ECOTOXICOLOGY AND BIOACCUMULATION OF ZINC IN MARINE ORGANISMS

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ABSTRACT

In recent years the coastal waters of India are getting polluted due to increased industrialization and urbanization which has become the major cause for reduction in coastal resources and destruction of natural defence structures. The present research work mainly focuses on protection of marine organisms by developing a Water Quality Criteria (WQC) for zinc on the responses of domestic aquatic biota along the Chennai coast.

A background study was done to monitor the existing pollution status along the coastal area of Chennai. Spatial and temporal variation of water quality and metal concentration of zinc, copper and lead were studied in three stations of Ennore creek, Chennai. Further, the accumulation of heavy metals (Cr, Cd, Cu, Zn, Pb and Ni), in sediment, water and tissue parts of *Mugil cephalus* and *Crassostrea madrasensis,* were studied in different locations of Pulicat Lake.

According to the current study, in Ennore creek, level of metal contamination was found to be high and the creek acts as an efficient trap for anthropogenic heavy metals. Ennore creek is highly polluted with zinc, copper and lead in station II (Creek region) when compared to

other two stations (Bar mouth and Buckingham canal) and the concentration of heavy metals was found to be high during summer in all the three stations.

The heavy metal concentration in water, in Pulicat Lake, were found in the order of Zn>Ni>Cu>Cr>Pb>Cd in both the Lake and bar mouth. While in sediments, in Lake region, the order of heavy metal contamination was observed as Cr>Ni>Zn>Cu>Pb>Cd and the accumulation pattern of Barmouth showed minor variation indicating the following sequential order Zn>Ni>Cr>Cu>Pb>Cd. Considering Fish and Oyster, the accumulation of zinc and copper were found in elevated concentration when compared with other metals, while in tissue parts, liver was found to accumulate more metals in fish and gills accumulated more in oyster.

Acute and chronic toxicity tests were performed to determine the effect of zinc on two fish *(Mugil Cephalus* and *Terapon jarbua),* a mollusc *(Perna viridis),* a crustacean *(Penaeus monodon)* and a phytoplankton *(Coscinodiscus centralis).* From the acute exposure experiments *Mugil cephalus* was found to be most 'tolerant' and *Coscinodiscus centralis* was observed to be most sensitive. Based on the LC_{50} values, the order of tolerance from least to highest for zinc exposure is given below: *Coscinodiscus centralis* < *Penaeus monodon* < *Perna viridis* < *Terapon jarbua* < *Mugil cephalus*

From chronic exposure experiments, it was found that the survival of organisms decreases with increase in zinc concentration. Among the five organisms examined, *Penaeus monodon* found to be more sensitive than other marine species. The tolerance of zinc was found to be in increasing order of *Penaeus monodon* < *Perna viridis* < *Terapon jarbua* < *Mugil cephalus* < *Coscinodiscus centralis.*

Apart from *Coscinodiscus centralis,* the other organisms were exposed to sub-lethal concentrations for biochemical responses. The change in enzymatic activities has indicated the toxic effects of metals in marine organisms. The increase in lipid peroxidation in all organisms indicates oxidative damage to the target tissues due to zinc exposure. The catalase can serve as a better biomarker of oxidative stress to assess and diagnose heavy metal pollution in *Mugil cephalus* and *Perna viridis* than *Penaeus monodon* and *Terapon jarbua.* The activity of glutathione *S* transferase found to decrease significantly in *Mugil cephalus, Penaeus monodon* and *Terapon jarbua,* while it found to increase in *Perna viridis.* The increased activity serves as a protective action against reactive oxygen species. The *Perna viridis* was found to have decreased activity of reduced glutathione, while in other organisms increased reduced glutathione activity was observed. Apart from *Terapon jarbua* other chosen organisms showed a higher acetyl cholinesterase activity. The present investigation recommends the utility of enzymatic and non enzymatic antioxidant responses as a biomarker to assess toxic effects. The study also reveals that, apart from bivalves, prawns and fishes are also found to be efficient bio-indicators.

The 'criterion continuous concentration' (CCC) value obtained from this study can provide useful data to develop Indian water quality standards for metal zinc to protect coastal zone. The water quality criteria, CCC, derived in the present study are primarily based on controlled, laboratory bioassays in which the toxic effects on organisms were measured in terms of the zinc levels in water. Therefore, the purpose of deriving numerical national WQC is to provide adequate protection to ecologically and commercially important species in waters at most times, and to avoid over-protection or under-production which was fulfilled from this research.