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ORIGINAL ARTICLE

BIOACCUMULATION OF CADMIUM IN CERTAIN TISSUES OF *MACROBRACHIUM ROSENBERGII*

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ABSTRACT

Environmental toxicants on entering the aquatic medium, accumulates in the water and sediments and consequently accumulates in the tissues of the organisms inhabiting there.cadmium is a toxic element present in the environment commonly, which enters the aquatic animals and accumulate indefinitely in the tissues through the food chain and affect the consumers ultimately. Shrimps are frequently used as bio-indicators in environmental monitoring. In this background, the present investigation was focused towards the bioaccumulation pattern of cadmium in the gills, hepatopancreas and muscle tissues of the giant fresh water prawn, *Macrobrachium rosenbergii*, inhabiting the three chosen stations of Mettur freshwater ecosystem during various months. The highest accumulation of cadmium was observed in the gill tissues followed by that of the hepatopancreas and the muscle tissues respectively. Seasonal variation in the bioaccumulation pattern was also noticed.

Keywords: Bioaccumulation, toxicant, food chain, bio-indicator

1.INTRODUCTION

Freshwater ecosystems are prone to a variety of toxicants that include heavy metals, pesticides, industrial effluents, sewage and many other contaminants from various sources. The nature and extent of pollution occurred to that ecosystem need to be understood in order to protect the inhabiting animals. The above toxicants mixes with water, sediments and ultimately enter the tissues of the inhabiting animals through the food chain, affecting the consumers at large.

Shrimps are frequently used as bio-indicators in environmental monitoring because these species have the ability to accumulate pollutants from their ambient environment. Usually the nature of the pollutant and the level of the pollutant accumulated in the tissues of different organs of such organisms will be addressed to understand the extent of pollution prevailing in that habitat (Abdullah and Moustafa, 2002). Pollution of aquatic environments with heavy metals has seriously increased world wide attention and under certain environmental conditions, shrimps may concentrate large amounts of some metals from the water and sediment in their tissues (Kaoud and Eldahshan, 2010). It is therefore essential to determine the extent of contamination occurred in the tissues of prawns.

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Heavy metals are known as a major source of aquatic pollution and have seriously increased in the recent years. Heavy metals have the ability to accumulate in the biota (Islam and Tanaka, 2004) and there is a general concern about the impact of metals in the aquatic environment (Grosell and Brix, 2005). Metals generally enter the aquatic environment through atmospheric deposition, erosion of geological matrix of due to anthropogenic activities caused by industrial effluents, domestic sewage, nuclear testing and mining wastes (Reddy et al, 2007).

Heavy metals such as cadmium has drawn considerable attention for its great different toxic effects on aquatic biota (Philips and Rainbow, 1994). It can also be potentially harmful to aquatic organisms and have been reported as hazardous environmental pollutants able to accumulate along the aquatic food chain with severe risk for aquatic organisms and human health. Prawns may concentrate large amounts of these metals from water and food in their tissues (Rainbow,1997). Freshwater crustaceans like *Macrobrachium resenbergii* have proved especially useful and could be commonly employed in the monitoring of metal pollution (Culshaw et al. 2002; Jung and Zauke, 2008), because they are normally consumed by human beings.

Although informations are available on the bioaccumulation of metals in crustaceans, no vast data are available on heavy metal levels of *M.rosenbergii*, which is an important food source for human consumption. Because of a wide range of

ecological and biological aspects and their high commercial value, the investigation of the important heavy metal, cadmium accumulation in the gill, hepatopancreas and muscle tissues of *M.rosenbergii* remains a necessary study and hence the present investigation was selected.

2.MATERIALS AND METHOD:

Study area

The study was conducted taking Mettur thermal power station (MPS) as Centre which is located adjacent to the Mettur reservoir. Study points were fixed at distances of about 1.0 km (station I), 3.5 km (station II) in west and east directions respectively and at the main drain shutterpoint (station III).

Bioaccumulation in the tissues

The giant prawn, *M.rosenbergii* was sampled seasonally, four times from January to December, 2013.The samples were placed into sterile bags and transported to the University in an ice cooler to maintain a temperature of approximately 4-5^{0}C. On reaching the laboratory the prawns were washed thoroughly with double distilled water and stored at-21^{0}C until heavy metal analysis.

The dissected gill, heptopancreas and muscle tissues of *M.rosenbergii*, sampled from the three stations of Mettur reservoiur were subjected to bioaccumulation of heavy metal cadmium,. About one gram of each sample was macerated and put in 100 ml of flask. 10 ml of 7:3 mixture of ultrapure concentrated nitric acid and hydrochloric acid were added to the tissue samples. The flask was tightly closed. Thecontent was gently shaken and allowed to stand overnight at room temperature for complete digestion. The flask was warmed at 95^{0}C until completely evaporated and then allowed to cool. The residue was redissolved into 10 ml nitric acid. The resultant solution was filtered through whatman paper No.1. The filtrate was collected in a tube and kept at room temperature until analysed by using atomic absorption spectrophotometer (Perkin-Elmer model-373) and residue levels are expressed as µg/g wet weight of the tissue according to Agemain *et al*.,(1980).

3.RESULTS AND DISCUSSION

The bioaccumulation of cadmium in the gill, hepatopancreas and muscle tissues of *M.rosenbergii*, sampled from three chosen stations of Mettur reservoir during different months are exhibited in figs. 1, 2 and 3. The overall mean cadmium accumulation was the highest in the gill tissues followed by that of the hepatopancreatic and muscle tissues, irrespective of the stations and months studied. Similarly, the months April to June, 2013 accumulated the maximum cadmium in the tissues and the months October to December, 2013 accumulated the minimum cadmium concentration, irrespective of the stations and tissues studied.

Bioaccumulation in the gill

The overall mean accumulation of cadmium was the maximum (1.48 µg/g wet weight of tissue) at station I and the minimum (0.61 µg/g wet weight of tissue) at station III. This clearly indicates that the heavy metal concentration should be comparatively more at station I, is well evident from the results of the present study. It is networthy to mention that the accumulation of metal was higher in the gill tissues when compared with that of the other tissues. The extent of occurrence or 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. Heavy metals may be accumulated by shrimps either through water or food. The more important route of heavy metal concentration in the aquatic biota is through water (Maddock and Taylor, 1977).

The significantly higher concentrations of cadmium in gills have shown that gills may also be an important route for metal efflux (Ever all et al, 1989). The gills function as the major route for uptake of heavy metals and act as a transient store for the accumulated cadmium (Martin and Rainbow, 1998). Several findings further authenticates the present study (Okocha and Adedehji, 2011). Among months, cadmium accumulation was maximum during April to June, 2013 (1.48 µg/g wet weight of tissue) and minimum (0.93 µg/g wet weight of tissue) during October to December, 2013. This indicates the metal was consistently high during the summer months and hence highly available which could lead to a rapid rate of cadmium uptake and accumulation in the tissues.

Bioaccumulation in the hepatopancreas

The bioaccumulation of cadmium in the hepatopancreatic tissues of M.rosenbergii, ranged from (0.47µg/g wet weight) at station III, during October to December, 2013 to 1.23µg/g wet weight at station I, during April to June, 2013. It was reported that the role of hepatopancreas appears to be like that of a "sponge' to mop up excess heavy metals from the blood and keep the level of heavy metals in blood fairly normal (Soundarapandian et al. 2010). Moreover, higher cadmium concentration in the hepatopancreas suggests that this organ plays a major role in metal storage and detoxification process by a metal binding component (Brown, 1982). Furthermore the higher content of cadmium in the hepatopancreas is in agreement with most literature on the metal contents in the tissues of different aquatic organisms, because the hepatopancreas is the major organ for metal accumulation (Frias Espericueta et al., 2009).

In the present study the increased cadmium concentration during April to June,2013 revealed the daily inputs of the effluents which contain toxic metals. The increase in temperature as evident from the present investigation, dissolved solids from April to June months also affect the bioaccumulation of metals in the tissues to some extent.

Bioaccumulation in the muscles

The mean bioaccumulation of cadmium in the muscle tissues of *M.rosenbergii in* the three station of Mettur reservoir during various months, showed significant fluctuation. The overall cadmium level ranged from 0.25µg/g wet weight of tissue at station III during October to December, 2013 to

0.96 µg/g wet weight of tissue at station I during April to June, 2013. It is to be noted that the muscle tissues harboured the lowest level of cadmium when compared with that of the gill and hepatopancreatic tissues. White and Rainbow (1986) obtained lower level of metals in the muscles than in the corresponding hepatopancreas samples. The aquatic organisms usually exhibit high degree of variability in the bioaccumulation of different metals suggesting the need for detailed studies involving more species of economic importance in evaluating the general background and toxic levels for utilizing them as indices of pollution (Soundarapandian et al., 2010).

Fig. 1 Bioaccumulation of cadmium (µg/g wet weight) in the gill tissues of *M.rosenbergii* sampled from the three chosen stations of Mettur reservoir during various months

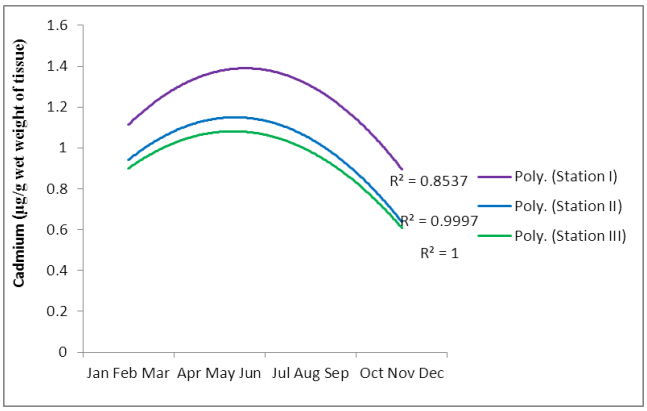


Fig. 2 Bioaccumulation of Cadmium (µg/g wet weight) in the hepatopancreas of *M.rosenbergii* sampled from the three chosen stations of Mettur reservoir during various months

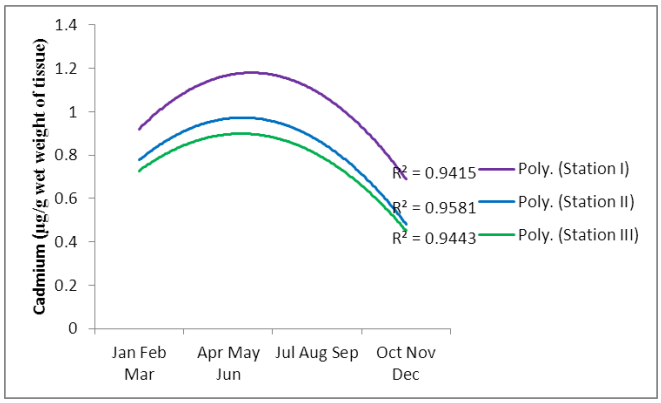
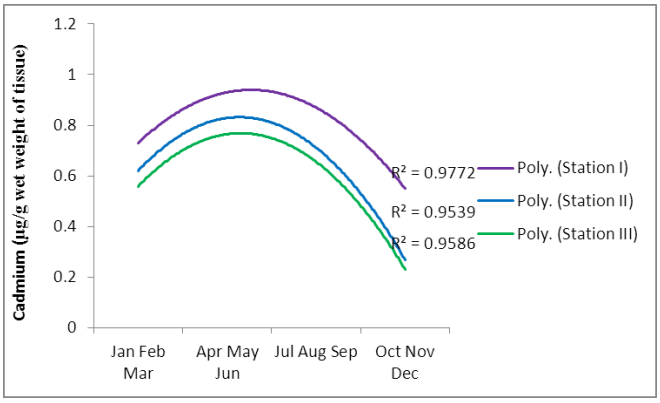


Fig. 3.Bioaccumulation of Cadmium (µg/g wet weight) in the Muscle tissues of *M.rosenbergii* sampled from the three chosen stations of Mettur reservoir during various months



Similarly, the months April to June 2013 harboured more cadmium (0.96µg/g wet weight of tissue) in the muscle tissues and October to December, 2013 had lesser cadmium (0.25 µg/g wet weight of tissue) respectively. As mentioned earlier, increased temperature might have played an important role in the increased cadmium accumulation during the summer months. In the present investigation, it has also been observed that a distinct seasonal fluctuations in the muscle tissues of *M.rosenbergii* Usually the metal concentration was found to be low in monsoon and high during monsoon (Soundarapandian et al., 2010).

4.CONCLUSION

The results of the present investigation indicates that the bioaccumulation of cadmium was in the following order:

Gills >Hepatopancreas> muscles

Further, it was found that station I was highly polluted due to the existence more heavy metal concentration and the consequent higher bioaccumulation in the tissues of the prawns. These elemental toxicants may be transferred to man on consumption of prawns which pose health hazards because of their cumulative effect in the body. Hence of is being suggested that these aquatic animals should be frequently monitored to understand the excessive presence of heavy metals in aquatic environments and to adopt strategies to ensure the safety of aquatic and human lives in future.

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