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RESEARCH ARTICLE

Bioaccumulation of Heavy Metals(Zn, Pb, Cd and Ni)in Tissues of*Metapenaeus dobsoni* (Miers, 1878) from Uran Coast, Raigad District, Maharashtra.

Leena N. Meshram, Sunil. M. Udawant, P. S. Mishra
Department of Zoology, Mahatma Phule Arts, Science and Commerce. College, Panvel,
Dist. Raigad, Maharashtra, India.

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***Corresponding Author**

Leena N. Meshram.

Abstract

The importance of shrimps as a food is primarily because of its unmatched nutritional qualities. *Metapenaeus dobsoni* (Miers, 1878) is commercially important seafood species.However rapid industrialization and urbanization have caused pollution of aquatic ecosystems to a great extent, which could lead to bioaccumulation of heavy metals in tissues of shrimp. Consumption of such shrimps may lead to the harmful effectson human health. The present study aimed to determine the extent of bioaccumulation of heavy metals (Zn, Pb, Cd and Ni) in hepatopancreas, gill, carapace, and muscle of *Metapenaeus dobsoni* from the Uran coast, Raigad district, Maharashtra using Inductively Coupled Plasma Atomic Emission Spectrophotometer. Zinc level in hepatopancreas, muscle, carapace and gill was33.5ppm, 23.537 ppm, 9.697 ppm and 23.1975 ppm respectively.Lead level in hepatopancreas, muscle, carapace and gill was 0.25ppm, 0.0926ppm,0.11 ppm and 0.1885 ppmrespectively. Nickel level in the hepatopancreas, muscle, carapace and gill was 0.2396 ppm, 0.041ppm,0.0406ppm and 0.0675ppm respectively.Cadmium level in hepatopancreas, muscle, carapace and gill was0.0256 ppm, 0.0106ppm,nil and 0.017 ppm respectively. The study showed that these metals were present in the samples at different levels but within the permissible limits.
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Introduction:-

Shrimp by their abundance and their high nutritional value are heavily exploited (Benkabouche-Bekadja, 2009). India earned $2.84 billion from seafood exports in 2010-11. India is rich in natural shrimp resources and nearly 52 species of shrimp are contributed in fishing. Of these, 8 shrimp species are economically important. *Metapenaeus dobsoni* is one of the important constituents of capture fisheries.

Heavy metals have contaminated the aquatic environment in the present century due to intense industrialization and urbanization.Several human activities that may result to water pollution include agriculture, irrigation, fire, mining and industrialization (Goudie, 1990). Pollution of aquatic ecosystems by heavy metals is an important environmental problem (Rayms-Keller et al., 1998, Wang et al., 2009). Environmental pollution in urbanized countries has deteriorated the quality of the water (Zhao et al*.,* 2011). During the last decade, various studies have shown that sea water and sediments of industrialized coastal regions are considerably contaminated by heavy metals (Wang et al., 2009, Fournier, 2005). Therefore, heavy metal contamination is still an environmental problem today in both developing and developed countries throughout the world (Wang et al., 2009).

Metals generally enter the aquatic environment through atmospheric deposition, erosion of geological matrix or due to anthropogenic activities caused by industrial effluents, domestic sewage and mining wastes (Reddy et al., 2007). The discharge of these wastes without adequate treatment often contaminate the estuarine and coastal water with pollutants like heavy metals, many of which bio-accumulate in the tissues of resident organisms.Due to their toxicity and accumulation in biota, determination of the levels of heavy metals in commercial fin fish and shell fish species has received considerable attention in different countries in the region and around the world (Krishnamurti and Nair 1999, Girija et al., 2007, Barrento et al., 2009, Zhao et al., 2011, Meshram et al., 2014). The shellfish is also the major exportable item of India and therefore contributes to the economy of the country. Hence, it is important to investigate the levels of heavy metals in these organisms to assess whether the concentration is within the permissible level and will not pose any hazard to the consumers (Krishnamurti and Nair, 1999).

Reports on heavy metal concentration in shrimps under natural conditions for coastal waters of India are limited. The growing rate of anthropogenic waste input into the Uran coast leads to bioaccumulation of heavy metals in biota and their levels in economically important crustaceans and fishes have become a matter of great concern. (Meshram et al, 2014). Hence, the present study was aimed to determine the extent of bioaccumulation of heavymetals (Zn, Pb, Cd and Ni) in hepatopancreas, gill, carapace, and muscle of *M. dobsoni* from the Uran coast, Raigad district, Maharashtra.

Materials and methods:-

Sampling:-

The samples of *M. dobsoni* were collected by trawling in the mid of September, 2014 from the Uran coastal water (18.98˚ N and 73.11˚ E), India. The collected samples were stored in a container, preserved in crushed ice, and brought to the laboratory for further analysis. The samples were identified in the laboratory. Similar sized 20 specimens were sorted out to estimate levelof metals in the hepatopancreas, gill, muscle and carapace.

Analysis:-

The shrimps were washed with double distilled water and dissected to collect hepatopancreas, gills, muscles and carapace. These tissues were kept in hot oven at 110ºC for 24 hrs. for drying. After drying these tissues were stored in clean tissue paper. Then these tissues were weighed and powdered. 0.5 g each of samples were taken into clean dried beaker (100 mL), 5 mL of aquaregiaHCl and HNO_3 (3:1) was then added to the sample for digestion. Few drops of H_2O_2 were then added to clear the solution to pale yellow. The samples were allowed to be evenly distributed in the acid by stirring with a glass rod and then the beaker was place on the heater. The digested sample was filtered through whatman filter paper No-40 into a graduating cylinder and the filtrate was made up to 50 mL using deionized water. A reagent blank was also run simultaneously. Inductively Coupled Plasma Atomic Emission Spectrophotometer was used to estimate the concentration of Zn, Cd, Pb, an Ni in the samples of shrimp. Heavy metals concentrations were expressed as mean±standard error (X±SE) ppm/dry weight.

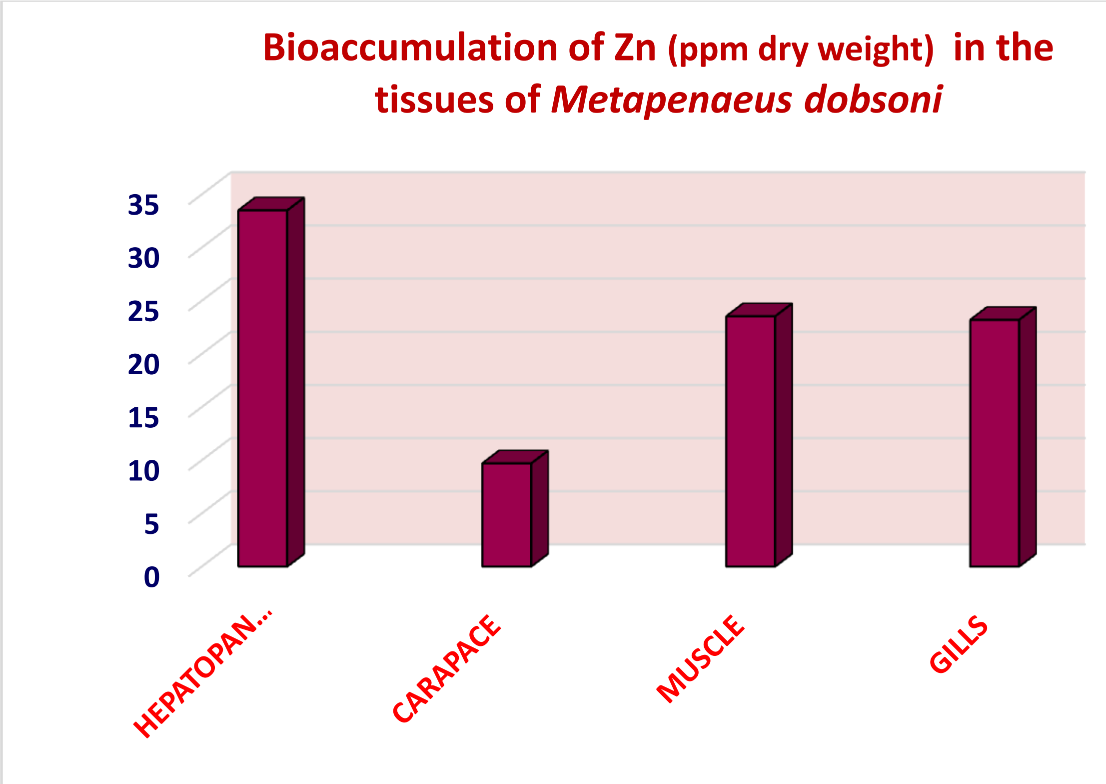
Result:-

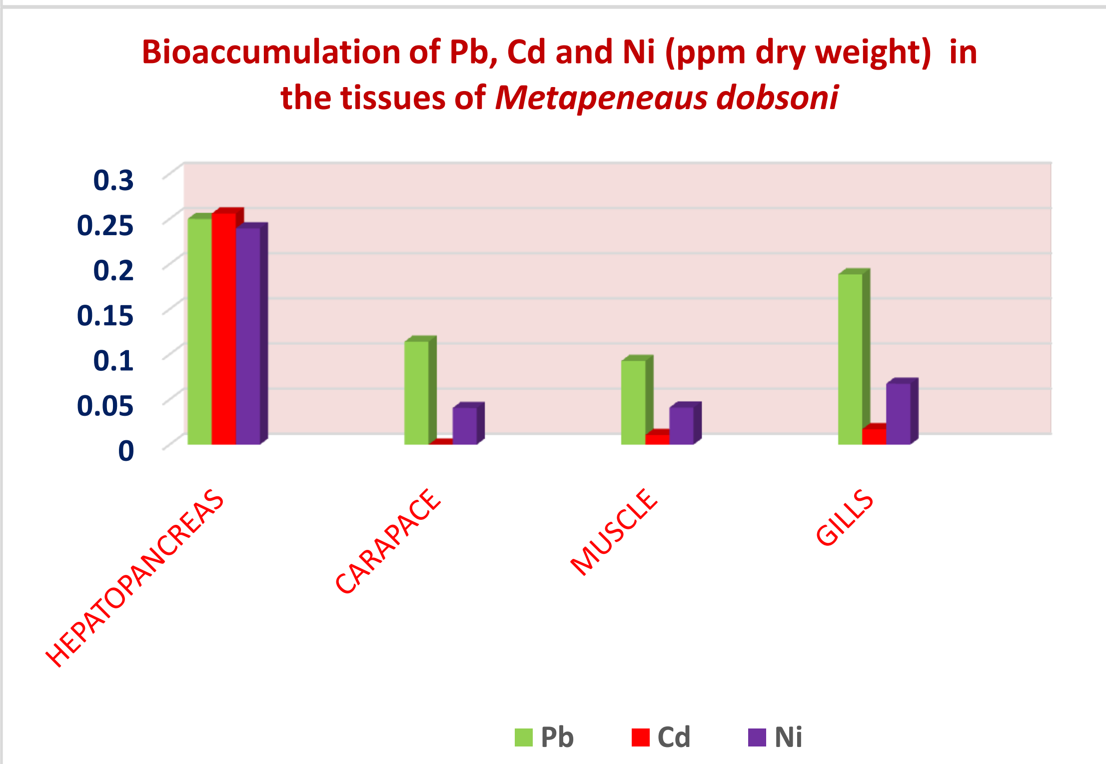
Concentration of zinc, lead, cadmium, and nickel detected in different tissuesof *M. dobsoni* is shown in table 1. Hepatopancreas is the most accumulating tissue of all the four heavy metals among all four tissues in *M. dobsoni*,whereas the carapace showed least accumulation of heavy metals (table 1). Zn was accumulated in largest quantity in all the four examined organs of *M. dobsoni* while Cd was not detected in the carapace.Hepatopancreas contained largest amount of Zn (33.5 ± 5.0281 ppm), followed by Pb, Ni, and Cd as 0.25 ±0.1060 ppm, 0.2396±0.0207 ppm, and 0.0256 ±0.0023ppm respectively in *M*. dobsoni. Carapace contained largest amount of Zn (9.697 ±0.5914 ppm), followed by Pb, Ni, and Cd as 0.114 ±0.0242 ppm, 0.0406 ±0.0055 ppm, and nil respectively in *M. dobsoni*.Muscle contained largest amount of Zn (23.537 ±2.7238 ppm), followed by Pb, Ni, and Cd as 0.0926 ±0.0030 ppm, 0.041 ±0.0045 ppm, and 0.0106 ±0.0005 ppm respectively in *M. dobsoni*. Gill contained largest amount of Zn (23.1975 ±0.0403 ppm), followed by Pb, Ni, and Cd as 0.1885 ±0.0855 ppm, 0.0675±0.0148ppm, and 0.017 ±0.0042 ppm respectively in *M. dobsoni*.

TABLE 1. Concentration of heavy metalsin*M. dobsoni*samples in ppm

	Zinc	**Lead**	**Cadmium**	**Nickle**
HP	**33.5± 5.0281**	**0.25±0.1060**	**0.256±0.0023**	**0.2396±0.0207**
CP	**9.697±0.5914**	**0.114±0.0242**	**ND**	**0.0406±0.0055**
M	**23.537±2.7238**	**0.0926±0.0030**	**0.0106±0.0005**	**0.041±0.0045**
G	**23.1975±0.0403**	**0.1885±0.0855**	**0.017±0.0042**	**0.0675±0.0148**

HP= Hepatopancreas; CP= Carapace; M= Muscle; G= Gill; ND= Not detectable





Discussion:-

The extent of accumulation of trace metals by organisms in different tissues is dependent on the route of entry, that is, either from surrounding medium or in the form of food or chemical form of material available in the media (Ghosh and Kshirsagar, 1973., Maddock and Taylor, 1977). The importance of marine shrimp for environmental monitoring studies as bio-indicators of heavy metal pollution has been emphasized by several investigators (Rainbow, P.S. 1993., Guhathakurta and Kaviraj, 2000; Hashmia et al, 2002; Kargın et al., 2001; Pourang et al, 2004). It was reported by several workers that the discharge of heavy metals into the sea through rivers and streams results in the accumulation of pollutants in the marine environment especially within shrimps (Yusof*et al.*, 1994). Thus, shellfish and shellfish products can be used for monitoring potential risk to humans because these are directly consumed by a large population (Subramanian and Sukumar, 1988). Bioaccumulation patterns of metals in shellfish muscle can be utilized as effective indicators of environmental metal contamination (Atchison *et al.*, 1977; Larsson *et al.*, 1985). Various studies have shown that aquatic invertebrates tend to accumulate high level of heavy metals. Thus, determination of harmful and toxic substances in water sediments and biota gives direct information on the significance of pollution in the aquatic environment (Meshram et al., 2014). Metal accumulation in crustaceans can be realized via two routes; either via hepatopancreas during feeding or via gills Reports on metal concentration in shrimps and crabs under natural conditions for coastal waters of India are limited (Zingde*et al.*, 1976; Matkar*et al.*, 1981; Qasim*et al.*, 1988).

In the present study, heavy metals accumulated in *M. dobsoni is* in the order Zn >Pb> Ni >Cd. Of the four metals studied, Zn is an essential element while Pb, Cd and Ni are non-essential element formost of the living organisms. The concentrations of zinc were relatively higher, compared to the concentrations of other metals in same shrimp samples. It can be explained because Zn is essential element required by animals for metabolic process. Zinc appears to diffuse passively by the gradients created through adsorption of membrane surfaces and are found in blood proteins metallothioneins. Carbonell and Tarazona, 1994concluded that different tissues of aquatic animals provide and/or synthesize nonexchangeable binding sites resulting in different accumulation levels. Romeo *et al.*, 1999 pointed out that the metal uptake from contaminated water and food may differ in relation to ecological needs, metabolism, and the contamination gradients of water, food and sediment, as well as other factors, such a salinity, temperature and interacting agents.Estimated zinc level in the hepatopancreas, muscle, carapace and gill were much lower than the permissible level, *i.e.*, 400 ppm in crustacean tissue (Franklin, 1987) and the permissible limit for human consumption, which is 1000 ppm for prawn (FAO, 1992). Lead is a toxic heavy metal, which finds its way in coastal waters through the discharge of industrial waste waters, such as from painting, dyeing, battery manufacturing units and oil refineries *etc*. These paints are designed to constantly leach toxic metals into the water to kill organisms that may attach to bottom of the boats, which ultimately is transported to the sediment and aquatic compartments. As result indicated, the lead levels in the hepatopancreas, muscle, carapace and gill were below the permissible level which is 4.0 μg/g for crustacean tissue (Franklin, 1987). When compared with the recommended value of WHO (1989) in context to consumption of prawn (2 ppm for Pb), the concentrations in shrimps were below this level.

The nickel and cadmium levels in the hepatopancreas, muscle, carapace and gill are lower than the WHO (1989) recommended value for prawn consumption which is 1 ppm. The main sources of Cd in the present geographical location are electroplating, manufacturing of Cd alloys and of pigments and plastic stabilizers, production of Ni-Cd batteries and wielding. In crustaceans, hepatopancreas has an important role in up taking, detoxification and elimination of metals (Barrento et al., 2009). Many studies have shown that, metal elimination in hepatopancreas takes place more slowly besides muscle tissue (Kalay and Canlı, 1999). In general, the metal concentrations tend to be higher in the hepatopancreas than in muscle tissue (Pourang et al., 2004). Muscle tissue in aquatic organisms is less active in metal accumulation depends on low metabolic activity and thus metal accumulation in muscles of decapods was less in comparison to other tissues (Madigosky et al., 1991). It was also possible that periodic moulting could have helped the shrimp in eliminating Pb and Cd levels from the exoskeleton or less availability of food sometimes might have led to uptake of heavy metal through drinking of water (Soundarapandian et al., 2010). Moulting has often been considered as one of the main excretory mechanisms of crustaceans since large amounts of metals may be lost with the moulted carapace (Viswanathan et al., 2013). Results of the present study indicate similarity with other studies (Barrento et al., 2009, Soundarapandian et al., 2010).Same pattern of accumulation is observed in shrimp and other crustaceans and is in agreement with that of the previous studies (Krishnamurti, 1998; Mitra et al ,2012., Meshram et al., 2014).

Conclusion:-

The result of the study has shown that Zn is the most prevalent metal in the tissues of *Metapenaeus dobsoni* compared to Pb, Cd and Ni.Zn, Pb, Cd, and Ni contents obtained in this study are less than that of international standards (WHO, FDA and EPA standards), thus the consumption of the shrimp is safe, but do not exclude bioaccumulation risk in crustacean meat. For this purpose, the study highlights the need for coastal biomonitoring to avoid possible contamination of shellfish consumers.

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