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ACUTE TOXICITY OF COPPER, ZINC AND MERCURY ON INTERTIDAL GASTROPODS OF MUMBAI COAST

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ABSTRACT

The acute toxicity test conducted by static bioassay techniques have revealed that among selected heavy metals, copper is more toxic than zinc and mercury to *Planaxis sulcatus* and *Trochus radiatus*. The natural availability of heavy metals in the surrounding environment of these organisms is found to be deciding factor for their toxicity. Natural habitat of the animal also contributes to the sensitivity of a particular animal to the heavy metals tested. In addition the tendency of the animal to overcome the adverse conditions in their surrounding also plays a significant role in toxicity of pollutants.

Keywords: Intertidal, *Nerita oryzarum, Planaxis sulcatus, Trochus radiatus*, Copper, Zinc, Mercury

INTRODUCTION

Today, environmental pollution has become one of the major areas of human concern and assumed importance all over the world. At present the pollution of hydrosphere has become a global phenomenon and it may lead to severe threat to the very existence of human population in future. The intensive urbanization and industrialization throughout the world along the coastal zone has resulted in higher level of heavy metals in the coastal ecosystem. Coastal waters of Mumbai receives the industrial effluents containing heavy metals Cr, Mn, Fe, Ni, Co, Hg, Cu, Zn, Cd, Ph and Ag through industries like pulp and paper mills, organic and inorganic chemical factories and petrochemical plants. As a result, these metals are not only present in an appreciable quantity in water and sediment, but also, reported to be accumulated in the body of marine animal; which is on increasing trend (Zingde and Prasad, 1981; Matkar *et al.*, 1981; Somayajulu and Rama, 1972; Patel *et al.*, 1985). Among heavy metals the copper and zinc are detected in excess over the expected background in sediments and water of Mumbai coast (Sahoo and Khopkar, 1987). The presence of mercury has also been shown in marine organisms of sea around Mumbai (Sreenivasan, 1990; Tejam and Haldar, 1975). The level of copper and zinc has also been investigated in intertidal gastropods from different areas of Mumbai coast (Zingde, 1985; Patel and Chandy, 1987; Fernandes, 1991).

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Therefore, it becomes necessary to know the tolerance limit of intertidal organisms to Cu, Zu and Hg. For this purpose an acute toxicity test has to be conducted. Many investigations have worked on acute toxicity of various pollutants to marine fishes (Sprauge, 1969; Joshi, 1978; Whipple *et al.,* 1981; Gaikwar, 1981), crabs (Kulkarni and Masurekar, 1983; Dhavale, 1984), prawns (Somani, 1980; Deshmukh, 1983) and clams (Kulkarni and Masurekar, 1984). However, scanty information is available on acute toxicity of Cu, Zn and Hg on intertidal gastropods inspite of their economic importance and vital position in the food chain of marine ecosystem (Maurode freitas rebelo *et al.,* 2003; Zunigo *et al.,* 2003; Sook-Jung Kim *et al.,* 2003). In view of this, the present bioassay studies on *Nerita oryzarum, Planaxis sulcatus and Trochus radiatus* was conducted to determine the acute toxicity level of $CuSO_4$, $ZnSO_4$ and $MgCl_2$.

MATERIAL AND METHODS

Specimens of *Nerita oryzarum, Planaxis sulcatus* and *Trochus radiatus* were collected during low tide from intertidal area of Backbay (Nariman Point) in Mumbai. These animals were acclimatized to laboratory conditions in glass aquaria (48 x 22 x22 cm^3) for 24 hr. Healthy animals with extended tentacles and actively crawling were selected for toxicity experiments. Bioassay technique described by Sprauge (1969) was followed. Gastropods to be exposed to the heavy metals were kept in thoroughly cleaned glass aquaria (22 x 15 x 15 cm^3) containing 2 litre seawater and 20 animals each maintained during the experiment. The test animals were acclimatized in the seawater at 27°C - 29°C, 8.0 - 8.2 pH, 6.0 - 8.2 mg/l dissolved oxygen and 30-33‰ salinity. The standard solutions of copper sulphate, zinc sulphate and mercury chloride were prepared with AR grade chemicals. Aliquots of these solutions were added to the experimental aquaria to obtain the desired concentrations. The experimental media were renewed after every 24 hr with fresh addition of toxicants. After recording mortality for every 24hr, the dead animals were removed. Criteria for death were cessation of any kind of movement by the animal and its failure to respond to mechanical stimulus over a period of two minutes. The LC_{50} values and their 95% confidence intervals were calculated by following method given by Litchfield and Wilcoxon (1949).

RESULTS AND DISCUSSION

Gastropods exposed to $CuSO_4$, $ZnSo_4$ and $HgCl_2$ have shown more or less identical response. They kept themselves inside the shell by closing their operculum tightly. It is well known that molluscs can survive for a longer period by keeping themselves inside the shell with closed operculum to avoid unwanted situations (Kulkarni and Masurekar, 1984). During the present experiment, the gastropods opened their operculum for a short duration in order to avoid high concentrations of heavy metals therefore the contact with the dissolved metal solution was also for a short duration. Hence very high concentration of metal is required for their death within 24 hrs.

Therefore, the difference was found in the LC_{50} (mg/l) values at 24 & 96 hr (Table 1). However, at low concentrations the animals showed free movements, thus, bodies of these animals remained in contact with the heavy metals for longer duration in turn bringing mortality at 96 hr. Another visible sign of their reaction to the stimulus by metallic pollution was higher rate of mucus secretion. This is

Table 1: LC_{50} values (mg/l) of some heavy metals

Pollutants	Method	24 hrs.	48 hrs.	72 hrs.	96 hrs.
I. *Nerita oryzarum*					
Copper	LC_{50}	2.64	2.48	2.03	1.42
	95% of C.I.	(2.74–2.54)	(2.82–2.17)	(2.10–1.95)	(1.77–1.13)
	slope F	1.17	1.43	1.10	1.30
Zinc	LC_{50}	8.399	5.10	3.40	2.83
	95% of C.I	(9.15–7.70)	(6.52–3.98)	(4.25–2.72)	(4.05–1.48)
	slope F	1.33	2.13	1.82	2.95
Mercury	LC_{50}	30.62	19.92	9.22	8.11
	95% of C.I	(33.98–27.58)	(26.89–14.75)	(11.06–7.68)	(9.56–6.87)
	slope F	1.3	2.22	1.64	1.57
2. *Planaxis sulcatus*					
Copper	LC_{50}	2.20	1.57	1.06	1.01
	95% of C.I	(2.50–1.90)	(1.75–1.40)	(1.32–0.84)	(1.28–0.79)
	slope F	1.47	1.42	1.97	2.01
Zinc	LC_{50}	8.79	6.81	3.97	2.20
	95% of C.I	(9.95–7.65)	(7.60–6.00)	(5.16–3.05)	(4.1–2.03)
	slope F	1.38	1.32	1.89	1.47
Mercury	LC_{50}	6.98	5.53	5.16	3.69
	95% of C.I	(8.30–5.04)	(7.40–3.44)	(7.74–3.44)	(3.91–3.48)
	slope F	1.48	2.33	3.22	1.27
3. *Trochus radiatus*					
Copper	LC_{50}	0.203	0.076	0.038	0.025
	95% of C.I	(0.253–0.162)	(0.100–0.057)	(0.055–0.020)	(0.030–0.010)
	slope F	1.73	2.01	2.48	2.86
Zinc	LC_{50}	2.95	2.27	1.02	0.567
	95% of C.I	(3.54–2.34)	(3.38–1.52)	(1.32–0.78)	(0.76–0.41)
	slope F	2.05	2.51		2.04
Mercury	LC_{50}	2.80	1.84	1.40	1.10
	95% of C.I	(3.50–2.24)	(2.17–1.55)	(1.42–1.37)	(1.43–0.84)
	slope F	1.51	1.70	1.08	2.60

probably for protection from heavy metals as the sticky mucus forms a protective layer on the margins of operculum.

During the present investigations copper was found to be most toxic among copper, zinc & mercury to all the tested gastropods. Whereas, Waldichuk (1974) and Deshmukh (1983) have found mercury to be most toxic than other heavy metals to the crabs, prawns & clams. The probable explanation for deviation of present results from earlier may be the high levels of copper & zinc already present in *Nerita oryzarum, Planaxis sulcatus.* Fernandes (1991) has detected average copper and zinc in the considerable quantities (69-98 mm/g) in *N.oryzarum* and *P. sulcatus* from Mumbai coast.

The level of heavy metals detected in the animals during the experiment might be the combined effect of experimental concentration and high concentration of these metals already accumulated in the body of animals from surrounding environment; as high level of copper and zinc has been reported in sediments of Bombay coast (Zingde, 1985). Similarly accumulation of greater quantity of Zinc than Mercury in the animals from surrounding may be the explaination Zinc being more toxic than Mercury. Such type of variations in relative toxicity of heavy metals for different test organisms have also been reported (Portman, 1972; Somani, 1980). Waldichuk (1974) reported toxicity in the order of copper>zinc> cadmium to sensitive larval stages of some marine molluscs and crustaceans, which strengthens present findings. A clear difference in the sensitivity of *Nerita oryzarum* and *Trochus radiatus* to heavy metals tested was observed (Table 1). This difference is possibly due to their different vertical distribution in intertidal zone. *Nerita oryzarum* and *P. sulcatus* found to be present in upper level of littoral zone and *T. radiatus* found in the lower levels of littoral. Therefore *Nerita oryzarum* and *P. sulcatus* were expose to atmospheric condition during low and neap tides also due to which they are acclimatized to tolerate wider range of physicochemical parameters, whereas, *Trochus radiatus* being submerged under water for most of the time and exposed only during low tide, is more sensitive to changes in environmental conditions.

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