ECOTOXICOLOGICAL STUDIES TO ASSESS SAFETY LEVEL OF LEAD (Pb) ALONG THE CHENNAI COAST

HARI HARAN G

NOVEMBER 2013

ABSTRACT

The presence of toxic chemicals in the marine environment has long been recognized as a potential threat to the health of the oceans and coasts. The oceans are the repository for many chemicals of anthropogenic origin. Research in marine toxicology ultimately seeks to monitor and predict the effects of a toxicant and to understand how environmental pollutants might be endangering marine species. The analysis of biological damages (biochemical and histology) in conjunction with other endpoints provides the evaluation of new insights that could help the interpretation of the effects of contaminants on aquatic organisms.

Heavy metal pollution of the coastal environmental is less visible and direct than other types of marine pollution but its effects on marine ecosystems and humans are very extensive. Overall assessment of metal pollution in coastal regions of Chennai reveals that the accumulation of heavy metals has increased in all the environmental matrices viz., water, sediment and biota. Among the metal pollutants, Lead (Pb) is a nonessential metal, ubiquitous in nature and considered toxic to humans and aquatic life.

These toxicity studies closely match with the USEPA protocol for selecting species for toxicity test. The organisms used were *Mugil cephalus* (Grey Mullet) and *Terapon jarbua* (Tiger perch) for marine fish species, *Perna viridis* (Green Mussel) and

Post larval stage 11- 14 of *Penaeus monodon* (Tiger prawn). The test concentrations for the acute and chronic toxicity tests were selected from the range finding tests. The organisms were exposed in the definitive test and prior to the definitive test run, the test organisms were acclimated for 10-14 days in FRP (Fibreglass Reinforced Plastic) tank containing filtered seawater. Continuous Flow through (CFT) method was used consisting of replicates for control and five test concentrations. Samples of the test solutions were analyzed to determine actual concentrations of the toxicant.

In the acute toxicity test, estimation of the 96 h median lethal concentration (LC_{50}) was the test endpoint. The calculated 96 h LC_{50} values (95% confidence limits in parentheses) were: *P. viridis*: 2.62±0.13 mg L^{-1} (2.20–3.24); *M. cephalus*: 2.57±0.47 mg L^{-1}(2.25–5.33);*T.jarbua*: 2.99±.23 mg L^{-1} (2.28–4.82) and *P. monodon*: 5.45±.26 mg L^{-1} (4.69 – 6.53) based on measured concentrations. The 96 h LC_{50} values obtained from the present study indicate increase in toxicity with increasing exposure time.

The chronic toxicity tests revealed that the survival of exposed organisms decreased with increased exposure concentrations. During chronic exposure, in the exposed organisms 100% survival was noticed in the control chambers. The no-observed-effect concentration (NOEC) and the lowest observed- effect concentration (LOEC) values were calculated based on survival of test organisms, and the final chronic value was calculated based on the geomean of the NOEC and LOEC.

Biomarker studies can be used to assess the exposure or the effects of toxicants. In this connection, significant differences in enzyme activity were observed between control and increasing exposure concentrations. Among the four species, *P. viridis* showed maximum level of induction in enzyme activity. In conclusion, the biochemical results showed changes in enzyme activity with increased exposure

concentration. This indicates that the organisms are in high stress condition. One of the main advantages of biochemical tests is their potential to serve as early warning signals and the enzyme studies are therefore useful as a general indicator of stress. Histological alterations in various organs of exposed organisms indicate that the organisms are responsive and sensitive to a wide range of contaminants. The present histological investigation confirms that the severe histological changes in the gill, liver, hepatopancreas, intestine, and adductor tissue reflect poor health condition of the animals induced to Pb exposure. Similarly, histological biomarker studies serve as good indicators of exposure to contaminants.

In the present study, enzyme activity and histological biomarkers act as tools to characterize the health status of organisms in contaminated coastal environments and laboratory exposure to contaminants. In conclusion, the biochemical tests serve as early warning signals for chronic toxicity and the biochemical studies are useful as a general stress-indicators. They can provide information about the health status of organisms and can be thus used as early warning signals of general or particular stress. Bioaccumulation results indicate higher amount of Pb accumulation in lower exposure concentrations when compared to higher exposed concentrations. The accumulation of Pb is found to be several folds higher in exposed organisms in all concentrations. The present results reveal that the bioaccumulation is higher at lower exposure concentration.

The median lethal concentration and chronic toxicity values were used to derive the safe limits expressed in the form of water quality criteria. In the present study, the sea water quality criteria adopted two expressions of allowable magnitude: a Criterion Maximum Concentration (CMC) to protect against acute (short-term) effects, which is an estimate of the highest concentration of a chemical exposed to marine organisms briefly

without causing unacceptable effects and a Criterion Continuous Concentration (CCC) to protect against Chronic (long-term effects), i.e. an estimate of the highest concentration of a chemical exposed to marine organisms indefinitely without causing unacceptable effects. The CCC is more relevant since it refers to the environment rather than the CMC which refers to the toxicity of Pb, hence the CCC was considered as the Seawater Quality Criteria and the calculated values of CCC and CMC/FAV for Pb, were found to be 7.4, 176 $\mu g\ L^{-1}$ respectively. The WQC/CCC are set at such values as to protect all forms of aquatic life and all aspects of the aquatic life cycles, including the most sensitive life stage of the most sensitive species over the long term.

This study reinforces the development of multidisciplinary studies as an important tool for monitoring effects in laboratory-based contamination investigations. The analysis of biological damages in conjunction with other endpoints provides the evaluation of new insights that could help the interpretation of the effects of heavy metal on aquatic organisms. The data obtained from this study will be useful to determine the concentrations of single contaminants that may cause ecologically significant effects, and the data could also be used to establish acceptable environmental standards. The assessment of acute and chronic toxicity is the primary step to determine the CMC and CCC on marine organisms. Water quality safe limits have been advocated to provide an early warning of potentially damaging changes in stresses to the aquatic organisms.