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BIOACCUMULATION OF TRACE METALS IN TWO SPECIES OF CRABS FROM CHILIKA LAGOON, EAST COAST OF INDIA

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ABSTRACT
The present study was conducted to determine heavy metal concentration (Mn, Fe, Cu and Zn) in body organ of two important species of crab (Scylla serrata and Portunus pelagicus) from Chilika lagoon. The heavy metal concentration observed in the muscles, body carapace and leg carapace. The highest length was 13.2 cm and weight was 238.52 gm observed in Scylla serrata. The highest length and weight of Portunus pelagicus was 8.5 cm and 92.3 gm. The metal concentration of Mn, Fe, Cu and Zn in the leg carapace varied from 4.2 to 5.5 ppm, 16.6 to 18.4 ppm, 5.7 to 9.5 ppm and 152 to 211 ppm dry weight respectively. Similarly the concentration of metals in the muscle were in the range of 3.8 to 5.1 ppm, 14.4 to 17.5 ppm, 4.8 to 7.4 ppm and 129 to 188 ppm dry weight for Mn, Fe, Cu and Zn respectively. Metal concentrations in the body carapace of the above metals varied from 3.8 to 5.3 ppm, 15.2 to 18.2 ppm, 5.8 to 8.6 ppm and 152 to 193 ppm dry weight respectively. The concentration of metals was lowest in the muscle as compared to other organs. Scylla serrata contained higher concentration of metals in the muscle as compared to Portunus pelagicus. There was no correlation between body size and heavy metal concentration. The metal concentration found in the present study was lower to metal concentration levels of crab collected from other parts of the world. Therefore, there is no public health problem if the crabs will consume it.

Keywords: Bioaccumulation, Trace metals, Two crabs, Chilika Lagoon, India.

Contribution/ Originality

This study is one of the very few studies which have been investigated in two edible crabs from Chilika lagoon. The local communities, the star hotels and other consumers will come to know that crab flesh is not having high concentration of the four trace metals for human consumption.

1. INTRODUCTION

Metals occur naturally in the environment. The presence of heavy metals in aquatic ecosystems is mainly from the source of contaminations like natural occurring deposits and anthropogenic activities. Marine pollution is the only one phase of total pollution

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complex that involves land, air, water and outer space. Among various types of marine pollution, heavy metal pollution is gaining much importance in the recent years owing to its hazardous effect on marine organisms. Marine organisms tend to accumulate heavy metals from the environment. In the sea the concentration of heavy metals is very low that they can easily increased by local processes involving water runoff, which are potential sources of ingress of metals into the sea [1]. Heavy metals exhibit an enormous range of chemical reactions, which has closely connected with the biogeochemical cycle in marine environment [2]. Heavy metal pollution has shown to have an adverse effect on ecosystem and the health of many organisms. Due to industrialisation, pollution has increased rapidly. In the result of which a massive amount of domestic wastewater, industrial effluents and agricultural runoff has been transported and discharged into water bodies like sea, lake and estuaries. Such anthropogenic pollutants are main source of heavy metal contaminants in the ocean [3]. Mangroves, estuaries and lakes are the main types of aquatic ecosystems, which are particularly vulnerable to trace metal pollution. For this, the fine sediments of these aquatic environments can easily retain the pollutants. These environments act as sinks for most of the heavy metal contaminants including air-borne pollutants. Many industrial processes produce toxic effluents such as tributyl tin and copper oxides from antifouling paints, which is commonly discharged into open water. In addition to the two main sources of contaminations, heavy metals also passively discharged into aquatic ecosystems from pipes and water tanks, which release Pb, Zn and Cu.

Toxic metals released into marine environment tend to accumulate in sediments and filter-feeding organisms take them up subsequently [4]. The metals entering the aquatic ecosystem may not directly damage the organisms; however, they can deposit into aquatic organisms through the effect of bio concentration, bioaccumulation and food chain process [5, 6]. Heavy metal accumulation in living organisms can have adverse effects on growth and development [7]. In contrast to the non-essential trace metals, the essential metals such as Cu, Zn, Fe and Co have important biochemical functions in the organisms. However, when the heavy metal concentration is too high, the essential heavy metals act as an acutely toxic manner. Thus, in the event of a resulting extended bioaccumulation of heavy metals, the organism may be damaged. The effect of heavy metals on different aquatic organisms is often complex and difficult to interpret. Dissolved oxygen, pH, salinity, temperature influence on the rate of uptake of heavy metals by organisms [8, 9].

There are 34 species of crabs found in Chilika lagoon. Among these, only six important crabs have dominated over global crab trade. Crabs serve as a vital food supplement for protein. Among the crab species, *Scylla serrata* is the important one, which has abundantly found in the Chilika lagoon. It normally grows up to a size of 120-130 mm weighing 0.7 to 1.0 kg. This contributes a major share in Indian crab trade. *Scylla serrata* when contains the heavy metals like As, Ca, Hg, Pb and Se, they effect on degenerative changes in hepato-pancreas and gills. Cyst formation was also found in gills [10]. *Portunus pelagicus* is another species of crab, found in Chilika lagoon. The local people also use it as food. It has not much demand as compared to *Scylla serrata*. *P. pelagicus* grows to a size of 60 to 165 mm and weighing 1.2 – 2.3 kg. Nayak, et al. [11] has carried similar study on heavy metal concentration in prawns and fishes from the Chilika lagoon.

Depending on the importance of the work and future need, our study has focused on the accumulation level of some heavy metals in two species of crabs from Chilika lagoon, East Coast of India.

2. MATERIALS AND METHODS

Chilika lagoon is the largest brackish water lagoon of our country situated between 19°-28′-19°-54′ N latitude and 85°-05′-85°-38′ E longitude. It is present in the East Coast of India stretching over Puri, Khurda and Ganjam districts. The present study has been carried out during the month of July 2012 to June 2013. Two species of crabs were collected from Chilika lagoon with the help of local fishermenand brought to the laboratory, Berhampur University which is about 60 km. Length and weight of crabs were measured and expressed in cm and gm respectively.The muscle (M), body carapace (BC) and leg carapace (LC) were dissected for heavy metal analysis.Samples were kept in separate pre-cleaned petridishes and were dried at 60°C until a constant weight was obtained. Each sample was ground to powder and re-dried. Approximately, 0.5 gm of dry sample was weighed and digested with 10-15 ml of nitric acid at 100°C for 12 hours. Additional nitric acid was added to residue and the solution was evaporated again on a hot plate. Finally, 1 ml of perchloric acid was added and continued until the sample was completely digested. Digested sample was transferred to 100 ml of volumetric flask to make the volume by using the double distilled water. The digested sample was filtered through 0.45 μm Millipore membrane filter and reading was taken by using atomic absorption spectrophotometer. The concentration of Mn, Fe, Cu and Zn were expressed in ppm dry weight.

3. RESULTS

Zinc: The concentration of zinc was found to be highest in leg carapace of *Scylla serrata* during December 2012 being 211 ppm in (Table-1). In *Portunus pelagicus*, the highest concentration of Zn was observed to be 198 ppm in leg carapace during September 2012(Table-2). The lowest concentration level was observed in muscle of *Scylla serarta* during January 2013 being 129 ppm. Similarly, in *Portunus pelagicus* lowest concentration was observed in muscle during April 2013, which was 141 ppm.

Copper: Highest copper concentration was observed in the leg carapace of *Scylla serrata* during December 2012 being 9.5 ppm and lowest was observed during November 2012, which had 5.4 ppm (Table-1). In *Portunus pelagicus*, the highest concentration was observed to be 7.4 ppm in leg carapace and the lowest concentration was found to be4.8 ppm in muscle (Table-2).

Fe: In *Scylla serrata*, the highest concentration was observed to be 18.4 ppm in leg carapace during July 2012while lowest was recorded 14.4 ppm in muscle during April 2013 (Table-1). The highest concentration of Fe in leg carapace of *Portunus pelagicus* was 18.1 ppm and lowest was observed in the muscle being 15.0 ppm (Table-2).

Mn: The concentration of Mn was 5.5 ppm, which was highest found in leg carapace of *Scylla serrata* during June 2013. Similarly, the lowest concentration was 3.8 ppm in muscle (Table-1). In *Portunus pelagicus,* the highest concentration of Mn was recorded 5.4 ppm in leg carapace during May 2013 and lowest observed during February 2013, which had 3.7 ppm (Table-2). So in each of the crab, the heavy metal concentration was found to be more in leg carapace than body carapace and muscle.

4. DISCUSSION

A significant fraction of heavy metals in natural water exists in complex forms together with miscellaneous organic legends, which regulate availability of these metals in the system as nutrients or as toxic agents [12]. It has been reported that there is a direct correlation between metal accumulated by organism and the amount of metal present in the environment [13].

Krishnamurti and Nair [14] worked on concentration of metals in shrimps and crabs from Thane-Basin Creek System, Maharashtra. The sample was analysed for Cu, Zn, Cd, Pb and Ni. Zn level was within a range of 148-644.2 ppm in *Scylla serrata*. Similarly, Cu level was 56.2 – 90.8 ppm. Their result differs from the present study. This may be due to less heavy metal concentration in Chilika lagoon in comparison to the creek, the present result is lower than the result obtained by Krishnamurti and Nair [14] from Thane-Basin Creek. Kumaraguru, et al. [15] has worked on the heavy metals in some marine organisms around Rameswaram Island, India. They analysed the Cu, Zn and Fe in *Scylla serrata* and *Portunus pelagicus.* During their study period, Cu level in *S.serrata* varied from 0.65-0.99 ppm. The Zn & Fe concentration level was 0.32-0.58 ppm and 2.84-4.96 ppm respectively. Similarly, in *Portunus pelagicus,* the concentration level of Cu, Zn and Fe was 16.08-21.01 ppm, 3.92-5.61 ppm and 14.86-20.70 ppm respectively. Their result was too low in comparison to present result. This may be due to more heavy metal concentration in Chilika lagoon than Rameswaram Island.

Nayakl [16] have worked on the concentration of trace metals in some marine organisms along Gopalpur Coast. They analysed the metals like Pb, Zn, Cr and Co in *Scylla serrata* and *Portunus pelagicus.* In the carapace and muscle of *S. Serrata*, Zn level was found to be within a range of 0.086-0.940 ppm and 0.420-0.496 ppm respectively. In *Portunus pelagicus*, the Zn level in carapace was 0.718-0.728 ppm and in muscle 0.291-0.331 ppm. Their result was slightly higher than the present result of Chilika lagoon, which may be due to polluted water of Gopalpur as compared to Chilika lagoon. The results clearly indicated that the concentration of all the four heavy metals analysed were below the prescribed limit for human consumption. Therefore, it is safe to consume the crabs collected from Chilika lagoon.

5. CONCLUSION

Heavy metals are one of the most important pollutants in the natural environment, because of their toxicity. Uptake of metals from polluted water by the organism may differ depending on the ecological need, metabolism and contaminated level. Besides these foods, sediment as well as other environmental factors like temperature, salinity, dissolved oxygen and other interacting agents also affect the uptake of metals in to the body. A long-term study on heavy metals from this area is required for better understanding of the researchers as well as for the local community.

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Table-1. Length, Weight and Concentration of Heavy Metals (ppm dry weight) in *Scylla serrata* collected from Chilika lagoon during July 2012 to June 2013.

Month/ Year	Total Length (cm.)	Total Weight (gm.)	Mn	Fe	Cu	Zn
July 2012	11.5	168.00	M 4.8 BC 4.9 LC 4.6	17.4 17.5 18.4	6.9 7.1 7.2	174 176 184
August 2012	10.56	153.14	M 4.8 BC 4.9 LC 5.1	15.6 18.2 17.1	6.5 6.8 7.2	156 171 182
September 2012	10.54	125.16	M 4.9 BC 4.5 LC 5.0	17.4 18.0 18.2	6.4 6.9 7.5	143 152 164
October 2012	10.8	166.70	M 4.5 BC 5.0 LC 5.4	15.7 17.0 18.2	5.9 6.4 7.7	175 182 192
November 2012	11.54	168.25	M 4.8 BC 4.7 LC 4.9	15.2 17.1 18.3	5.4 6.9 7.2	148 153 185
December 2012	12.42	212.18	M 5.1 BC 4.7 LC 5.4	15.5 16.5 16.6	7.4 8.6 9.5	152 193 211
January 2013	12.0	205.00	M 4.8 BC 5.3 LC 5.4	15.1 15.2 17.0	6.5 8.2 9.3	129 148 152
February 2013	12.2	210.15	M 4.2 BC 4.3 LC 5.2	14.5 16.4 17.2	7.2 7.5 8.3	148 162 179
March 2013	12.5	215.10	M 4.6 BC 4.8 LC 5.0	16.6 16.9 17.5	6.5 6.2 7.5	153 182 198
April 2013	12.7	218.00	M 3.8 BC 4.1 LC 4.5	14.4 15.8 17.6	6.9 7.1 7.9	188 193 210
May 2013	13.0	232.41	M 3.9 BC 4.4 LC 4.9	16.6 17.2 17.5	6.2 7.5 8.2	178 182 198
June 2013	13.2	238.52	M 4.8 BC 5.2 LC 5.5	14.4 16.2 17.8	5.9 7.7 8.2	148 163 178

Table-2. Length, Weight and Concentration of Heavy Metals (ppm dry weight) in Portunus pelagicus collected from Chilika lagoon during July 2012 to June 2013.

Month/ Year	Total Length (cm.)	Total Weight (gm.)	Mn	Fe	Cu	Zn
July 2012	7.8	80.4	M 4.2 BC 4.3 LC 4.8	15.2 16.5 16.8	4.8 5.2 5.7	153 165 170
August 2012	8.2	86.2	M 4.0 BC 4.5 LC 5.1	15.0 17.4 18.0	5.2 5.5 6.3	148 152 165
September 2012	8.0	82.0	M 4.3 BC 4.6 LC 4.7	16.2 16.8 17.2	6.1 6.3 6.6	180 185 198
October 2012	7.5.	78.3	M 4.0 BC 4.2 LC 4.9	17.4 17.8 18.0	6.2 6.8 7.0	148 153 165
November 2012	7.0	70.5	M 4.3 BC 4.8 LC 5.2	15.5 15.8 16.7	4.9 6.3 7.1	179 183 190
December 2012	6.2	58.3	M 4.1 BC 4.2 LC 4.6	17.0 17.3 18.0	5.5 6.1 6.3	155 163 175
January 2013	6.5	62.5	M 4.5 BC 4.8 LC 5.2	17.5 17.6 17.8	6.4 6.5 7.4	143 152 161
February 2013	6.3	60.4	M 3.8 BC 3.9 LC 4.2	15.3 16.0 17.8	5.8 6.2 6.9	171 175 189
March 2013	7.3	71.2	M 4.3 BC 4.6 LC 4.9	15.5 17.3 17.8	6.5 7.0 7.3	182 187 193
April 2013	8.1	85.3	M 3.7 BC 3.8 LC 5.2	16.3 16.9 17.2	5.3 5.9 6.1	141 157 168
May 2013	8.4	89.1	M 5.0 BC 5.2 LC 5.4	17.3 17.8 18.1	6.2 6.5 6.8	159 178 190
June 2013	8.5	92.3	M 4.8 BC 5.2 LC 5.3	16.3 17.0 17.5	5.6 5.8 6.7	168 175 188