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Evaluation of Acute Toxicity of Mercury, Cadmium and Zinc to a Freshwater Mussel *Lamellidens consobrinus*

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Abstract
Acute toxicity testing of fresh water mussel *Lamellidens consobrinus* to $HgCl_2$, $CdCl_2$ and $ZnSO_4$ was carried out. The median lethal concentration (LC_{50}) of $HgCl_2$, $CdCl_2$ and $ZnSO_4$ for 24, 48, 72 and 96 hrs were 1.9616, 1.8602, 1.6983 and 1.4066; 1.9050, 1.8631, 1.7542 and 1.6195; 1.9952, 1.9664, 1.9529 and 1.6756 ppm respectively. Analysis of results indicates that *L. consobrinus* is highly sensitive to $HgCl_2$ than $CdCl_2$ and $ZnSO_4$. The toxicants can be arranged in order of their toxicities as Hg>Cd>Zn.

***Key words*:** *Lamellidens consobrinus*, mercury chloride, cadmium chloride, zinc sulphate, acute toxicity

Introduction
Indiscriminate use of heavy metal compounds for various purposes and effluents arisen due to their production in water pollution thereby created serious threat to life on the earth. Aquatic pollution is of great concern as every kind of life depends on water.

Heavy metals that reach the aquatic bodies deteriorate the quality of life sustaining water and cause damage to both flora and fauna (Nriagu and Sprague, 1987; Mason, 1996; Kotsanis and Georgudaki, 1999; Zyadah and Abdel Bakey, 2000; Georgudaki and kotsanis, 2001; Verma *et al*., 2005; Sharma and Agrawal, 2005). Accumulation of toxic metals to hazardous level in the aquatic ecosystem has become a serious problem over the last few decades and it became a threat to public water supplies as well as the damage caused to the aquatic life (Manahann, 1994). The problem increases many folds due to their long half life period and non-biodegradable property, bioaccumulation and biomagnifications (Burman and Lal, 1994; Sandres, 1977; Pitler, 1999; Lodhi *et al.,* 2006).

Cadmium, a nonessential heavy metal has been Black listed in European community (Mason, 1996). It is a non-biodegradable metal with unknown biological function but reported to be a major contaminant of aquatic ecosystems through diverse sources including both natural and anthropogenic activities. The major sources of contamination includes electroplating, paper, PVC, Plastic, ceramic industries, battery, mining and smoldering units and many other modern industries (Gupta *et al*., 2003). Zinc is used in preparations of alloys, galvanizing iron, electroplating, metal spraying, electrical phases, batteries and cable wrappings (Merck, 1989).

Review of literature on water pollution mainly on the river system, includes the use of test animals mainly fish from vertebrates and freshwater mussels from invertebrates. Individual and combined toxicity of mercury and cadmium to tropical green mussel *Perna viridis* have been reported (Mohan *et al.*, 1986). Comparative toxicity of Hg and Cd to the juvenile water snail *Filopaludina martensi* (Piyatiratitivorakul and Boonchamoi, 2008) and remedial effect of $Ca^{+ +}$ on Lead induced alteration in protein and phosphatase activities in gill and mantle of freshwater bivalve *Lamellidens marginalis* have been reported (Injal and Raut, 2009). The mussels act as a food chain component of the ecosystem and play role in biological control by removing a number of bacterial population and toxic substances from water. The concentration of heavy metals in bivalves changes with respect to the environmental pollution. It has been well established that the study of bio-accumulation of heavy metals in different molluscs facilitates the assessment of water quality as well as the selection of suitable bio-indicator of heavy metal pollution (Chaudhari and Hazra, 2001).

Mercury and its compound is a highly toxic metal but their hazardous nature as pollutant of aquatic environment became a matter of grave concern only after Minamata disaster in Japan. Thus, studies reveals that there is no information on toxicity of Mercury, Cadmium and Zinc to *Lamellidens consobrinus*, a common bivalve inhabiting in river Darna of Nashik district (M.S.) Hence, present studies were aimed to evaluate comparative toxicity of heavy metals *viz*., Mercury, Cadmium and Zinc to *Lamellidens consobrinus.*

Materials and methods

Mussels *L. consobrinus* were collected from the river Darna at Nashik road, brought to the laboratory and acclimatized in aged tap water for a period of three days. During acclimatization they were fed with crushed green algae. Pilot experiments were carried out so as to select the final concentrations of heavy metals. Healthy active animals of *L. consobrinus* approximately same size and weight were selected for toxicity testing irrespective of their sex. Three heavy metals *viz*., $HgCl_2$, $CdCl_2$ and $ZnSO_4$ were used for toxicity testing. The stock solutions (1%) of each toxicant were prepared in distilled water and from which 8-10 concentrations were prepared by diluting the stock solutions so as to set them in the final experiments. Physico-chemical analysis of aged tap water was carried out as per standard methods of APHA (1981). Ten animals were exposed to each concentrations containing five liter toxicant along with control maintained in aged tap water. Three replicates were run for each concentration.

Static bioassays were carried out for a period of 96 hours as per standard methods of APHA (1981). The experimental concentrations were renewed after every 24 hours using aged tap water as diluent medium. During bio-testing, feeding was discontinued. Mortality was recorded after every 24 hrs and data was analyzed so as to compute 24, 48, 72 and 96 hrs LC_{50} values for three heavy metals by probit analysis (Finney, 1971).

Results

The physico-chemical analysis of aged tap water showed the temperature 26±2°C, pH 7.8±0.2; total hardness 55±2 ppm as $CaCo_3$;

total alkalinity 6.5±0.3 ppm as $CaCo_3$ and dissolved oxygen 6.5±0.3 mg/lit.

The LC_{50} values for different heavy metal pollutants to *L. consobrinus* for 24, 48, 72 and 96 hrs were calculated. The relative toxicity of heavy metal pollutants, Probit regression equation, LC_{50} fudicial limits are summarized in table 1. It is evident from the results (Tab. 1) that the mussel *L. consobrinus* was found to be highly sensitive to $HgCl_2$ than $ZnSO_4$ and $CdCl_2$. The heavy metals can be arranged in order of their toxicities as Hg>Zn>Cd.

During the bio-testing, the bivalve showed response to heavy metal treatment. At higher concentration, the test solutions became turbid due to copius secretion of mucus. Another notable effect observed was loss of ability to retract the foot even after mechanical stimulation.

Discussion

Toxicity studies measure a response of an organism to a biologically active substance (Alderdice, 1966) and are useful in determining water quality. From the result (Tab. 1), it is quite clear that the mussel *L. consobrinus* is highly sensitive to $HgCl_2$ than $CdCl_2$ and $ZnSO_4$. Similar observations have also been reported by various workers using different heavy metals on different test animals (Pundir and Saxena, 1992; Wandkhede and Dhande, 1999; Shrivastava and shrivastava, 2002; Bhamre *et al*., 1996; Drastichova *et al*., 2004; Ksherwani *et al*., 2009). The wide variation in sensitivity of different species to different heavy metals depends on various factors like age, sex, weight, physical stage of the animal and presence or absence of enzyme system that can degrade the pollutants (Nagratnamma and Ramamurti, 1981; Piansiri *et al*., 2008). Similar findings were also reported by Georguadaki and Kotsanis (2001).

In the aquatic animals Gills are important organs of respiration. Damage to the gills by different heavy metals and pesticides has been reported by number of workers (Khangarot, 1982; Pawar and Katdare, 1983; Nilkant and Sawant, 1993). It seems therefore anoxia may be an important factor causing death of organisms exposed to pollutants (Skidmore, 1964; Burton *et al*., 1972).

Another contributing factor causing death may be toxic effect of pollutant on the osmoregulatory mechanism of the animal. It is well known that fish and crustacean gilsl are involved in ionic regulation (Evans, 1975; Hughes and Morgan, 1973) and hence impairment of gill function may affect osmoregulation.

Results of present studies (Tab. 1) clearly indicate that the rate of mortality for any fixed time increases with increase in concentration and for a particular concentration with increase in exposure time and a regular mode of action of toxicant, due to accumulation up to dangerous level leading to death.

The lethal effects of heavy metals (Hg, Cu, Cd, Zn and Pb have been described to coagulation of mucus (i.e., precipitation of insoluble metal proteins compounds) on gill surface, damage done to gill tissues and consequently result to the respiratory failure (Dandroff and Katz, 1953).

Thus, from the present studies it can be concluded that the toxicity of tested heavy metals to *L. consobrinus* affect respiratory and nervous system of the animal resulting into death. The present investigations also confirm a high sensitivity of mollusc to mercury as compared to Cd and Zn.

Table 1. Regression equations of probit mortality (y) against x, the logarithm of the metal concentrations, and LC_{50} values for *L. consobrinus* exposed to $HgCl_2$, $ZnSO_4$ and $CdCl_2$.

SN	Pollutant	Exposure period in Hrs	Probit Regression equation [y = a + b (x - m)]	LC_{50} in ppm	Fiducial limits	
					M_1	M_2
1	$HgCl_2$	24	y = 0.41+ 2.3393 (x – 0.2925)	1.9616	0.1560	0.4230
		48	y = 0.94+ 2.1779 (x – 0.2699)	1.8602	0.1583	0.3801
		72	y = 2.02+ 1.7490 (x – 0.2302)	1.6983	0.1402	0.3198
		96	y = 2.17+ 1.7714 (x – 0.1480)	1.4066	0.0111	0.2849
2	$ZnSo_4$	24	y = 0.97+ 3.1786 (x – 0.3000)	1.9952	0.1902	0.4098
		48	y = 1.59+ 1.7098 (x – 0.2936)	1.9664	0.1165	0.9697
		72	y = 2.46 + 1.3131 (x – 0.2860)	1.9329	0.0691	0.5029
		96	y = 1.69 + 1.9751 (x – 0.2799)	1.6756	0.1405	0.3255
3	$CdCl_2$	24	y = 0.01 + 2.7593 (x – 0.2799)	1.9050	0.1777	0.3825
		48	y = 0.98 + 2.0583 (x – 0.2702)	1.8631	0.2304	0.3099
		72	y = 1.53 + 2.0172 (x – 0.2440)	1.7542	0.1439	0.3441
		96	y = 1.99 + 1.9333 (x – 0.2094)	1.6195	0.1061	0.3121

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