Uttar Pradesh J. Zool. 14 (1) : 25-28, 1994 *ISSN 0256–971X*

SUSCEPTIBILITY OF *CATLA CATLA* (HAM.) TO THE TOXIC EFFECTS OF THE HEAVY METALS, CADMIUM AND CHROMIUM

S. VINCENT, T. AMBROSE AND M. SELVANAYAGAM

PG-DEPARTMENT OF ZOOLOGY, LOYOLA COLLEGE, MADRAS - 600 034, INDIA.

Susceptibility of *Catla catla* to the toxic effects of the heavy metals, cadmium and chromium as a function of time was studied using static bioassay method. Cadmium was found to be more toxic than chromium. Median lethal concentrations of Cd and Cr for the given experimental major carp are reported and statistically analysed.

INTRODUCTION

Continued anthropogenic input of heavy metal toxicants into the aquatic environment dictates a continued assessment of their species specific effects on representatives of the ecoystem. Toxic effects of heavy metals have been widely reported in a number of animals (Pickering, 1980; Gautam & Lall, 1988; Awari & Gaikwad, 1990; Darmono *et al.*, 1990).

Intrusion of heavy metals and their salts into the environment causes massive fish kills (Bengeri *et al*, 1986). Toxicity of waterborne heavy metals necessitates studies on tolerance of the most sensitive bioindicator of aquatic pollution, the fish. Since aquatic toxicity tests are the cornerstone of the assessment of biological effects and are used to detect and evaluate the potential toxicological effects of chemicals on aquatic biota (Rand & Petrocelli, 1985) in the present investigation toxicity tests were conducted to assess adverse effects of the heavy metals cadmium and chromium on the freshwater fish *Catla catla* (Ham.) under standardised and reproducible conditions.

MATERIAL AND METHODS

Catla catla a reverine major carp of India weighing 9.36 ± 0.28 g were procured from CHR Farm, Padappai, Madras and acclimatised to laboratory conditions in glass aquaria ($58 \times 30 \times 30$ cm). Abrupt changes in the quality of the holding water (DO 6.55 ± 0.45 ml/l, chlorides as Cl 580 ± 20 mg/l, salinity 1.09 ± 0.12 ppt, pH 7.1 ± 0.05, total hardness as $CaCO_3$ 604 ± 10 mg/l, electrical conductivity 2760 ± 210 μ mhos/cm^3 at 20°C and temperature 28 ± 1°C) was avoided. Fish were fed *ad libitum*. During acclimatization if mortality exceeded .5% in a batch, it was discarded (Anderson, 1977). Stock solutions and experimental concentrations of cadmium and chromium were prepared from their respective analytical grade cadmium chloride ($CdCl_2 - 2H_2O$) and potassium dichromate ($K_2Cr_2O_7$) salts using glass distilled water. Experimental concentrations were fixed following range finding tests (APHA, 1980).

Feeding of fish was stopped 48 h prior to the commencement of the experiment to avoid any possible change *in situ* in the toxicity of metals. After the addition of toxicant into the test tank with 10 l of water, 20 fish were introduced and mortality was recorded after 24, 48, 72 and 96 h. Six replicates were maintained simultaneously. Per cent mortality was transformed into Probit scale. Slope function and confidential limits of the regression line with Chi-square test were calculated following UNEP/FAO/IAEA (1987).

Table I . Tolerance of fish *Catla catla* to the metal toxicant cadmium.

Exposure period (h)	LC_{50} (mg/l)	Regression Equation	Slope	Confidence limits		Chi-square values	
				Lower	Upper	Calculated	Table
24	159.95	Y = − 0.0361 + (2.437) ×	2.801	65.02	393.48	5.20	7.82
48	100.00	Y = − 0.027 + (2.625) ×	2.450	45.66	219.00	2.38	7.82
72	79.07	Y = − 0.052 + (2.678) ×	2.420	36.50	171.26	2.45	11.10
96	50.00	Y = − 0.021 + (3.005) ×	1.990	27.78	90.00	0.44	7.82

Table II . Tolerance of fish *Catla catla* to the metal toxicant chromium.

Exposure period (h)	LC_{50} (mg/l)	Regression Equation	Slope	Confidence Limits		Chi-square values	
				Lower	Upper	Calculated	Table
24	153.18	Y = − 0.01 + (1.9401) ×	3.723	111.76	1116.05	2.30	5.99
48	250.03	Y = − 0.028 + (2.1293) ×	3.556	82.38	758.84	5.14	7.82
72	129.31	Y = − 0.25 + (2.388) ×	3.240	44.67	351.49	1.80	7.82
96	100.00	Y = − 0.076 + (2.588) ×	3.130	38.82	271.60	2.75	11.10

RESULTS AND DISCUSSION

Susceptibility of *Catla catla* to the toxic effects of the heavy metals cadmium (Table I) and chromium (Table II) as a function of time, observed as per cent mortality increased with an increase in concentration of toxicants. Mortality in controls was virtually absent. Analysis of the degree of scatter of the observed LC_{50} narrowed down with an increase in exposure period. Thus the regression coefficient in the fitted regression is in correlation with treatment periods. All values indicated a good fit at 0.05 probability level. There was a decline in slope function from 24 h to 96 h. Cadmium was found to be more toxic than chromium. Toxicity of cadmium and chromium, and the consequent mortality of fish is in conformity with the findings of Awari & Gaikwad (1990).

Susceptibility of *C. catla* to cadmium and chromium might exclusively be due to the toxic influence of the heavy metals. Kill of animals by metal toxicants may be through poisoning of enzymes (Verma *et al.*, 1983), depletion in oxygen consumption (Haniffa & Porchelvi, 1985). Similar such cytotoxic effects could vouch for the mortality of fish in the present investigation.

In the present study cadmium is shown to be more toxic than chromium. This difference could be due to the biological diversity and functional variability of organismal cells and tissues to chemical pollutants. Toxicity of metals may vary depending upon their permeability into organisms and detoxification mechanisms (Darmono *et al.*, 1990). Toxicity of chromium to fish is well-known from the findings of Fromm & Stokes (1962). The differential response of *C. catla* to the essential and nonessential metals could well be explained by the fact that a considerable quantum of chromium might have been incorporated into the animal owing to its essentiality.

Decrease in LC_{50} with increase in exposure period is evident as it is further signified by the coefficients of the fitted regression equation. Variations in LC_{50} for different acute exposure periods were well documented by USEPA (1980). Pronounced toxicity of the heavy metal cadmium agrees with Darmono *et al.* (1990). The 96 h median lethal concentration of 50 mg/l of cadmium was recorded for the fish *Notopterus notopterus* (Chand *et al.*, 1988) is comparable to the present results. Awari & Gaikwad (1990) reported a much reduced LC_{50} (1.35 mg/l) for *Ambassis ranga*, where as Spehar (1976) reported a highly elevated LC_{50} (250 mg/l) to the flag fish *Jordanella floridae* exposed to cadmium. Differences in LC_{50} may be understood in terms of altered physicochemical properties of the holding water and size of the test animal (Stedahl & Sprague, 1982) and species specificity (Rand & Petrocelli, 1985).

Median lethal concentration of chromium to the experimental major carp after 96h was 100 mg/l. This tolerance limit is comparatively higher than that of *Fundulus heteroclitus* (Eisler & Hennekey, 1977). Hence it may be concluded that the test species *Catla catla* is moderately sensitive to chromium than cadmium. Therefore no substance is a poison by itself, it is the dose that makes a substance poison.

ACKNOWLEDGEMENTS

Authors sincerely thank Rev. Dr. Joseph Inchackal, S.J., Secretary, Rev. Dr. Xavier Alphonse, S.J., Principal, Loyola Colege, Madras for help and encouragement.

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