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Proximate composition and bioaccumulation of metals in some finfishes and shellfishes of Vellar Estuary (South east coast of India)

G. Marichamy, S. Shanker*, A. Saradha, A.R. Nazar and M.A. Badhul Haq

CAS in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, Tamilnadu

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ABSTRACT

Seven fish samples of different species (Mugil cephaluss, Siganus javus, Etroplus suratensis, Penaeus monodon, Perna viridis, Meretrix casta and Scylla tranguebarica) collected from Vellar estuary, East coat of India were assessed for proximate composition and accumulation of metals. The protein level is varied from 11.81 to 20.34%, likewise Lipid (1.15 to 2.65%), Carbohydrates (2.43 to 6.16%) and Moisture (73.60 to 81.13%). Metals like Co, Cr, Fe, Cu, Mg, Mn, Ni, Cd and Zn were also determined and find in normal level.

Key words: Proximate Composition, Metals, Vellar estuary, Fin fishes and Shellfishes.

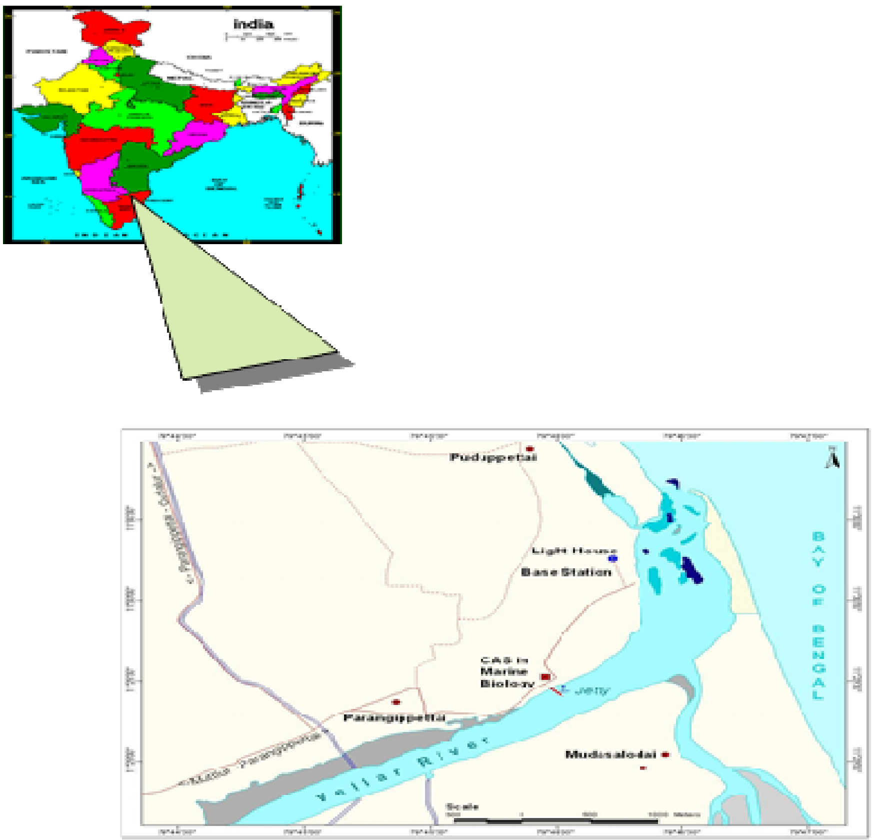
INTRODUCTION

Fish is a major and easily available source of food in nature for mankind. Meat is one of the best source of proteins, vitamins and minerals which are essential nutrients required for proper growth and maintenance [1]. It provides a significant amount of animal protein, fatty acids, minerals and vitamins in the diet of people. Majority of fish usually consists of about 70-80% of water, 20-30% of protein and 2-12% of lipid [17]. However, these values may vary considerably within and between species to species and as well with size, sexual condition, feeding and physical activity. Proteins are fundamental bio molecule in all aspects of cell structure and function. Nutritionally protein is the important constituent of fish. Fish proteins are rich in essential amino acids (EAA) which is easily digestible and nutritionally superior to vegetable protein. Lipids broadly consist of fats; phospholipids, waxes, sterols and sphingomyelins. Lipids of marine origin are source of ω-3 poly unsaturated fatty acids and they have pronounced hypercholesterolemia effect when supplemented in human diet. The lipid content of fish is found to vary from 0.2-30%. The lipid content of the fatty fish may show wide fluctuation at the different stages of growth, maturity, feeding, spawning etc.

The percentage of water is good indicator of its relative contents of energy, proteins and lipids. If lower the percentage of water, greater the lipids, protein contents and higher the energy density of the fish [13]. Carbohydrates are chemically defined as aldehyde or ketone derivatives of higher polyhydric alcohols. Carbohydrates are basically divided into four major groups such as Monosaccharide, Disaccharide, Oligosaccharide and Polysaccharide which are readily available as immediate source of energy. Hence it is called as animal starch.

Among the many pollutants, attention must be focused on heavy metals because of their environmental persistence, toxicity at low concentration and ability to incorporate into food chain of aquatic organism [22 and 16]. Due to the deleterious effect of metals on aquatic ecosystem, it is necessary to monitor their accumulation in fishes. Pollution by heavy metals received a considerable interest after the occurrence of several well published incidents in Japan during 1953. Cadmium is a common contaminant of hazardous waste site and is released from sources such as fossil fuel combustion and municipal waste incineration and as a component of cigarette smoke [12]. What come to known as “Minamata diseases” was due to mercury discharge into the Minamata Bay [21]. During 1960s cadmium related endemic disease known as “Itai-Itai” was wide spread in Japan and the victim suffered from decalcification of bones [23].

Figure – I



Considering the above this study was to evaluate the proximate composition (water, protein, lipids, and carbohydrates) in selected finfish and shellfish from Vellar estuary, Parangipettai and also to estimate the level of metals present in the selected species.

Description of study area

Vellar estuary is situated on the east coast of India (Lat11^{0}29'N, Long 79^{0}46'E). The river originates from the Servarayan hills in Selam district (Tamil Nadu, South India). After flowing a distance of 480km it opens into the Bay of Bengal at Parangipettai. It has a year round connection with open sea. The estuary is subjected to semidiurnal tide with maximum tidal amplitude of about 0.8 m.

MATERIALS AND METHODS

Collection of sample

Specimens were collected from the Estuary and the samples were identified using FAO sheet and field manuals, physical measurements were made for the entire specimens table-I. Samples were handled with cleaned stainless steel equipments. All samples were stored frozen until analysis. Only muscle tissue was analyzed for the determination of proximate composition and trace metals levels. The selected specimens were shown in Figure- II to VIII.

Table I- Specimen collected from Vellar estuary

Sl. No.	Common name	Scientific name	Local name
1	Mullet	*Mugil cephalus*	Madavai
2	Streaked spinefoot	*Siganus javus*	Ora meen
3	Pearl spot	*Etroplus suratensis*	Setthakendai
4	Black tiger prawn	*Penaeus monodon*	Karuppu era
5	Green muscle	*Perna viridis*	Patchai chippy
6	Clams	*Meretrix casta*	Mutti
7	Mud crab	*Scylal tranguebarica*	Kalnandu

Figure -II *Mugil cephalus*

Figure -III *Siganus javus*

Figure -IV ***Etroplus suratensis***

Figure -V ***Penaeus monodon***

Figure -VI ***Perna viridis***

Figure -VII ***Meretrix casta***

Figure -VIII ***Scylla tranguebarica***

Total Protein

The Folin-Ciocalten Phenol method of [20] was used for the determination of the total protein in the tissue. The dried tissue sample weighing 10mg was thoroughly homogenized with 1 ml of de-proteinising agent (10%TCA) by keeping the tube in ice. All samples were centrifuged for 20min at 3000 rpm. The precipitate obtained was used for protein estimation. The precipitate was dissolved in 2ml 1N NaOH and to 1 ml of this solution, freshly prepared 5 ml alkaline reagent was added. This was kept at room temperature for 10min, after which 0.5ml of 1N Folin-Ciocalt reagent was added and mixed rapidly. A standard solution was prepared by using Bovin Serum Albumin (BSA) crystal at a concentration of 0.25-2.5mg/ml from the stock solution, the alkaline reagent and Folin-Phenol reagent was added as in the case of tissue samples. A blank was prepared with 1ml 1N NaOH and treated the same way above. All the test tube was kept for 30min at room temperature and the optical density (OD) of the blue colour developed was measured against the blank at 660nm.

Total Lipids

The lipid content was estimated by the procedure given by [15]. Lipid was extracted from 500mg of powered oven dried tissue with 5ml of chloroform: methanol (2:1) mixture. The filtered extract was taken in a pre weighed beaker subjected to oven dried. Beaker was weighed with lipids the difference in weight was taken as total lipid content and percentage was calculated.

Total Carbohydrates

The total carbohydrate was estimated by Phenol- Sulphuric acid method described by [14]. About 5mg of oven-dried tissue was taken for carbohydrate analysis. This tissue was taken in a test tube and 1ml of Phenol (5%) and 5ml of concentrated Sulphuric acid were added in quick succession. The tube was kept for 30 minutes at 30° C and the optical density of the colour developed was measured at 490nm against the blank.

Water content

The total amount of water content in the fish was estimated by drying a known mass of fish muscle in a hot air oven at 70°C for 24hrs. The difference in weight before and after drying is the amount of moisture present and the result are represented in percentage of wet weight of the muscle.

Trace metals

The analysis of trace metals was carried out using the method suggested by [2]. For this all the reagents used are analytical grade. The sample was digested with concentrated nitric acid. Dissected samples were transferred to a clean beaker. Then 10ml of concentrated Nitric acid was added and the sample was heated using a hot plate for near dryness. Finally 2ml of 1N HNO_3 was added to the residue and the solution evaporated again on the hot plate, continuing until every sample was completely digested. After cooling, a further 10ml of 1N $HNO_3$was added. The solution was then diluted and filtered through a 0.45µm nitrocellulose membrane filter. Determination of the elements in all samples was carried out by ICP- AES (Optima 2100 DV, Perkin-Elmer, USA).

RESULTS

Proximate composition

In the present study the nutritional composition (Proteins, Lipids, Carbohydrates and Moisture content) of the following commercially important edible finfish and shellfish belongs to different genus were analyzed and the results are presented in Table II.

Table II- Proximate composition of fin and shellfishes

Fish Species	Protein (%)	Lipids (%)	Carbohydrates (%)	Moisture (%)
Mugil cephalus	17.68	1.60	3.05	76.68
Siganus javus	18.01	2.50	4.43	73.60
Etroplus surstensis	16.74	1.15	2.43	78.55
Penaeus monodon	20.34	1.40	3.66	74.18
Perna viridis	12.03	2.48	5.62	81.13
Meretrix casta	11.81	2.00	6.16	81.11
Scylla tranguebarica	18.06	2.65	2.71	76.75

The protein value in finfish ranged between 16 to 18 % and was recorded higher in *Siganus javus* (18.01%) lower in *Etroplus suratensis* (16.74%). The lipids value ranged from 1-3% and it was recorded more in *Siganus javus* (2.5%) and found to be less in *Etroplus suratensis* (1.15%). The Carbohydrates value ranged from 2 to 4%. However, the carbohydrate was maximum in the *Siganus javus* (4.43%) and less in *Etroplus suratensis* (2.43 %).

The percentage of protein in shellfish ranged between 12 to 20% and was recorded higher in *Penaeus monodon* (20.34%), lower in *Meretrix casta* (11.81%). The lipids value ranged from 1-3% among the samples and *Perna viridis* was having higher value of 2.48%. The lowest value was reported *Penaeus monodon* (1.4%). The Carbohydrates value ranged from 3 to 6%. However, the carbohydrate was maximum in *Meretrix casta* (6.16%) and less in *Scylla tranguebarica* (2.71%). The total body water content was analyzed by the method as mentioned above which varies between 74 to 81 % in all the cases. The highest water content was observed in *Perna viridis* (81.13%) and the lowest value in *Penaeus monodon* (74.18%).

The study on percentage of protein, moisture, fat and carbohydrates were in good agreement with the work done by [9]. He has reported that the percentage of protein in edible muscles of 20 Indian species was ranging from 8 to 21% in which *Mugil cephalus* was having 15.3% of protein. The moisture content ranged from70 to 89% in all the fishes studied with 79.1% for *Mugil cephalus.* The fat content was reported as 1-15% for all the fishes studied and the reported value for *Mugil cephalus* was 2.2%. [24] observed that the percentage of protein, carbohydrate, and lipids in aqua cultured sea bass (Dicentrarchus labrax) and sea bream (Sparus aurata) was ranging from19 to 20%, 0 to 1% and 6 to 15% respectively.

The present study revealed that different fish group shows difference in their proximate composition. [19] Suggested that several factors like size, ecological, physical, and nutritional status of the fish may affect the proximate composition in the fishes. Even when the samples are taken from the same catch, the composition of fish varies considerably. The small variation in the present study can be attributed to one of the above reasons.

Trace elements

The trace metals concentration in the edible part of three finfish and four shellfish were analyzed. Among the metals, Mg was found in higher concentration in all species studied.

In finfish, the concentration of Co ranged from 0.4-9.0 µg/g and maximum concentration was found in *Etroplus suratensis* (8.56µg/g) and minimum amount was observed in *Mugil cephalus* (0.40µg/g). The amount of Cr was ranged from 33-38 µg/g. It shows higher value in *Siganus javus* (38.52µg/g) and the lower value (33.96µg/g) was same in two species *Etroplus suratensis* and *Mugil cephalus*. The value of Cu varied from 12-25µg/g. The higher concentration was reported in *Etroplus suratensis* (24.92µg/g) and lower in *Siganus javus* (11.84µg/g). The amount of Fe ranged from 268-566µg/g with a maximum found in *Etroplus suratensis* (566.40µg/g) and minimum in *Siganus javus* (268.48µg/g). The value of Mg was various from 1.1-1.4µg/g. its value was reported in highest in *Siganus javus* (1.44mg/g) and lowest were noted in *Etroplus suratensis* (1.15mg/g). The value of Mn was varied from 8 to 39µg/g. The higher concentration was reported in *Etroplus suratensis* (39.44µg/g) lower in *Siganus javus* (8.72µg/g). The amount of Ni ranged from 2.0 to 2.6µg/g with a maximum in *Etroplus suratensis* (2.64µg/g) and minimum in (2.08 µg/g) observed in other two species. The level of Cd was ranged from 0.2-1 µg/g**.** However, the higher value was reported in *Etroplus suratensis* (1.12µg/g**)** the lower value in *Siganus javus* (0.24µg/g). The level of Zn was observed from 31-83µg/g with a higher value reported in *Etroplus suratensis* (83.04µg/g**)** and lower value in *Siganus javus* (31.32µg/g).

In shellfishes, the concentration of Co ranged from 0.5-7.0µg/g with a maximum concentration found in *Meretrix casta* (7.48µg/g) and minimum amount observed in *Penaeus monodon* (0.32µg/g). The amount of Cr was ranged from 26 to 27µg/g. It shows higher value in *Scylla tranguebarica* (27.96µg/g) and the lower value was found in *Meretrix casta* (26.84µg/g). The value of Cu was varied from 23 to 86 µg/g. The higher concentration was reported in *Scylla tranguebarica* (86.56µg/g) lower concentration was noted in *Meretrix casta* (23.96µg/g). The amount of Fe ranged from 253-430µg/g with a maximum found in both *Perna viridis* and *Meretrix casta* (430µg/g) and minimum was observed in *Scylla tranguebarica* (253.24µg/g). The value of Mg was varying from 1 to 2 mg/g. Its value was reported highest in *Scylla tranguebarica* (2.56mg/g) and lowest in *Perna viridis* (1.07mg/g). The value of Mn was varied from 9 to 44µg/g. The higher concentration was reported in *Scylla tranguebarica* (44.64µg/g) lower in *Penaeus monodon* (9.40µg/g). The amount of Ni ranged from 1-2 µg/g where in maximum was found in *Perna viridis* (2.64µg/g) and minimum value (1.44µg/g) was observed in *Penaeus monodon*. The level of Cd was ranged from 0.4-1.4µg/g**.** However, the higher value was reported in *Meretrix casta* (1.12µg/g**)** and lower value found in *Penaeus monodon* (0.40µg/g). The level of Zn was ranged from 61-121µg/g**.** with the higher value reported in Scylla *tranguebarica* (121.4µg/g**)** and lower value in *Penaeus monodon* (61.80µg/g).

Table III- Composition of trace elements in fin and shell fishes

Fish name	Co (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (µg/g)	Mg (mg/g)	Mn (µg/g)	Ni (µg/g)	Cd (µg/g)	Zn (µg/g)
Mugil cephalus	0.40	33.96	13.64	301.00	1.094	20.84	2.08	0.60	81.28
Siganus javus	0.76	38.52	11.84	268.48	1.44	8.72	2.08	0.24	31.32
Etroplus suratensis	8.56	33.96	24.92	566.40	1.15	39.44	2.64	1.12	83.04
Penaeus monodon	0.32	26.96	37.20	272.16	1.512	9.40	1.44	0.40	61.80
Perna viridis	7.28	27.40	24.12	430.00	1.069	35.12	2.64	1.32	68.28
Meretrix casta	7.48	26.84	23.96	430	1.092	35.08	2.60	1.4	70.80
Scylla tranguebarica	0.52	27.96	86.56	253.24	2.564	44.64	2.12	1.00	121.4

DISCUSSION

The present study revealed that concentration of both essential and non essential metals present in the finfish and shellfish showed great variation in their edible part. [17] Suggested that different fish species contained strikingly different metal level in their tissue. This may be related to the difference in ecological needs behavior and the metabolic activities among the finfish and shellfish species. Previous studies also indicated that different fish species from the same area contained different metals levels in their tissue [5]. The metal accumulation in different fish tissues depends on their physiological role, behavior and regulatory ability as reported by [9] and [11]. Bioaccumulation is species dependent and therefore feeding habits and life style can be strongly related to the sediment exposure [10]. The uptake of essential and nonessential metals may occur by respiratory and dietary routes where as dermal route is usually a minimal contributor of exposure due to the often effective barrier provided by the external epithelium.

The concentration of essential metal, such as Cu and Zn in organism tends to be highly regulated compared to nonessential metals. Fish can use different strategies of metal homeostasis to achieve a steady state balance. The mechanism of reducing metal accumulation and toxicity include uptake inhibition, increased elimination and detoxification and storage.

The following authors also revealed that variability of metals in different species depends on the feeding habitats [4], [25] ecological needs, metabolism [7], [6] age, size and length of the fish [3]. In the present study, the data obtained for trace metals in edible part of the selected finfish and shellfish species were in good agreement with the value reported by [8], [10] and [18].

CONCLUSION

Fish is a major source of animal protein and it is also contains vitamins. Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also contains omega fatty acids known to support the good health. Marine foods are very rich source of mineral components. Consumption of fish and other marine product has a major factor in the economy and nutrition of coastal population. India with its 8,118 km long vast coastal line has tremendous potential in terms of marine food resources. Several species of marine and fresh water fish are available for human consumption. A balanced diet is essential for avoid nutritional deffiency disease. So it is very essential to known the biochemical composition and micro nutrient present in the some locally available fishes. Information on their nutrient levels is very scarce. In the present study the determination of proximate composition of some commercially important finfish and shellfish were carried out by using the standard procedure.

In this scenario the present study revealed that the biochemical composition varied considerably in all the fishes. The protein content was highest in *Penaeus monodon* where as lipid content and moisture content was maximum in *Perna viridis* and the carbohydrate value was more in *Meretrix casta* and bio accumulation of trace metals in these fin fishes and shellfishes were clearly known and the accumulation does not surpass the normal level with the reported values of several authors in India and other parts of the world.

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