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Acute Toxicity of Copper in Selected Mollusc Species of Barak Valley

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ABSTRACT

The acute toxicity of Copper (Cu) in selected mollusc species viz, *Lamellidens* sp. (Hanley & Theobald, 1833), *Parreysia* sp. (Mueller, 1774), and *Brotia* sp. (Rafinesque, 1833) was evaluated. The median lethal concentration (LC_{50}) values of Cu at 24, 48, 72 and 96 h were found to be 51.381, 21.083, 12.148 and 8.336 mg L^{-1} for *Lamellidens* sp.; 0.690, 0.395, 0.196 and 0.143 mg L^{-1} for *Parreysia* sp.; and 1.589, 0.512, 0.198 and 0.057 mg L^{-1} for *Brotia* sp. Order of sensitivity of selected mollusc species to Cu was found to be: *Brotia* sp.>*Parreysia* sp.> *Lamellidens* sp. The implications of these findings on the occurrence of these species in various freshwater ecosystems of Barak Valley is discussed.

Keywords: Acute toxicity, *Lamellidens* sp., *Parreysia* sp., *Brotia* sp.

1. Introduction

Copper (Cu) is an essential element to most life forms. However, at high bioavailable concentrations, Cu becomes toxic. With its application in industry and agriculture (e.g., Cu containing fungicides and herbicides), Cu release from these sources into the environment is substantial (Alva et al., 1995; US DA, 2006; Hoang et al., 2008). In Asia, recent industrial and economic development has increased pressure to the environment. Cu^{2+} ions are known to be particularly toxic to a wide variety of aquatic organisms (Anderson and Morel, 1978; Toledo et al., 1979; Brown and Rattigan, 1979; Muramoto, 1982; Peterson, 1982; Tanaka et al., 1982; Zamada and Sunda, 1982; Andrew et al., 1977; Swartzman et al., 1990; Xue and Sigg, 1990). Studies on heavy metal pollution especially using molluscs as bioindicators in Assam in particular and North East India as a whole, are still scarce. Therefore, it is important to conduct studies with local species that can be used to gain data on metal toxicity, to determine the organism's sensitivity and to derive a permissible limit for water that can protect the local aquatic communities. The freshwater molluscs of the region are common, and most extant species are relatively easy to collect. A total of 16 molluscan taxa belonging to 2 classes, viz., Gastropoda and Bivalvia, 4 orders, 5 families and 9 genera were recorded from 12 different sites on River Barak and its tributaries like Chiri, Sonai, Rukni, Ghagra and Katakhal. Of the 16 species, 5 gastropods and 2 bivalves were recorded in a few sites only and appeared to be sensitive to anthropogenic disturbances (Roy and Gupta, 2010). Molluscs have long been regarded as promising bioindicators and biomonitoring subjects. They are abundant in aquatic ecosystems, being easily available for collection.

In our research work a trial was being made to evaluate the acute toxicity of Cu in selected mollusc species viz, *Lamellidens* sp. (Hanley & Theobald, 1833), *Parreysia* sp. (Mueller, 1774), and *Brotia* sp. (Rafinesque, 1833).

2. Materials and Methods

2.1 Collection and Maintenance of Molluscs

Brotia sp. of length, breadth, weight 45± 3.25 mm ,14.1 ± 2.23 mm, 5.21 ± 1.3 g; *Lamellidens* sp. of length, breadth, weight 75.18 ± 4.15 mm, 33.22 ± 3.45 mm, 34.42 ± 3.5 g; *Parreysia* sp. of length, breadth, weight 37 ± 2.2 mm, 29 ± 2.2 mm, 9.58 ± 0.7 g , respectively were handpicked directly from the stream Salganga, Silcoori, Cachar, India. The collected mollusc species were brought to the laboratory and reared in glass aquaria (60 x 30 x 30) cm of 40L capacity and acclimatized for about 7 days prior to the experiment in the laboratory condition. They were not fed during the acclimatization to void gut contents. Aeration was provided continuously and water was renewed every day. During the acclimatization, dead mollusc, if any, were removed to prevent water from fouling.

2.2 Metal Procurement

The metals used in the present study was Cupric Chloride, Molecular formula: $CuCl_2.2H_2O$. Manufactured by Thermo Fisher Scientific India Pvt. Ltd, Mumbai, India.

2.3 Acute Toxicity Test

After acclimatization, a range finding test was conducted with two selected concentrations before the definitive test which enables to know the appropriate range of concentrations. A static-with-renewal 96 h bioassay test was performed with renewal of test solution every 48 h. Groups of experimental organisms consisting of 7 individuals each were selected at random and used in the control and each metal treatment concentrations. Food was withheld one day prior to the experiment, and the test organisms were not fed during the experiment. Similarly, controls were also maintained in which no metal was added. Mortality was recorded at 24, 48, 72 and 96 h, and dead organisms if any, were remove (OECD, 1992). The lethal concentrations (LC) for all the test species were estimated by log-probit analysis according to Finney (1971) with the help of SPSS 20 statistical software for windows.

The end points of mortality in acute toxicity test (Brahma and Gupta, 2020; Brahma, 2023):

1) In Gastropod - no movement, discharge of milky white substance, lots of bubbles from the buccal mass, operculum remain protruded outside the shell and float on the surface of the solution.

2) In Bivalves – no movement, discharge of large amount of milky white substance, valves remain open, foot extensively remains protruded outside the shell and float on the surface of the solution.

3. Results and Discussion

The physico-chemical properties of the test medium (Table 1): temperature 16 – 8°C ; pH 5.4 – 6.5; Electrical Conductivity 70.2 µS/cm ; Dissolved Oxygen (DO) 8.34 – 10.93 mg L^{-1}; Alkalinity 5 – 6 mg L^{-1}; Total Hardness 8 – 10mg L^{-1} ; Free CO_2 1.2 – 1.8 mg L^{-1}. The values were found to be in the suitable range during the test.

Duration and Lethal Concentration (LC) values LC_{10} – LC_{90} at h 24 – h 96 of *Lamellidens* sp, *Parreysia* sp., and *Brotia* sp. in metal copper are given in Table 2.

The LC_{10}, LC_{25}, LC_{50}, LC_{75} and LC_{90} values of Cu for *Lamellidens* sp. at 24, 48, 72 and 96 h were found to range from 22.010– 119.942, 6.192 – 71.781, 5.338 – 27.646 and 5.206 – 13.347 mg L^{-1}, respectively. The median lethal concentration (LC_{50}) values of Cu at 24, 48, 72 and 96 h for *Lamellidens* sp. were found to be 51.381, 21.083, 12.148 and 8.336 mg L^{-1}, respectively.

The LC_{10}, LC_{25}, LC_{50}, LC_{75} and LC_{90} values of Cu for *Parreysia* sp. at 24, 48, 72 and 96 h were found to range from 0.315 – 1.512, 0.166 – 0.941, 0.080 – 0.543 and 0.070 – 0.290 mg L^{-1}, respectively. The median lethal concentration (LC_{50}) values of Cu at 24, 48, 72 and 96 h for *Parreysia* sp. were found to be 0.690, 0.395, 0.208 and 0.143 mg L^{-1}.

The LC_{10}, LC_{25}, LC_{50}, LC_{75} and LC_{90} values of Cu for *Brotia* sp. at 24, 48, 72 and 96 h were found to range from 0.239 – 10.570, 0.131 – 2.007, 0.052 – 0.752 and 0.016 – 0.205 mg L^{-1}, respectively. The median lethal concentration (LC_{50}) values of Cu at 24, 48, 72 and 96 h for *Brotia* sp. were found to be 1.589, 0.512, 0.198 and 0.057 mg L^{-1}, respectively.

Order of sensitivity of selected mollusc species to Cu was found to be: *Brotia* sp.>*Parreysia* sp.> *Lamellidens* sp. Patil and Mahajan (2012) found the 24, 48, 72 and 96 h LC_{50} of cupric chloride for *Lamellidens corrianus* to be 1.95, 1.85, 1.69 and 1.4 mg L^{-1} and those for cupric sulphate to be 1.98, 1.95, 1.92 and 1.67 mg L^{-1}. These values are lower than the 24, 48, 72 and 96 h LC_{50} values for *Lamellidens* sp. found in the present study, which are 62.026, 20.980, 12.536 and 8.478 mg L^{-1}, respectively. Thus *Lamellidens* sp. appears to be more resistant to Cu toxicity than *L. corrianus*. On the contrary, 24-96 h LC_{50} values of Cu for *Parreysia* sp. range from 0.69 – 0.143 mg L^{-1}, which are lower than those found for *L. corrianus*, indicating higher sensitivity of *Parreysia* sp. Shuhaimi-Othman et. al. (2012) found the LC_{50} value for the 96h exposure of *Melanoides tuberculata* (Gastropod) to Cu as 0.14 mg L^{-1}, which is lower in case of *Brotia* sp. (Gastropod), which is 0.057 mg L^{-1}.

Table 1: Variations of some physico-chemical parameters in test water used in acute toxicity tests (with copper, in h 96)

Species	Conc. of Cu (mgL^{-1})	Dissolved Oxygen Mean ± SD (mgL^{-1})	Total Alkalinity Mean ± SD (mgL^{-1})	Total Hardness Mean ± SD (mgL-1)	Free CO2Mean ± SD (mgL-1)	pH Mean ± SD	Conductivity Mean ± SD (μS)
Lamellidens sp.	0	6.35 ±0.3	64.28 ±0.42	120.62 ±0.81	17.17 ±0.27	6.52 ±0.17	70.53 ±0.51
	5.8	6.48 ±0.19	16.48 ±0.63	300.14 ±8.49	11.23 ±0.27	5.52 ±0.21	279.62 ±2.17
	10.44	5.74 ±0.11	45.18 ±0.78	175.75 ±0.74	33.37 ±1.06	6.28 ±0.47	379.88 ±6.9
	18.56	4.44 ±0.25	44.81 ±0.26	199.76 ±2.8	53.58 ±0.43	6.38 ±0.25	473.92 ±3.29
	32.48	2.62 ±0.32	52.83 ±0.47	104 ±5.81	65.46 ±1.19	6.44 ±0.27	152.89 ±3.13
Parreysia sp.	0	6.75 ±0.2	52.89 ±5.04	97.25 ±6.82	17.15 ±1.87	6.30 ±0.34	71.42 ±2.06
	0.116	6.39 ±0.3	101.97 ±2	149.03 ±2.21	19.92 ±2.86	5.37 ±0.11	236.12 ±51.16
	0.232	5.67 ±0.43	154.38 ±5.7	329.63 ±12.82	46.21 ±1.43	5.59 ±0.06	304.21 ±9.08
	0.348	4.86 ±0.19	309.31 ±0.8	447.43 ±3.25	39.92 ±1.16	5.66 ±0.28	507.63 ±1.02
	0.464	5.76 ±0.28	239.88 ±1.36	32.43 ±0.43	54.99 ±0.6	6.18 ±0.16	222.30 ±2.47
Brotia sp.	0	10.75 ±0.73	59.83 ±0.93	69.19 ±1.22	16.72 ±0.88	6.48 ±0.13	77.66 ±0.84
	0.115	7.44 ±0.58	40.92 ±0.64	244.88 ±1.06	23.65 ±1.23	5.60 ±0.16	184.11 ±1.32
	0.347	6.20 ±0.09	67.81 ±1.02	304.11 ±1.28	87.55 ±0.76	5.64 ±0.15	185.12 ±1.28

Species	**Conc. of Cu (mgL^{-1})**	**Dissolved Oxygen Mean ± SD (mgL^{-1})**	**Total Alkalinity Mean ± SD (mgL^{-1})**	**Total Hardness Mean ± SD (mgL-1)**	**Free CO2Mean ± SD (mgL-1)**	**pH Mean ± SD**	**Conductivity Mean ± SD (μS)**
	0.646	5.57 ±0.1	115.90 ±0.58	404.69 ±0.99	54.49 ±0.5	5.99 ±0.08	143.51 ±0.88
	1.071	4.34 ±0.19	123.80 ±0.62	415.37 ±0.52	120.52 ±0.69	6.29 ±0.13	454.53 ±4.87

Table 2: Duration and Lethal Concentration (LC) values LC_{10} – LC_{90} at h 24 – h 96 of different mollusc species in metal copper

Species	Duration (hours)	LC_{10}	LC_{25}	LC_{50}	LC_{75}	LC_{90}
Lamellidens sp.	**h24**	20.013	34.199	62.026	112.495	192.239
	h48	5.581	10.45	20.98	42.119	78.868
	h72	4.655	7.442	12.536	21.117	33.764
	h96	5.005	6.424	8.478	11.188	14.361
Parreysia sp.	**h24**	0.315	0.457	0.69	1.043	1.512
	h48	0.166	0.25	0.395	0.624	0.941
	h72	0.08	0.126	0.208	0.345	0.543
	h96	0.07	0.098	0.143	0.207	0.29
Brotia sp.	**h24**	0.239	0.586	1.589	4.308	10.57
	h48	0.131	0.25	0.512	1.051	2.007
	h72	0.052	0.098	0.198	0.4	0.752
	h96	0.016	0.029	0.057	0.112	0.205

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