Recent Research in Science and Technology 2011, 3(3): 01-05
ISSN: 2076-5061
www.recent-science.com

ZOOLOGY

HEAVY METAL TOXICITY TO A FRESHWATER CRAB, *BARYTELPHUSA CUNICULARIS* (WESTWOOD) FROM AURANGABAD REGION

Atul R. Chourpagar* and G.K.Kulkarni

Department of Zoology, Dr.Babasaheb Ambedkar Marathwada University Aurangabad-431004 (M.S.), India

Abstract

Pesticides of heavy metal salts are common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. *Barytelphusa cunicularis* is a key-species in Marathwada region having good nutritional value. Crabs live in close association with the sediment where accumulation of heavy metals pesticides is reported. Acute toxicity tests were conducted against the pesticides copper sulphate and mercuric chloride. Median Lethal Concentration (LC50) values of Copper sulphate were found to be 282, 258, 238 and 215 ppm respectively for 24, 48, 72 and 96 h., while those for mercuric chloride were 1.04, 0.84, 0.63 and 0.45 ppm respectively. This crab was found more sensitive to mercuric chloride than copper sulphate.

Keywords: Freshwater Crab, Heavy metal pesticides, Toxicity test

Introduction

Living organisms require trace amounts of some heavy metals including iron, cobalt, copper, magnesium, vanadium and zinc for good health. Excessive amounts of these metals however can be detrimental to living organisms. Other heavy metals such as cadmium, lead and mercury have no known beneficial effect and their accumulation over the time in animals can cause illness (Hawkes, 1997).

Aquaculture industry worldwide is making significant progress in the development of technology to increase aquaculture production every year. The concept of green revolution was emphasized in the recent past to meet the demands of the increasing human population. Many different agrochemicals such as fertilizers, pesticides, fungicides, insecticides and weedicides are in common use.

The most important heavy metals from the water pollution point of view are Zn, Cu, Pb, Cd, Hg, Ni and Cr and become toxic at higher concentrations (Agrahari, 2009). Heavy metal from man-made pollution sources are continually released into aquatic ecosystem (Ozturk, *et al.,* 2008). Total concentrations of most metals in sediments are several orders of magnitude higher than aqueous concentrations (Louma, S.N. 1989). The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades (Vutukuru, 2005; Vinodhini and Narayanan, 2008). The natural aquatic systems may extensively be contaminated with heavy metals released form domestic, industrial and other man-made activities (Conacher, *et al.,* 1993).

Indiscriminate use of heavy metal pesticides caused non-specific hazards to target aquatic animals of economic importance like crabs, leeches, bivalve etc. The aquatic animals are particularly susceptible to heavy metal pesticides, since their habitats are strictly confined to water bodies and are exposed more to toxic compounds dissolve in the medium.

Crabs constitute a significant portion of the freshwater ecosystem. Very often they become the victim of pesticides used against some other activity or agricultural pest. Therefore their population in this area was found decreasing during the last decade.

In the present study toxic effect of heavy metals e.g. $CuSO_4$ and $HgCl_2$ to freshwater crab, *Barytelphusa cunicularis* is determined due to its adaptation in polluted aquatic environment.

Material and Method

The female crabs, *Barytelphusa cunicularis* were collected from freshwater ponds on the outskirts of Aurangabad and were brought to the laboratory in large plastic troughs and acclimatized for one week. Healthy intermoult (stage C-3) female crabs having equal size (Carapace width 30 to 35 mm) and weight (25 to 30 g) were used. Two heavy metal pesticides selected for experiment were Copper sulphate ($CuSO_4$, 5 H_2O) and Mercuric chloride ($HgCl_2$). Stock solution of copper sulphate and mercuric chloride were prepared by dissolving appropriate amount of salts in distilled water. Test was repeated three times for each concentration and results averaged.

For the selection of test concentration, some pilot tests were carried out. The range of concentration was

* Corresponding Author, *Email:* atul_chourpagar@rediffmail.com

Editor: Sujeet Jamdar

selected between 0 to 100% mortality. In order to maintain the concentration of the pesticide, water was changed after every 24 hr during the exposure.

The mortality rate of *Barytelphusa cunicularis* was recorded at 24, 48, 72 and 96 h of exposure to the heavy metal pesticide. The percentage for corrected mortality was calculated using the Abbott's formula (1952).

$$\text{Corrected mortality (\%)} = \frac{\text{Percentage living in control- Percentage living in treatment}}{\text{Percentage living in control}} \times 100$$

The corrected mortality data were analyzed to determine the LC $_{50}$ values for 24, 48, 72 and 96 h and were calculated by probit method of Finney (1971). By graphical interpolation LC $_{50}$ values were fixed and the values of maximum and minimum fiducial limits and safe concentrations were calculated.

Results and Discussion

Copper sulphate toxicity

The mean LC_{50} values of copper sulphate for 24 (Fig.1 A), 48 (Fig. 1 B), 72 (Fig. 1 C) and 96 (Fig. 1 D) hr of exposure were estimated as 282, 258, 238 and 215 ppm respectively (Table 1 Fig. 1).

The observed data of present study indicate that the crab, *Barytelphusa cunicularis* survived well from 1 to 275 ppm for 24 hr, 1 to 250 ppm for 48 hr, 1 to 230 ppm for 72 hr and 1 to 220 ppm for 96 hr of exposure .

Fig. 1 - Empirical and Expected Probit lines for *Barytelphusa cunicularis* exposed to Copper Sulphate showing LC 50 values in 24, 48, 72 and 96 hrs

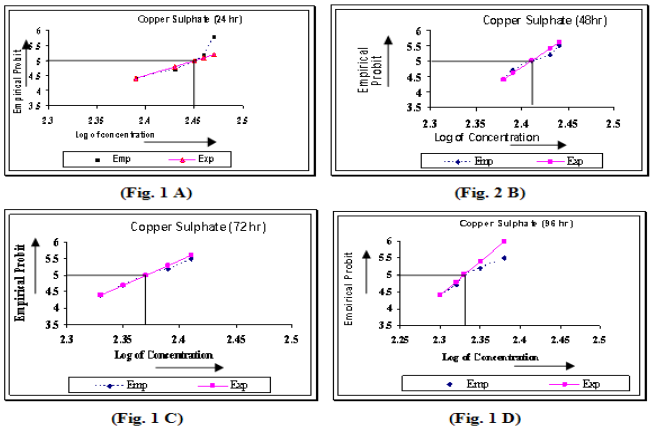


Table 1:- The LC50 values and regression results for the freshwater crab, *Barytelphusa cunicularis* treated with Copper sulphate ($CuSO_4$)

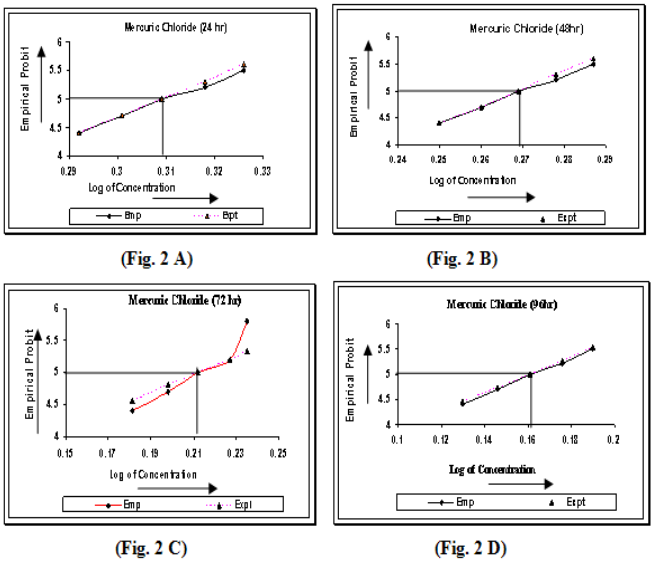
Exposure period (hr)	LC_{50} value (ppm)	Regression results Y'= (y-bx) + bx	Chi-square (f^2)	Fiducial limits up to 95% Confidence	
				M1	M2
24	282	32.6694 + 15.4323x	0.616163	2.4209	2.4667
48	258	32.4445 + 15.5137x	0.005058	2.3904	2.4369
72	238	24.0867 + 12.2476x	0.017696	2.3455	2.4041
96	215	24.2865 + 12.5218x	0.154211	2.3082	2.3669

Mercuric chloride toxicity

The mean LC_{50} values of mercuric chloride for 24 (Fig. 2 A), 48 (Fig. 2 B), 72 (Fig. 2 C) and 96 (Fig. 2 D) h of exposure were estimated as 1.04, 0.84, 0.63 and 0.45 ppm respectively (Table 2.).

The observed data show that the crab, *Barytelphusa cunicularis* survival well from 0.01 to 1.00 ppm for 24 hr, 0.01 to 0.80 ppm for 48 hr, 0.01 to 0.60 ppm for 72 hr and 0.01 to 0.40 ppm for 96 hr of Mercuric chloride (Table 2).

Fig. 2 - Empirical and Expected Probit lines for *Barytelphusa cunicularis* exposed to Mercuric Chloride showing LC 50 values in 24, 48, 72 and 96 hrs



(Fig. 2 A) **(Fig. 2 B)**

(Fig. 2 C) **(Fig. 2 D)**

Table 2:- The LC50 values and regression results for the freshwater crab, Barytelphusa cunicularis treated with Mercuric chloride (Hgcl2)

Exposure period (hr)	LC_{50} value (ppm)	Regression results Y'= (y-bx) + bx	Chi-square (f^2)	Fiducial limits up to 95% Confidence	
				M1	M2
24	1.04	4.7475 + 15.5112 x	0.002690	-0.0067	0.0395
48	0.86	5.8508 + 12.8136 x	0.003616	-0.0944	-0.0384
72	0.63	6.7537 + 8.3251 x	0.520714	-0.2475	-0.1625
96	0.45	9.0083 + 5.2904 x	0.018373	-0.4202	-0.2842

Not only in India, but globally the pollution is a scare-word (Hatai, *et al.,* 2005). Extensive studies have been carried out all over the world on for the effects of pesticides on aquatic organisms (Ramana Rao, *et al.,* 1987; Cripe, 1994; Shanmugam, *et al.,* 2000). Heavy metals are natural components of the earth's crust. They can enter the water and food cycles through a variety of chemical and geochemical processes (Tinsley, 1979; NDES, 1999).

The freshwater female crab, *Barytelphusa cunicularis* (Westwood) is abundantly found in Marathwada region and is a good source of food and has high market value. People prefer them due to high content of protein. Maharastra Pollution Control Board (IS, 10500, 1991) has reported the presence of heavy metals in different freshwater bodies around Aurangabad above the maximum permeable limit (MPL: Copper Sulphate:-5.0 ppb and Mercuric chloride: - 1.0 ppb).

The toxicity of pesticides depends on many factors such as weight, size (Sherkar 1986, Pickering *et al.,* 1968) developmental stages (Kamaldeep and Toor, 1977), time of exposure, temperature (Macek *et al.,* 1969), pH, Hardness of water (Henderson *et al.,* 1959) and dissolved oxygen content of the medium (Ester, 1970). Pesticide affects behavior and gets accumulate in the test animals reduces their survival rate.

Results of pesticide toxicity are reported by other authors (Galli *et al.* 1994; Kaiser and Devillers, 1994; Ruiz *et al.,* 1997; Amoros, *et al.,* 2000). Variations in the degree of toxicity of different pesticides have also been reported by other workers (Ramana Rao *et al.,* 1987).

Saksena (1987) has reported 96 hr. LC 50 value of mercuric chloride on *Clarias batrachus* and *Puntius ticto* as 0.15mg/l and 0.1mg/l respectively and further observed that *Puntius ticto* is more susceptible to the toxicant with much less tolerance than *Clarias batrachus*.

Through toxicity tests, Mean LC_{50} values, lethal concentration, safe concentration, fiducial limit etc have been calculated. Regression line and regression

equation have been calculated. An attempt has been made to simplify this intractable process for a biologist to understand, since it alone provides the basis for the calculation of LC_{50}, chi square values for reliability of data, fiducial limits, lethal and safe concentration of pollutants etc.

The contamination of heavy metals is a serious threat because of their toxicity, long persistence, bioaccumulation and biomagnifications in the food chain. Freshwater crab, *Barytelphusa cunicularis* can be considered as one of the most significant indicators of pollution in freshwater systems.

Conclusion

Therefore future eco-toxicological investigations that characterized the use of *Barytelphusa cunicularis* as well as implementation of environmental policy to regulate untreated pollutant discharges into freshwater and maintain sanitation are recommended. Furthermore, this study recommends futuristic investigations on biodegradability of biocides, bio-concentration of biocides and time profile of biocides quality discharge into freshwater ecosystems.

The toxicity for heavy metal pesticides is dependant on time of exposure and nature of heavy metal pesticides. In present study $HgCl_2$ (Mercuric Chloride) is found to be more toxic than $CuSO_4$ (Copper Sulphate) to a freshwater crab.

Acknowledgement

Author Atul R.Chourpagar is thankful to university Grand Commission (UGC), New Delhi for financial assistance through Rajiv Gandhi National Fellowship (SRF).

References

Abbott's, W. S. (1952): A method of computing the effectiveness of an insecticide*. J. Econ. Entomol.* 18: 265-267.

Amoros, I., Connon, R., Garelick, H., Alonso, J.L. and Carrasco, J.M. (2000): An assessment of the toxicity of some pesticides and their metabolites affecting a natural aquatic environment using the Microtox system. Water Science & Technology.

APHA, AWWA and WPCS (1998): Standard method for the examination of water and waste water, 20th Edition, Washington D.C.

ASTDR (Agency for toxic substances and Disease Registry) (2000): Toxicological profile for Arsenic U.S. Department of Health and Human Services. Public Health Service. A-5.

Agrahari, K.C. (2009): Heavy metals in aquatic ecosystem: some environmental implications. Everyman's Science, Vol. XLIV No.2. PP: 88-93.

Athar, M. and S.B.Vohara (1995): Heavy metals and environment. In man and environment series (Ed. P.K. Ray) Wiley. Eastern. Ltd. New Delhi. PP., 1-195.

Awasthi, S.K. (2000): Prevention of food adulteration Act. No. 37 of 1954, central and state rules as amended for 1999 IIIrd Edition. Ashoka Law house, New Delhi.

Babatunde, M.M., Oladimeji, A.A and Balogun, J.K. (2001): acute toxicity of Gramoxone to *Oreochromis niloticus* (Trewavas) in Nigeria, Water, Air and Soil Pollution 131: 1-10.

Cripe, G.M. (1994): Coparative acute toxicants of several pesticides and metals to *Mysidopsis bahia* and post larval *Panaeeus duorarum.* Environ. Toxicl. Chem., 13, 1897-72.

D. Kar; P. Sur; S.K.Mandal; T.Saha and R.K.Kole (2008): Assessment of heavy metal pollution in surface water. Int. J. Environ. Sci. Tech., 5 (1): 119-124.

Finney D.J. (1971): Probit Analysis. Cambridge University Press. London.

Gbaruko, B.C. and Friday, O.U. (2007): Bioaccumulation of heavy metals in some fauna and flora. Int. J. Environ. Sci.Tech. 4(2): 197-202.

Galli, R., Rich, H. W., and Scholtz, R. (1994). Toxicity of organophosphate insecticides and their metabolites to the water flea *Daphnia magna*, the Microtox test and a acetylcholinesterase inhibition test *Aquatic Toxicology*, 30, 259-269.

Hatai, L.D. and Subhashish, (2007): Effect of environmental pollution in agriculture and its control. Agrobios News letter, Vol. V, Issue No. 8.

Hawkes, S.J. (1997): What is a heavy metal? Jour.Chem.Edu, 74:1374.

Hippocrates, circa 300 B.C.: On Airs, Waters and Places; in: Great Books of the Western World. IS, 10500, (1991): Indian Standard Drinking Water - Specification

Kaiser, K, L. E. and Devillers, J. (1984). Ecotoxicity of chemicals to Phtobacterium phosphoreum. J. Devillers (ed.). *Handbooks of Ecotoxicological Data*, 2, 547-548.

Kamaldeep K.and Toor, H.S. (1977): Indian J. Exp. Biol. 15 :193.

Louma S.N. (1989): Can we determine the biological availability of trace elements? Hydrobiologia. 176/177:379-396.

Meral Ozturk, Gokce Ozozen, Orkide Minareci and Ersin Minareci (2008): Determination of heavy metals in of fishes, water and sediment from the Demirkoprill Dam lake (Turkey). JABS, 2(3): 99-104.

Macek, K.J., Hatchinson, C. and Cope, O.B. (1969): Bull. Environ. Contam. Toxicol. 4 : 174.

Paul E.A., Simonin and tomajer (2005): A comparison of the toxicity of synergized and technical

formulations of toxicant. *Arch. Environ. Contam. Toxicol*. 48: 251-259.

Pickering, Q. H., Herdeerson, C and Lomte, A.E. (1968): Trans Am. Fish Soc. 91:175.

Mujumdar, T.N. and Gupta, A (2008): Acute toxicity of endosulfan and malathion on *Chironomus ramosus* (Insecta: Diptera:Chironomidae) from north Cachar hills, Assam, India. Journal of Environmental Biology, 30(3): 469-470.

(NDES) Niger Delta Environmental Survey (1999): Phase I Report, Vol.1 Environmental and Socio-economic characteristic (Revised edition).

Shanmugam, M., Venkateswarlu, M. and Naveed, A. (2000): Effect of pesticides on the freshwater crab, *Barytelphusa cunicularis* (Westwood). J. Ecotoxicol. Environ. Monit, 10: 273-279.

Tinsley, I.J., (1979): Chemical concepts in pollutants behavior. J. Willey and Sons Inc. NY.

Ramana Rao, K.V., Rao, K.S., Sahib, I.K.A. and Sivaiah, S. (1987): Different toxicity of methyl parathion and Malathion on some selected aquatic species. Proc. Nat. Acad. Sci. India, 57: 367-370.

Ruiz, M. J., Lopez- Jaramillo, L., Redondo, M. J. and Font, G. (1997): Toxicityassessment of pesticides using the Microtox test application to environmental samples. Bull. Environ. Contam. Toxicol.59, 619-625.

Vinodhini, R. and Narayanan, M. (2008): Bioaccumulation of heavy metals in organs of freshwater fish *Cyprinus carpio* (Common carp). Int. J. Environ. Sci.Tech., 5 (2), 179-182.

Vutukuru.S.S. (2005): Acute effects of hexavalent chromium on survival, oxygen consumption, hematological parameters and some biochemical profiles of the Indian major carp, *Labeo rohita.* Int.J. Environ.REs. Public Health, 2 (3), 456-462.

Weimin Y, Batley G.E. and Ahsanullah M. (1994): Metal bioavailability to the soldier crab, *Mictyris longicarpus.* The Science of the Total Environment. 141:27-44.