Asian Fisheries Science **21**(2008):13-19
https://doi.org/10.33997/j.afs.2008.21.1.002

Asian Fisheries Society, Manila, Philippines

Occurrence of Heavy Metals (Zn, Pb, Cd, Cu and Fe) in the Edible Tissue of *Megalaspis cordyla* of the Coastal Waters of Visakhapatnam, A.P. India

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Abstract

Bioaccumulation of the heavy metals Zn, Pb, Cd, Fe and Cu in the muscle tissue of fish *Megalaspis cordyla* from the waters at Visakhapatnam harbour (St-I) and Gosthani estuary (St-II) has been studied to find out the differences, if there is any, due to pollution of coastal waters of Visakhapatnam caused by industrial effluents. Higher and significant levels of bioaccumulation of the trace metals were observed in the muscle tissues of fish collected at Visakhapatnam harbour, compared to those from Gosthani estuary.The pattern of absorption was similar at both the stations. Accumulation of zinc was high followed by iron, lead, copper and cadmium. Bioaccumulation of these metals was also observed to be affected by the pH of the coastal waters in different seasons of the year.

Introduction

The seas around the world hold rich, varied and diverse flora and fauna with great potentials to feed the ever growing human population. With the increasing deterioration of the environmental quality caused by pollution through industrial, agricultural, municipal wastes etc., the productivity of the aquatic ecosystems is being challenged. Research has

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shown that organisms such as finfish and shellfish exposed to pollutants are capable of accumulating the compounds in their tissues. At high levels these compounds pose a threat not only to the fish themselves but also to the humans consuming fish from such contaminated areas. The occurrence of Minimata disease, caused by consumption of mercury contaminated shell fish and fin fish collected from Minimata Bay and Itai-Itai disease caused due to consumption of the cadmium contaminated foods in Toyoma Bay in Japan, paved the way to the increased concern over the metals present in the environment and their transport through the different trophic levels in an ecosystem. The rich coastal habitats of India are being threatened among other things, by deforestation of mangroves and also pollution from land based sources such as industries, ports etc. Present investigation is aimed at finding out the extent of bioaccumulation of the heavy metals zinc, lead, cadmium, iron and copper in the edible tissue of the fish *Megalaspis cordyla* (Linnaeus) inhabiting the coastal waters of Visakhapatnam.

Materials and Methods

Study sites

Visakhapatnam is situated on the east coast of India midway between Kolkata and Chennai ports at 17°41’34’’ N and 83°17’45” E (Fig. 1). The present industrial landscape of Visakhapatnam was formed only during the last 40 years and is genuinely the outcome of the modern harbor. The coastal waters of Visakhapatnam receive the fresh water discharge of Mehadrigedda stream via the harbor. The surroundings of inner harbor are influenced by thr rapid growth of industries such as Coromandel Fertilizers, Hindustan Zinc Ltd., Hindustan Polymers, Hindustan Petroleum Corporation Ltd and a number of large workshops under the Visakhapatnam Port Trust. The effluents from these industries are drained into the inner harbor aside from the domestic sewage of the city. All these pollutants gradually enter the coastal waters of the outer harbor (St-I) where a fishing harbor has also been constructed in 1982.

Bheemili situated at about 30 km north-east of Visakhapatnam, was a flourishing sea port for sometime during the late 19th and early 20th centuries with an offshore anchorage and the mouth of river Gosthani serving as the entrance channel for light cargo boats during high tide and is devoid of industries (St-II).

Fresh samples of *M. cordyla* were collected at regular monthly intervals by employing a fisherman from both the Stations for a period of one year. A total of 183 males and 271 females from St-I and 224 males and 228 females were collected from St-II. After collection the fishes were brought to the laboratory and washed with metal free double distilled water. Prior to analysis the fish were preserved in deep freeze at a temperature of 20°C. The length of the fish were measured and recorded in centimeter scale. *M. cordyla* length 15.1 - 25.0 cm in size, were used for analysis.

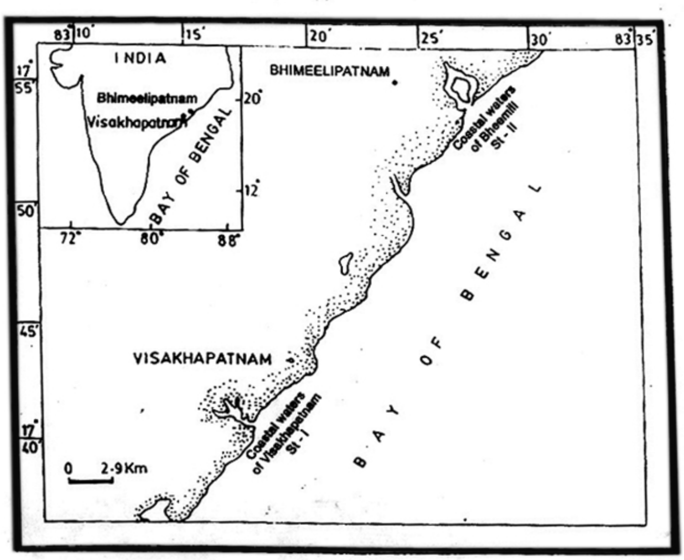


Fig. 1. Location map of study areas, ST-I and St-II.

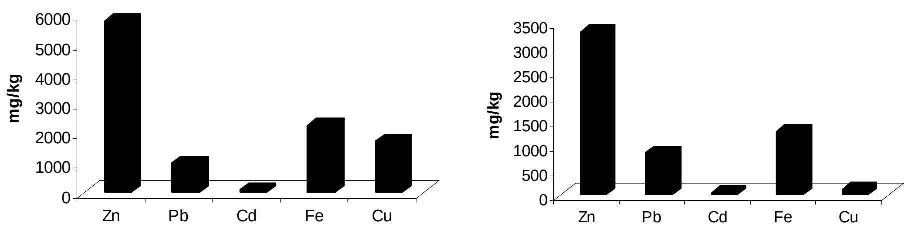
*Tissue digestion and estimation of heavy metal*s

The muscle tissue was removed from the fish and was dried at constant temperature of 80°C for 48 hr. Dried samples if individual tissues were ground into fine powder using Teflon glass homogenizer. One gram of the sample was taken in a silica crucible and ashed in a muffle furnace at 600°C for five hours. The ash so obtained was digested with concentrated nitric acid, perchloric acid and sulphuric acid. Following the digestion, the samples were allowed to cool down and dissolved in 1N nitric acid and made up to 10ml with triple distilled water. Standard solutions of Zn, Pb, Cd, Fe and Cu were obtained from SRL chemicals. 1, 2, 5 and 10 ppm were prepared by diluting from the 1000 ppm stock solution for each of the heavy metals to prepare a calibration curve. Determination of heavy metal concentration was carried out using atomic absorption spectrophotometer (GBS Avanti Model)

The data of heavy metal contents in the muscle tissue of *M. cordyla* from the two stations was subjected to student's 't' test of significance.

Results and Discussion

From the results (Fig. 2), it is clear that the muscle tissue of *M. cordyla* has some accumulation of the heavy metals Zn, Pb, Cd, Fe, and Cu. The statistical parameters of heavy metals in muscle tissue of *Megalaspis cordyla* from St-I and St-II are given in table 1. From the results it is evident that the concentration of the heavy metal is higher at St-I compared to St-II and is significant (Table 't'value-1.79588). The bioaccumulation of zinc in the muscle tissue of *M. cordyla* ranged between 176 and 1086 mg/kg at St-I and 153 and 515.2 mg/kg at St-II ('t' value= 2.33526); lead ranged between 16.6 and 272 mg/kg at St-I and 14.3 and 241 mg/kg at St-II ('t' value= -0.58449) ; cadmium ranged between 4.0 and 9.6 mg/kg at St-I and 0.1 and 3.7 mg/kg at St-II ('t' value= 9.47640); iron ranged between 28.3 and 380.3 mg/kg at St-I and 4.5 and 260.8 mg/kg at St-II ('t' value = 5.00544) and copper ranged between 6.0 and 885 mg/kg at St-I and 0.0016 and 0.0188 µg/g at St-II ('t' value= 3.68021). Bioaccumulation of zinc was higher followed by iron, lead, copper and cadmium. Samples from both the stations showed the same pattern of accumulation.



St-1 St-II

Fig. 2. Concentration of heavy metals in muscle tissue of *Megalaspis cordyla* from St-I and St-II

The bioavailability of a chemical in a fish is its ability to permeate through the gill membrane (Gobas and Russel 1991) and get selectively accumulated in different parts of the body. Fish tissues are mostly unable to metabolize the pollutants because they lack efficient systems for depuration of heavy metals and are stored as metallotheneins (Bryan 1976) which seem to protect the fish tissues to some degree from their toxic action. It is clear that the occurrence of the heavy metals in the muscle tissue of *M. cordyla* at St-I is significant, except for lead, since fishes are known to accumulate very little lead in edible tissues (Philips and Russo 1978). Chen et al. (2000) stated that Hg and Zn concentrations in fish get biomagnified whereas Pb and As get bio-diminished through the food chain. Studies on heavy metal accumulation in different organs of an organism are important to understand the extent of the accumulation in an organism (Evans and Lasenby 1983). Deb and Fukushima (1999) stated that gills, intestine and digestive glands have relatively high potential for metal accumulation. Similarly studies of Jackim et al. (1970) showed that, of the various tissues analyzed, gills and liver were seen to accumulate more heavy metals, while the muscle showed the least accumulation in an organism.

Table -1. Statistical parameters of heavy metals in muscle tissue of *Megalaspis cordyla* at St-I and St-II

Metal	Parameter	Muscle (mg kg^{-1})	
		St-I	St-II
Zinc	X	484.7	277.4
	STD	309.9	173.2
	C.I.	309.3-660.0	179.3-375.4
Lead	X	72.5	66.2
	STD	89.0	94.8
	C.I.	22.1-122.9	8.6-116.0
Cadmium	X	6.7	1.0
	STD	1.9	1.3
	C.I.	5.6-7.8	0.2-1.7
Iron	X	189.9	108.6
	STD	127.5	98.4
	C.I.	117.7-.262.0	52.9-164.3
Copper	X	33.4	8.3
	STD	2.7	5.4
	C.I.	18.1-48.7	5.3-11.4

X - Mean; STD - Standard deviation; C. I. – Confidence Interval.

This study further reveals that the accumulation of heavy metals in the muscle tissue is influenced by the pH of water and is higher during the summer months (Premonsoon period). Studies made by Lewis and McIntosh (1986), showed that accumulation of heavy metals is comparatively higher at low pH values. In the present study the accumulation of heavy metals was high during summer months, when the pH of the waters was low and hence high solubility of the metals in water and a greater uptake by the fish from its surrounding medium (Geisy and Weiner 1977).

The values of bioaccumulation of heavy metals are found to be low in the muscle tissue of *M. cordyla* compared to the reports of the other workers who had studied the bioaccumulation of the metals in different organs of different species. Environmental pollutants at very low concentrations in nature and through laboratory experiments have shown to interfere with basal metabolism in fish (Allen 1995). Thorough laboratory investigations confirmed the findings of adequacy of fish as the principal source of protein. Fishes have a major role in elemental compartmentalization and flux in certain aquatic systems (Kitchell et al. 1975) because of their significant pathway for transport of toxic substances. Heavy metal uptake and concentration in food chains, especially those terminating in human beings are topics of renewed interest, largely due to several instances of human intoxication that occurred with Hg, Cd and Pb. This study indicates that the occurrence of heavy metals in the edible tissues of fish capable of causing health hazards to the consumer deserves special attention. As such the coastal waters of Visakhapatnam might pose a threat in due course to the fish and fishery of *M. cordyla*.

Acknowledgement

The authors are thankful to the Head, Department of Zoology and the authorities of Andhra University for the facilities provided. The last author is thankful to the Council of Scientific and Industrial Research for the financial assistance provided during the study.

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Received October 14, 2006; Accepted December 9, 2006