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Effect of Copper and Lead in Freshwater Mollusc Corbicula sp.

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Abstract

Laboratory experiments were carried out on adult freshwater bivalve Corbicula sp. to assess mortality and behavioral changes when exposed to two heavy metals copper (Cu) and lead (Pb). In this study acute toxicity tests of 24 – 96 hours were conducted to determine the different lethal concentrations of the metals. The mortality was recorded after every 24, 48, 72, and 96 hours. The criteria of death were white mucus secretion, immobilization and lack of response to touching of the body parts, floating on the surface of the water, and valves remain open. During the study behavioral changes were also observed. The median lethal concentration (LC_{50}) values at 24, 48, 72, and 96 h of Cu were found to be 75.949, 37.172, 21.651, and 14.884 mg L^{-1}, and of Pb were 1029.741, 323.714, 269.906, and 236.108 mg L^{-1}, respectively for Corbicula sp. The implications of these findings on the occurrence of this species in various freshwater ecosystems of Barak Valley is discussed.

Keywords: Acute toxicity, behavior, bivalve, LC_{50}

1. Introduction

Metal pollution in aquatic ecosystems has been recognized as a serious and increasing environmental problem worldwide. Copper is an essential element to most life forms at low concentrations, but is toxic to aquatic organisms at high bioavailable concentrations (USEPA, 2007). Lead is non-essential metal and its toxic effect is known to be higher than the essential metals (Zhiyou et al., 2016).

Toxicity testing has been widely used to identify suitable organisms as bio-indicator and to derive water quality standards. Acute toxicity test usually provides estimates of the exposure concentration causing 50% mortality (LC_{50}) to test organisms during specified period of time (Johnson and Finley, 2016). Sensitive end-points are the very important requirements in toxicity tests, and behaviour changes are one of the criteria in fulfilling requirements. Freshwater molluscs are used in biomonitoring purposes (Viarengo et al., 2007). A mollusc species Corbicula fluminea of Genus: Corbicula, is recognized as a bioaccumulator of contaminants (Graney et al., 1983; Hartley and Johnson, 1983) and used as a bioindicator of trace metals in fresh water (Elder and Collins, 1991). Corbicula sp., also known as Asiatic clam are biologically filter feeding freshwater bivalves which filter the water with a lifespan of 1 – 3 years. Studies on toxicity of this species due to metals is very scarce in this region.

2. Objective

In this research work a trial is being made to evaluate the toxicity of metals copper (Cu) and lead (Pb) on the mollusc species Corbicula sp.

3. Materials and methods

3.1 Procurement of Metal

The metals used in the experiments were Lead Nitrate, Molecular formula: $Pb(NO_3)_2$ and Cupric Chloride, Molecular formula: $CuCl_2.2H_2O$. Manufactured by Thermo Fisher Scientific India Pvt. Ltd, Mumbai, India.

3.2 Sampling

Corbicula sp. of approximately similar size were handpicked from the Ghaghra river, Cachar, Assam, India during February, 2021 – April, 2024 and brought to laboratory in a plastic bucket with some river water in it.

3.3 Acclimatization

Molluscs were acclimatized in an aquarium in the laboratory 7 days. Aeration was provided and food was not supplied.

3.4 Range finding test

To find out the probable range of concentrations the range finding test was conducted for 24 h before the acute test. Concentrations of low and high were used in this test.

3.5 Acute toxicity test

The acute toxicity of Cu and Pb was done by following "a static-with-renewal 96 h bioassay" method (OECD, 1992). Test solution was made by taking tap water and the various concentrations of Cu and Pb. The test solution was renewed every 48 h during the experiment. Approximately of similar size (length 12 ± 0.6 mm, width 9 ± 0.2 mm, weight 0.271 ± 0.2 g) animals were selected for the use in the experiment. Total 7 animals were kept in the control (without added metal), and different concentrations of Cu and Pb. Neither food nor aeration were provided during the experiment. If there were any dead organisms, they were recorded and removed from the test solution after every 24 h till 96 h. The lethal concentrations (LC) were estimated by log-probit analysis (Finney, 1971) with the help of SPSS 20 statistical software for Windows. The criteria of mortality were milky white mucus secretion, prolonged extensive foot protrusion outside the shell, immobilization, lack of response to touching of the body parts, floating on the surface of the test medium, and valves remaining open.

Based on the range finding tests, the clams were exposed to different concentrations of Cu and Pb:

1) Nominal concentrations of Cu 66.96, 119.04, 208.32, and 230.64 mg L^{-1}

2) Nominal concentrations of Pb 1250, 1750, 2000, and 2250 mg L^{-1}.

4. Results and Discussion

4.1 Acute toxicity

The LC_{10}, LC_{25}, LC_{50}, LC_{75} and LC_{90} values of Cu for Corbicula sp. at 24, 48, 72 and 96 h were found to range from 36.915 – 156.258 mg L^{-1}, 12.474 – 110.771 mg L^{-1}, 10.301 – 45.507 mg L^{-1}, and 9.405 – 23.554 mg L^{-1} (Table 1). The median lethal concentration (LC_{50}) values of Cu at 24, 48, 72 and 96 h for Corbicula sp. were found to be 75.949, 37.172, 21.651, and 14.884 mg L^{-1} (Figure 1).

The LC_{10}, LC_{25}, LC_{50}, LC_{75} and LC_{90} values of Pb for Corbicula sp. at 24, 48, 72 and 96 h were found to range from 327.478 – 3237.977 mg L^{-1}, 236.804 – 442.52 mg L^{-1}, 212.592 – 342.671 mg L^{-1}, and 179.288 – 310.936 mg L^{-1} (Table 2). The median lethal concentration (LC_{50}) values of Pb at 24, 48, 72 and 96 h for Corbicula sp. were found to be 1029.741, 323.714, 269.906, and 236.108 mg L^{-1} (Figure 2).

Present study LC_{50} value of Cu at 96 h (14.884 mg L^{-1}) of Corbicula sp. is higher from the results of Rodgers et al. (1980) of Corbicula fluminea (0.09 mg L^{-1}), and of Harrison et al. (1984) of Corbicula man-

ilensis (2.6 mg L^{-1}).

The obtained LC_{50} value of Pb at 96 h (236.108 mg L^{-1}) of Corbicula sp. is lower than the value reported by Labrot et al. (1999) in Corbicula (1023.32 mg L^{-1}). The difference may be due to the difference in type of species.

Table 1: LC values of copper for Corbicula sp.

Species	Duration	LC10	LC25	LC50	LC75	LC90
Corbicula sp.	h24	36.915	51.954	75.949	111.026	156.258
	h48	12.474	20.924	37.172	66.038	110.771
	h72	10.301	14.645	21.651	32.008	45.507
	h96	9.405	11.69	14.884	18.951	23.554

Table 2: LC values of lead for Corbicula sp.

Species	Duration	LC10	LC25	LC50	LC75	LC90
Corbicula sp.	h24	327.478	563.464	1029.741	1881.871	3237.977
	h48	236.804	274.602	323.714	381.609	442.52
	h72	212.592	238.041	269.906	306.035	342.671
	h96	179.288	204.261	236.108	272.921	310.936

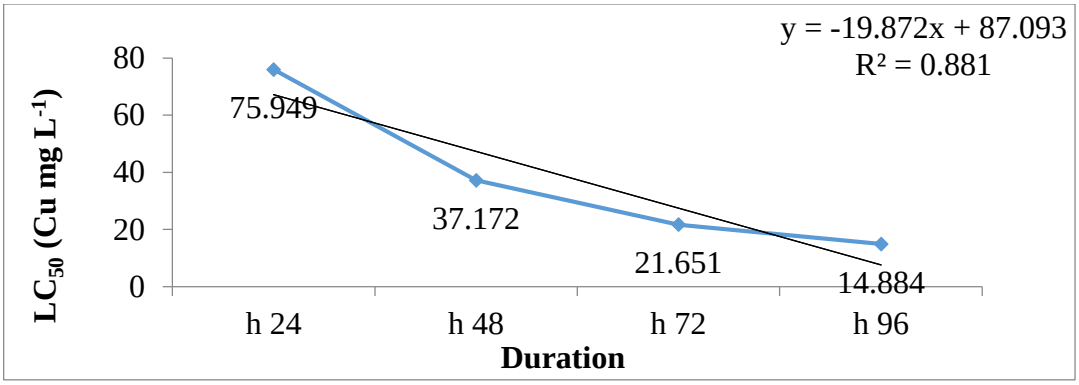


Figure 1: 24 - 96 h LC_{50} values of Cu for Corbicula sp.

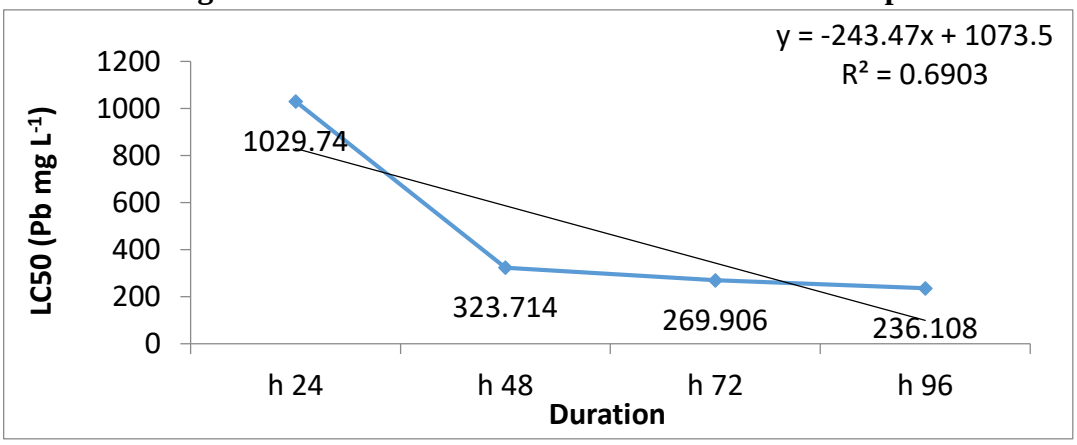


Figure 2: 24 - 96 h LC_{50} values of Pb for Corbicula sp.

4.2 Behavioral response

Table 3: Behavior responses of Corbicula sp. in control and Cu and Pb exposed group

Sl. No.	Type of response	Behavior of bivalve in control	Behavior of bivalve in Cu and Pb toxic condition
1	Protective response	Quick response	Valves closed
2	Movement	Regular locomotion	Reduced locomotion or absent
3	Mucus secretion	No	White colored secretion
4	Response to stimuli	Yes	Very poor or no response

Some behavioral changes such as secretion of white coloured milky mucus, reduction or complete absence in movement, and closing of valves in the Cu and Pb exposed media were observed. No mucus secretion and regular movements were observed in the Corbicula sp. in the control. Such kind of behavior responses were also reported by Kumar et al. (2012) and Yasmeen and Begum (2015) in freshwater bivalve Lamellidens marginalis in toxicity to cypermethrin and mercury, respectively. Toxic effect of Cu on reduction of crawling speed in Lymnaea sp., Bellamya sp., and Planorbis sp. was also reported by Nijira and Sangita (2025).

5. Conclusion

Exposure of freshwater bivalve Corbicula sp. to high concentrations of copper and lead have caused mortality and behavioral changes. It may be concluded that copper is more toxic compared to lead to Corbicula sp. Their presence can indicate the environmental conditions of that aquatic system. Further study and increase in information about the physiological processes will certainly help in adding information about the modes of actions of pollutants and hence, may help in development of water quality criteria.

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References

1. Brahma, N., and Bhowmik, S., “Effect of copper on crawling speed in the freshwater snails Pila globosa, Lymnaea sp., Planorbis sp., and Bellamy sp.”, International Journal of Enthomology Research, 2025, 10 (12), 117 – 120.
2. Elder, J.F., and Collins, J.J., “Freshwater molluscs as indicators of bioavailability and toxicity of metals in surface-water systems. Review on Environmental Contamination and Toxicology”, 1991, 122, 37 – 79.
3. Finney, D.J., “Probit analysis: A statistical treatment of the sigmoid response curve”, third ed. Cambridge University Press, 1971, pp 318.
4. Graney, R.L., Cherry, D.S., and Cairns, J.Jr., “Heavy metal indicator potential of the Asiatic clam (Corbicula fluminea) in artificial stream systems”, Hydrobiologia, 1983, 102, 81 – 88.
5. Harrison, F.L., Knezovich, J.P., and Rice, D.W., Jr., “The toxicity of copper to the adult and early life stages of the freshwater clam, Corbicula manilensis”, Archives of Environmental Contamination and Toxicology, 1984, 13, 85 – 92.

6. Hartley, D.M., and Johnston, J.B., "Use of the fresh water clam Corbicula manilensis as a monitor for organochlorine pesticides", Bulletin of Environmental Contamination and Toxicology, 1983, 31, 33 – 40.
7. Johnson, W.W. and Finley, M.T., "Handbook of acute toxicity of chemicals to fish and aquatic invertebrates: summaries of toxicity tests conducted at Columbia National Fisheries Research Laboratory", 2026, 1965-78.
8. Kumar, S., Pandey, R.K., Das, S., and Das, V.K., "Acute toxicity and behavioural responses of a freshwater mussel Lamellidens marginalis (Lamarck) to dimethoate exposure", Recent Research in Science and Technology, 2012, 4 (11), 39 – 45.
9. Labrot, F., Narbonne, J.F., Ville, P., Saint Denis, M., and Ribera, D., "Acute toxicity, toxicokinetics, and tissue target of lead and uranium in the clam Corbicula fluminea and the worm Eisenia fetida: comparison with the fish Brachydanio rerio", Archives of Environmental Contamination and Toxicology, 1999, 36, 167 – 178.
10. OECD, "Guideline for testing of chemicals", Adopted by the council on 17th July, 1992, 203, 1 – 9.
11. Rodgers, J.H., Cherry, D.S., Graney, R.L., Dickson, K.L., and Cairns, J., Jr., "Comparison of heavy metal interactions in acute and artificial bioassay techniques for the Asiatic clam (Corbicula fluminea)", In Eaton, J.G., Parish, P.R., Hendricks, A.C. eds. Aquatic Toxicology, ASTM STP 707, Philadephia: American Society for Testing and Materials. 1980, pp. 266 – 280.
12. USEPA, "Aquatic life ambient freshwater quality criteria – copper", EPA-822-R-07-001. Office of Water, 4304T, Washington, DC, 2007.
13. Viarengo, A., Lowe, D., Bolognesi, C., Fabbri, E., and Koehler, A., "The use of biomarkers in biomonitoring: a 2-tier approach assessing the level of pollutant induced stress syndrome in sentinel organisms", Comparative Biochemistry and Physiology, 2007, 146, 281 – 300.
14. Yasmeen, S., and Begum, S. M., "Effect of mercury on behaviour of the freshwater bivalves L. marginalis in different time hours. International Science Journal, 2015, 2 (1), 2348 – 6058.
15. Zhiyou, F.U., Fengchang, W.U., Chen, Lulu, Bingbing, X.U., Feng, Chenglian, Bai, Yingchen, Liao, Haiqing, Sun, Siyang, Giesy, John P., Guo, and Wenjing, "Copper and zinc, but not other priority toxic metals, pose risks to native aquatic species in a large urban lake in Eastern China", Environmental Pollution, 2016, 219, 1069 – 1076.