibly the only species of *Metapenaeus* contributing in the commercial fishery along the whole coast line of India. *M. affinis* is an important commercial species, because of its availability along the entire west coast and the southern east coast. It also has a comparatively larger size. *P. stylifera* is one of the abundant species in the coasts of Gujarat to Kerala, mostly occur at a depth of 90 m. It is confined to the sea water and does not migrate to estuaries and backwaters, which also forms one of the main species in the inshore fishery.

The high popularity of shrimps among shellfishes is due to their unique texture and color. In general, they are rich in digestible proteins, beneficial

Received 30 June 2023; Revised 09 October 2023; Accepted 27 October 2023

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polyunsaturated fatty acids, many vitamins and minerals. Shrimp meat is a rich source of protein as well as good amount of minerals like calcium than finfish (Yanar & Celik 2006). Proximate composition and various nutrient levels can vary depending on the seasons (Yanar et al., 2004). Ozogul et al., (2008) also reported the variations in proximate composition of shellfishes with respect to habitats, season, feed, species, and also spawning cycle. The specific taste and flavor of shrimps makes it a highly preferable item among seafood consumers. The variation in nutritional composition can contribute towards the variation in acceptability of different shrimp species among consumers. The information on nutritional composition of selected species under study such as flower tail, brown, jinga and kiddi shrimps is little. Hence the nutritional composition of these four commonly consumed shrimp varieties were evaluated and compared. The nutritional value of these species can be utilized for developing health beneficial products for different applications.

Materials and Methods

Fresh samples of shrimps were collected from Kalamukku landing centre of Cochin, Kerala in the month of December 2018 (Fig. 1). The samples were immediately iced at 1:1 ratio (shrimp to ice) and transported to the laboratory in insulated boxes. The shrimps were then beheaded, peeled, separated the meat, homogenized and subjected to further analysis in triplicate. The average length and weight of the shrimps are given in Table 1.

Table 1. Weight and length of shrimp species studied

Species	Average weight (g)	Average length (cm)
Metapenaeus dobsoni	13.6 ± 0.51	3.76 ± 0.25
Metapenaeus affinis	25.2 ± 0.38	9.12 ± 0.52
Metapenaeus monoceros	16.82 ± 0.44	6.54 ± 0.2
Parapenaeopsis stylifera	17.5 ± 0.56	7.36 ± 0.33

Standards of fatty acid methyl esters, amino acids were procured from Sigma- Aldrich (Spruce street, St. Louis, USA). ICP standards of minerals were procured from Merck, Germany. Cascada LS water, Lab water technology (Pall Corporation, Port Washington, New York) was used for preparation of distilled water. Analytical grade reagents and solvents were used in this study.

The analysis of proximate composition of shrimp meat included moisture, protein, crude fat and ash. Analyses were carried out as per AOAC (2012) such as moisture content of the sample by oven drying method, crude protein content by Micro Kjeldahl method, crude fat content of moisture free sample by Soxhlet extraction and ash content by incineration of sample using muffle furnace.

Fatty acid profiling of homogenized shrimp meat was carried out as described. Lipid content in the samples was extracted as per Folch et al. (1957). Fatty acid methyl esters (FAME) were prepared and injected into gas chromatogram (Varian, Guindy, Chennai; Model no: CP-3800) for fatty acid profiling using Varian capillary column CP-Sil 88 (100 m length x 0.25 mm internal diameter; 0.20 ìm film thicknesses). A flame ionization detector was used to identify the peaks by comparing retention time with standards. Individual fatty acids were shown as percentage of total fatty acids. Index of atherogenicity (AI) and index of thrombogenicity (TI) were calculated.

The amino acid profiling of homogenized shrimp sample was carried out using HPLC (High Performance Liquid Chromatography) (Shimadzu Prominence, Japan) (Ishida et al., 1981). The sample preparation included digestion of 100 mg of sample in 10 ml of 6 N HCl, under nitrogen in a sealed test tube at 110 ºC for 24 hours. The separation was carried out using Poroshell HPH-C18 column having 4.6 mm diameter, 100 mm length and 2.7 ì particle sizes.

Samples were digested using 8 ml of concentrated HNO_3 (TraceMetal™ Grade, Fisher Scientific) and 2 ml of H_2O_2 (30-32 %, Optima, Fisher Scientific) using a microwave assisted extraction system, Milestone START D (MilistoneSrl., Italy). Mineral profiling of homogenized shrimp sample was carried out using Inductivity Coupled Plasma–Optical Emission Spectrometer (iCAP 6300 Duo, Thermo fisher Scientific, Cambridge, England) with dual configuration (axial and radial). Operational software iTEVA (version 2.8.0.97) was used for elemental analysis.

The analytical data obtained in triplicate is expressed as mean ± standard deviation. Statistical significance of data was determined using one-way analysis of variance (ANOVA) by the statistical software Statistical Package for the Social Sciences, SPSS.16 (SPSS Inc., Chicago, IL, USA). The statistical significance was identified at 95 % confidence level ($p<0.05$). Post hoc analysis was carried out using Duncan's multiple range test.

Results and Discussion

The nutrient content, sensory characteristics and shelf life of shrimp can vary with the proximate composition of individual species, which is decided by different factors such as growth stage, feed and season (Karakoltsidis et al., 1995). Proximate composition of four shrimp species were evaluated and given in Table 2. Moisture, the major component in the homogenized tissue ranged from 78.87 to 79.98 %. Dincer & Aydin (2014) reported moisture content in the range of 77.47 to 78.43 % in male and female jinga shrimps.

Shellfishes contain higher protein content than that of finfishes in general. Among the four different species evaluated, content of crude protein was highest in *M. affinis*. No significant difference in the crude protein content between *M. dobsoni* and *M. monoceros* was observed ($p>0.05$). The reported average protein content in shrimp varied between 17 to 22 g/100g. Sriket et al. (2007) reported higher protein content in the meat of white shrimp than that of black tiger shrimp; as the former has higher stroma proteins and pepsin-soluble collagen. The raw meat of brown shrimp (*Crangon crangon*) from the Black sea was reported with a protein content of 18.5 % (Turan et al., 2011).

There was significant ($p<0.05$) variation in crude fat content among the species and ranged from 1.53 to 1.78 %. *M. monoceros* contained comparatively higher crude fat content than that of other shrimp species evaluated under the study. Sriket et al. (2007) reported crude fat content of 1.23 % and 1.3 % respectively in case of *Penaeus monodon* and *Penaeus indicus*. The fat (%) reported in deep water pink shrimp (*Parapenaeus longirostris),* northern shrimp (*Pandalus borealis)* and brown shrimp (*Crangon crangon)* were 1.13, 1.0 and 1.10 respectively by Schubring (2009). In case of cultured prawn (*Macrobrachium rosenbergii*) percentage of total lipid reported was 3.18 % (Krzynowek & Murphy 1987). Shellfishes have lower crude lipid content in general (upto 2 %), which is lower than other meaty foods. The lipid composition of shrimp contains 65–70 % phospholipids, 15–20 % cholesterol and 10–20 % total acyl glycerols (Dayal et al., 2013) and predominance of phospholipids in shrimp is an indication of its rich nutritional quality, which is essential for cell membrane and transport lipoproteins.

Ash is a minimally studied biochemical component in crustaceans. Ash content showed a significant ($p<0.05$) variation ranging from 1.41 to 1.84 %. Nair & Prabhu (1990) reported ash content in *M. dobsoni* as 15.79 % on dry weight basis. Marginal increase in ash content along with growth were previously reported by Achuthankutty & Parulekar (1984) in *P. stylifera* and *M. affinis* and Ajithkumar (1990) in *Macrobrachium idella*. Schubring (2009) reported an ash content of 0.2 % in deep water pink shrimp and 1.9 % in northern shrimp. Banu et al. (2016) reported the ash content of *M. monoceros* and *M. dobsoni* as 1.54 and 1.48 % respectively. Raw shellfishes contain ash content upto 2 % (Venugopal & Gopakumar 2017).

The fatty acid profiles of four species of shrimps evaluated under the study are given in Table 3. In all the three *Metapenaeus* spp., content of saturated fatty acids (SFA) was higher ranging from 44.97 to 45.84 %, followed by PUFA and mono unsaturated fatty acids (MUFA) in which PUFA was in the range

Table 2. Proximate composition of shrimp species under study

Composition (% Wet weight)	*M. dobsoni*	*M. monoceros*	*M. affinis*	*P. stylifera*
Moisture	79.55 ± 0.26^a	79.98 ± 0.01^a	79.03 ± 0.43^b	78.87 ± 0.28^b
Crude Protein	16.7 ± 0.12^a	16.81 ± 0.08^a	17.84 ± 0.03^b	17.62 ± 0.03^{ab}
Crude Fat	1.53 ± 0.04^a	1.78 ± 0.31^d	1.59 ± 0.06^b	1.62 ± 0.02^c
Ash	1.7 ± 0.2^c	1.41 ± 0.01^a	1.47 ± 0.09^b	1.84 ± 0.04^d

Values are given as mean ± standard deviation, n=3; values in a row with different superscripts indicate significant difference ($p < 0.05$)

Table 3. Fatty acid profile of shrimp species under study (%)

Fatty acids	*M. dobsoni*	*M. monoceros*	*M. affinis*	*P. stylifera*
C6:0 (Caproic acid)	1.96 ± 0.05	1.35 ± 0.03	2.16 ± 0.08	1.96 ± 0.03
C8:0 (Caprylic acid)	2.22 ± 0.01	1.13 ± 0.02	2.17 ± 0.01	2.02 ± 0.01
C10:0 (Capric acid)	1.93 ± 0.03	-	-	1.59 ± 0.05
C11:0 (Undecylic acid)	-	0.85 ± 0.02	-	-
C12:0 (Lauric acid)	-	0.25 ± 0.00	-	0.62 ± 0.01
C13:0 (Tridecylic acid)	1.78 ± 0.04	0.64 ± 0.01	-	1.42 ± 0.01
C14:0 (Myristic acid)	1.79 ± 0.01	3.71 ± 0.03	1.90 ± 0.02	1.78 ± 0.04
C15:0 (Pentadecylic acid)	1.88 ± 0.04	3.87 ± 0.04	2.95 ± 0.03	2.30 ± .02
C16:0 (Palmitic acid)	21.99 ± 0.06	20.54 ± 0.02	20.02 ± 0.05	15.04 ± 0.2
C17:0 (Margaric acid)	1.88 ± 0.05	3.11 ± 0.01	3.20 ± 0.03	2.51 ± 0.01
C18:0 (Stearic acid)	9.85 ± 0.08	9.25 ± 0.03	11.31 ± 0.02	8.26 ± 0.03
C20:0 (Arachidic acid)	-	0.45 ± 0.00	0.76 ± 0.01	-
C21:0 (Heineicosylic acid)	0.44 ± 0.01	0.69 ± 0.01	0.50 ± 0.00	-
Σ SFA	45.72 ± 0.40	45.84 ± 0.2	44.97 ± 0.23	37.5 ± 0.4
C16:1 (Palmitoleic acid)	5.95 ± 0.48	6.64 ± 0.02	3.71 ± 0.01	3.29 ± 0.05
C17:1 (Heptadecanoic acid)	-	1.80 ± 0.01	-	1.41 ± 0.02
C18:1 n-9 (Oleic acid)	6.85 ± 0.08	4.31 ± 0.04	5.89 ± 0.04	8.14 ± 0.07
C20:1 n-11 (Paullinic acid)	2.09 ± 0.05	0.71 ± 0.01	0.69 ±0.01	1.18 ± 0.01
C24:1 (Nervonic acid)	1.03 ± 0.01	1.48 ± 0.02	-	2.07 ± 0.02
ΣΣMUFA	15.92 ± 0.6	14.94 ± 0.12	10.29 ± 0.06	16.09 ± 0.15
C18:2 n-6 (Linoleic acid)	2.33 ± 0.2	1.20 ± 0.05	0.98 ± 0.02	1.59 ± 0.02
C18:3 n-3 (Linolenic acid)	-	-	0.62 ± 0.01	-
C20:2 n-6 (Eicosadienoic acid)	0.54 ± 0.02	0.26 ± 0.01	0.50 ± 0.01	-
C20:3 n-3 (Eicosatrienoic acid)	-	0.45 ± 0.03	1.20 ± 0.03	-
C20:4 (Arachidonic acid) n-6	5.58 ± 0.31	8.28 ± 0.14	0.62 ± 0.01	10.13 ± 0.06
C20:5 n-3 (Eicosapentaenoic acid)	14.85 ± 0.54	18.81 ± 0.23	13.37 ± 0.05	14.67 ± 0.12
C22:6 n-6 (Docosahexaenoic acid)	12.42 ± 0.32	8.65 ± 0.03	16.99 ± 0.10	16.29 ± 0.15
Unidentified peak	1.67 ± 0.01	1.58 ± 0.01	-	3.74 ± 0.02
(ΣPUFA)	35.72 ± 1.8	37.65 ± 0.5	24.28 ± 0.2	42.68 ± 0.4
Σ n-3 PUFA	14.85 ± 0.54	19.26 ± 0.2	15.19 ± 0.1	14.67 ± 0.12
Σ n-6 PUFA	20.87 ± 0.8	18.39 ± 0.21	19.09 ± 0.12	28.01 ± 0.2
Σ n-3/ Ó n-6	0.71	1.05	0.80	0.52
ΣPUFA/ Ó SFA	0.78	0.82	0.54	1.14
AI	0.53	0.68	0.62	0.39
TI	0.53	0.46	0.47	0.25

Values are given as mean ± SD, n=3

of 24.28 to 37.65 % and MUFA was in the range of 10.29 to 15.92 %. Among the three *Metapenaeus* spp, the PUFA content was highest in *M. Monoceros* followed by *M. dobsoni*. Higher SFA content was found in *M. Monoceros* and *M. dobsoni*. While in case of *Parapenaeopsis* spp., the content of PUFA (42.68 %) was higher followed by SFA and MUFA. Dominant SFA fraction of 53.64 (male) to 60.31 % (female) was previously reported in Jinga shrimp (*M. affinis*) by Dincer & Aydin (2014). Brown shrimp (*C. crangon* L) meat also contained 33 % SFA, 22 % MUFA, and 29 % n-3 PUFA. PUFA fraction was dominant fraction in case of black tiger shrimp and white shrimp in the range of 42.2 to 44.4 % (Sriket et al.,

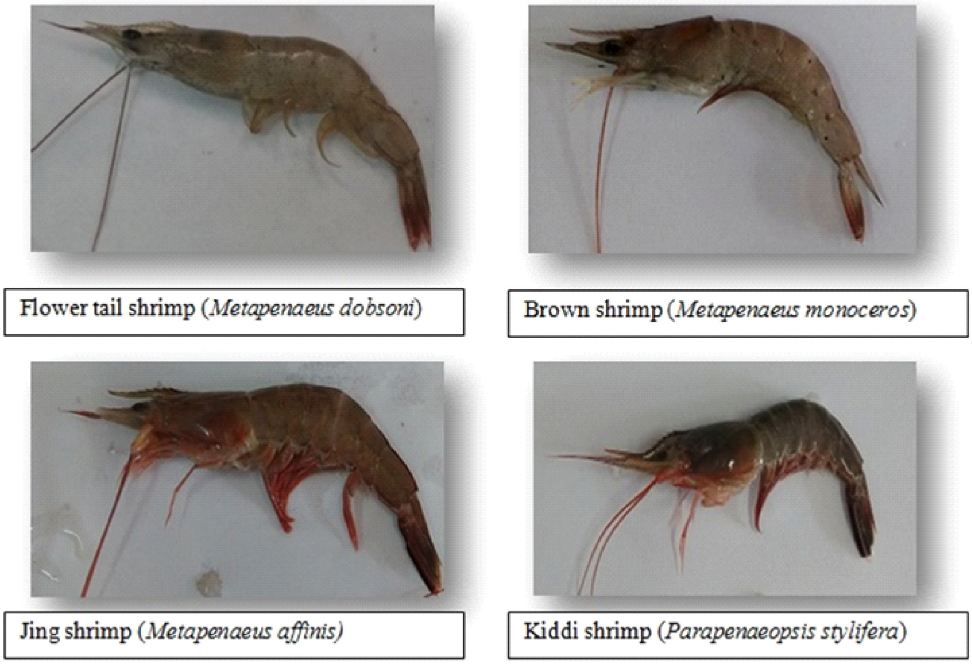

Fig. 1. Shrimp species studied

2007). It was reported that content of PUFA is higher than SFA, and MUFA in shellfishes (Bergé & Barnathan, 2005). The recommended minimum PUFA/SFA ratio is 0.45 (HMSO, 1994) and in the present study all the species demonstrated a much higher-level ranging between 0.54 to 1.14 % with the highest value for *P. stylifera*.

The abundant fatty acid present in all the four species is palmitic acid in the range of 15.04 to 21.99 %. Stearic acid was the second abundant SFA present in shrimp species. Sriket et al. (2007) also reported palmitic acid and stearic acid as abundant SFA in *P. monodon* and *P. indicus*. Medium chain fatty acids namely caproic and caprylic acids were present in all the four species. Presence of capric acid was observed in *M. dobsoni* and *P. stylifera*. Akintola et al. (2013) has first reported the content of this SFA in *P. monodon*. Oleic acid was the dominant MUFA in shrimp species studied except *M. monoceros* and where palmitoleic acid was the major MUFA. Li et al. (2011) also reported oleic acid as the major MUFA in the edible portion in seven shrimps from China. Among PUFA, content of EPA was significantly higher in case of *M. dobsoni* and *M. monoceros* while content of DHA was higher in case of *M. affinis* and *P. stylifera.* Yanar & Çelik (2005) reported EPA and DHA content in the range of 8.3 to 12.6 % and 5.3 to 10.1 %, respectively in *M. monoceros* from eastern coasts of Turkey during different seasons. Rosa & Nunes (2004) reported palmitic acid, stearic acid, EPA and DHA as the most abundant fatty acids in shrimps from Norway.

Pigott & Tucker (1990) recommended n-3/n-6 ratio as a better index for comparing the relative nutritional value of fish oils. A ratio of 1.1 for n-3/n-6 is considered nutritionally optimal (Simopoulos, 1989). The n-3/n-6 ratio was ranging from 0.52 to 1.05 and the ratio was found above 1 only in case of *M. monoceros*. A ratio of 1.60 was reported for *M. monoceros* by Yanar & Çelik (2005). Epidemiological studies reported that eating of seafood, such as shrimp, which are rich in n-3 fatty acids reduce risk of coronary heart diseases (Kris-Etherton et al., 2002; Mozaffarian et al., 2011) and cancer (Murphy et al., 2012).

Ulbricht & Southgate (1991) proposed indices of lipid quality, specifically atherogenicity index (AI) and thrombogenicity index (TI) for the composition of a fat based on effect of fatty acids on serum cholesterol and low- and high-density lipoprotein concentrations. According to these, saturated fatty acids with chain lengths of 12 to 16 C atoms are atherogenic, and unsaturated fatty acids are effective in decreasing atherogenicity. Higher indices indicate cardiovascular pathologies resulting from atherogenic lipid intake. AI values reported for coconut oil - 13 to 20, palm kernel oil - 7, cocoa butter - 0.7, and other vegetable oils - <0.5. AI and TI values are higher than 2.0 in case of milk, butter, and cheese, and in case of meat, AI values range from 0.7 to 1.0, and the TI values from 0.8 to 1.6 (TS EN ISO 15304, 2004). In the present study, AI values of *Metapenaeus* spp. range from 0.53 to 0.68 and in case of *P. stylifera* AI value was 0.39. TI values of *Metapenaeus* spp. range from 0.46 to 0.53 and in case of *P. stylifera* TI value was 0.25. Rosa & Nunes (2004) reported lower AI and TI values in different shrimp species. Akintola (2015) also reported lower AI and TI values in case of Southern pink shrimp (*Penaeus notialis*).

Crustaceans have comparatively higher content of amino acids than finfishes. The amino acid composition of four different shrimp species were analysed (Table 4). The variation in amino acids can contribute towards variation in taste and meat textural properties. Highest content of glutamic acid was observed in all the four species followed by aspartic acid, arginine, lysine, leucine and alanine in that order. Highest glycine content was observed in *P. stylifera* among the four species evaluated. Previously Shamsundar & Prakash (1994) reported highest content of glutamic acid followed by aspartic acid in *M. dobsoni.* Yanar & Celik (2006) and Sriket et al. (2007) also reported amino acid composition in different shrimp species. The most abundant amino acid reported in case of black tiger shrimp and white shrimp was arginine followed by proline, leucine, isoleucine, phenylalanine and glutamic acid (Sriket et al., 2007). Akintola (2015) also reported glutamate, aspartate, proline, lysine, arginine, and glycine as the six most abundant amino acids in Southern pink shrimp (*Penaeus notialis*). Sikorski et al., (1990) reported that sweet taste of shrimps and crabs is due to the rich content of free glycine. Higher content of arginine in shellfishes can enhance the sweetness and provides seafood like flavor (Sikorski et al., 1990). Fuke (1994) reported that alanine, proline and serine play role in the preference of shrimps and lobsters.

The total content of non-essential amino acids (NEAA) was found higher than essential amino acids (EAA) in all the four shrimp species. EAA/NEAA ratio was ranging from 0.74 to 0.89 with highest in case of *M. dobsoni*. The EAA/NEAA ratio reported by Sriket et al. (2007) in black tiger shrimp and white shrimp were 0.7 and 0.67, respectively. The ratios of 0.60 and 0.59, respectively for green tiger shrimp (*Penaeus semisulcatus*) and speckled shrimp (*M. monoceros*) were reported (Yanar & Çelik, 2006). The EAA/NEAA ratio of different fishes was 0.70 while for crab and squid, the value was 0.56 (Iwasaki & Harada, 1985).

Shellfishes contain rich content of minerals in addition to good quality proteins and which include both macro and micro mineral elements. The mineral profile of shrimp meats were evaluated (Table 5). Dominant minerals present in the shrimp meat were potassium and sodium followed by calcium and magnesium. Iron, copper and zinc were also present in comparatively higher level. Heavy metals like cadmium and lead were present in negligible levels. Cobalt content was not detected in all the shrimp meat samples. Dincer & Aydin (2014) similarly reported higher content of potassium and sodium followed by calcium and magnesium in Jinga shrimp (*M. affinis*). Sriket et al. (2007) reported dominant content of magnesium followed by calcium and iron in meats of *P. monodon* and *P. indicus*. Copper ion present in hemocyanin pigment of shrimps can accelerate the oxidation process during handling, processing and storage. Higher content of PUFA also activate the process of oxidation. Major sources of mineral composition are seawater and feed (Ichihashi et al., 2001). The variations observed in the mineral composition of four shrimp species evaluated in the present study could have been due to the variations in the nutrient availability in the water body and also on the ability to absorb and convert the essential nutrients from the diet or the water bodies (Bernard & Bolatito, 2016).

Meats of flower tail (*Metapenaeus dobsoni*), brown (*Metapenaeus monoceros*), jinga (*Metapenaeus affinis*) and kiddi (*Parapenaeopsis stylifera*) shrimps are rich sources of protein with many essential and non-essential amino acids, health beneficial poly unsaturated fatty acids and many important minerals. However, the nutrient composition showed variation between shrimp species. Among the four shrimp species evaluated, content of crude protein was higher in *M. affinis*. *M. monoceros* contained comparatively higher crude fat than that of other shrimp species evaluated under the study. Ash content was found higher in *P. stylifera*. The abundant fatty acid present in all the four species is palmitic acid. Among PUFA, content of EPA was significantly higher in case of *M. dobsoni* and *M.*

monoceros while content of DHA was higher in case of *M. affinis* and *P. stylifera.* High content of glutamic acid was observed in all the four species followed by aspartic acid, arginine, lysine, leucine and alanine in that order. Dominant minerals present in the shrimp meat were potassium and sodium followed by calcium and magnesium. The variation in nutrient composition can be characteristics of respective species. This data would be useful in providing the nutritional labelling while marketing the products from these species and also for selecting the most optimum method of preservation/ processing technique for the product.

Acknowledgements

This research work was carried out with the support of Indian Council of Agricultural Research, New Delhi, India. The authors are sincerely thankful to the Director, Indian council of Agriculture Research-Central Institute of Fisheries Technology (ICAR-CIFT), Cochin for providing facilities and support.

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