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COMPARATIVE TOXICITY OF MERCURY AND CADMIUM TO THEFRESH WATER GASTROPOD SNAIL BELLAMYA BENGALENSIS (L.)

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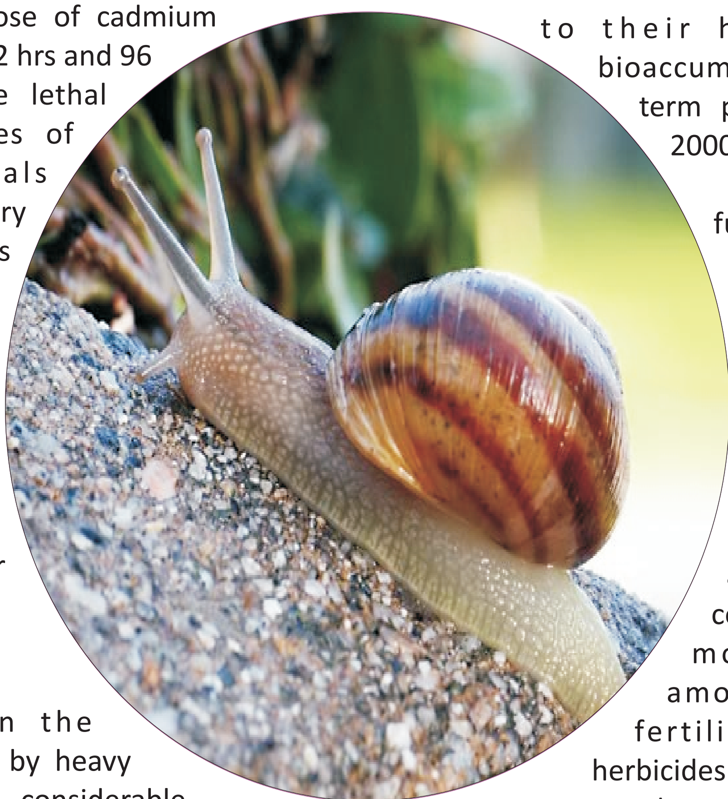
ABSTRACT:

The fresh water snail *Bellamya bengalensis (L.)* were exposed to mercuric chloride and cadmium chloride .Mortality was assessed for 24 hrs, 48 hrs, 72 hrs and 96 hrs. Lethal concentration (mean LC50) values for each heavy metal mercuric chloride and cadmium chloride was calculated. The median lethal concentration values of mercury were lower than those of cadmium after 24 hrs, 48 hrs, 72 hrs and 96 hrs exposure. The lethal concentration values of both heavy metals indicate that mercury was more toxic as compaired to that of cadmium.

KEYWORDS: Gastropod, Bellamya bengalensis (L.), LC_{50}, probit analys- is, heavy metals, water pollution.



INTRODUCTION :

Pollution in the aquatic environment by heavy metals has received considerable attention (Depledge M.H. 1994, Bryan G.W. 1984).Owing to their toxicity at very low levels, persistence in the environment and their ability to accumulate in the animal tissue. It is well known that metal toxicants seldom occur individually in the aquatic environment. Increased population, heavy metal industrialization, indiscriminate dumping and discharge of industrial effluents with petroleum waste contaminated the aquatic media (Wills J. 2000). Wide spread use of synthetic pesticides have been found to affect water bodies due to their high toxicity , bioaccumulation ,and long term persistence (Wills J. 2000).

Pesticides are help full when they are used in proper way . But due to indiscriminate use of these pesticides, it gets accumulate in air, water and soil to pollute the environment. In agricultural practi- ces, in order to take more yield, large amount of chemical fertilizers, pesticides, herbicides and molluchicides were used to control the pests. Toxic contents through run off find its way to water bodies (Awati A.A.2004).

Mercury is one of the most toxic metals. It causes protein denaturation in foot, gill and digestive tract of fresh water mussel and snails (Bhamre P.R. 1996, Arunee S. 1986). Mercury also inhibits both alkaline phosphatase and acid phosphatase activity in Macrobrachium rosenbergii, while cadmium inhibits only acid phosphatase activity (Piyatirativorakul P et.al. 1998). Cadmium has also been shown to be harm full to adult Physagyring (Wier C.G.1976) and also adversely affects the development of the veliger of this species (Cheung C.C. 1998) and Lymnea stagnalis (Gomot A. 1989).

Gastropods proved use full and were employed for biomonitoring of metal pollution, as they have importance in food chain and broad geographical range (Peden J.D.1973, Paster A. 1994 and Brown B.E. 1984). Mortality is nothing but death of an organism at a particular time. The death rate found to be increased tremandiously mainly due to environmental contamination . Environmental pollution has become global problem because of undesirable change in air, land and water, which has threatened animal life (Menzel D.W. 1977).

The purpose of present study is to determine the acute toxicity of two heavy metals mercuric chloride and cadmium chloride in fresh water gastropod snail Bellamya bengalensis (L.) during 4-days static bioassay experiment.

Material and methods:

Selection and collection of experimental animals:

The gastropod snail *Bellamya bengalensis* (Viviparus) were collected from the suki dam near Garbardi village Tal Raver Didt Jalgaon (M.S.). The gastropods were acclimatized to laboratory condition for 2 to 3 days, before setting the experiments. Water was changed after every twelve hours. Healthy and active animals of approximately same size (25 to 30 mm) and weight were chosen to avoid the experimental bias.

Experimental design:

The experimental toughs containing 5 liters dechlorinated water were used to maintain the animals. Stock solution of the toxicant mercuric chloride, cadmium chloride and lead nitrate were prepared in double distilled water and added to the test medium to get the desired concentration. Ten snails were exposed to 10 to12 different concentrations of heavy metal salts. After every 12 hours the water with heavy metal salt form each tough was changed by the fresh solution of the same concentration of respective heavy metal salt. Dead gastropods were counted individually. The criteria for death were the failure of animal to respond to the prickining of its foot with a needle or release of the major body mass from the shell. The resulting mortality was noted in the range of 10% to 90 % for each concentration for the duration of 24, 48, 72 and 96 hours. Each experiment was repeated trice to obtain the accurate results. The acute toxicity test were carried out under static conditions up to 96 hours .The data collected was then analyzed statistically by means of the probit analysis on transforming the toxicity curve (% mortality versus log of concentration) into regration lines (mortality in probit / log concentration) , which allows the average medium lethal concentration of LC_{50} to be calculated for 24,48,72 and 96 hours.

Results:

The LC_{10} values, LC_{50} values ,variance values 'V', fidducial limits , safe concentrations, and lethal dose of two heavy metal salts of mercuric chloride ($HgCl_2$)and cadmium chloride ($CdCl_2$) observed during acute toxicity test are summarized in table number 1.1 , 1.2 and 1.3.

Table 1 .1. Relative toxicity of heavy metal salts ($HgCl_2$ and $CdCl_2$) to *Bellamya bengalensis*

Sr. No.	Name of Heavy Metal salt	Exposure time in Hrs.	Regration equation $Y = y + b(X - \overline{X})$	Lc_{50} Value ppm	Variance 'V'	chi?Value
1	$HgCl_2$	24	17.3940 x -3.7149	3.17	0.000126732	1.284495
		48	19.4783 x -2.90997	2.54	0.000106635	0.0670487
		72	7.3752 x + 3.426360	1.63	0.000651304	0.49572629
		96	13.2261 x + 3.1568	1.37	0.000221385	0.053213837
2	$CdCl_2$	24	23.50796 1x -9.823606	2.26	0.000066404	0.21863629
		48	21.345834 x -6.779742	3.17	0.000080980	0.39584006
		72	16.767527 x-2.179789	2.67	0.000141944	0.04718371
		96	11.782096 x +0.765316	2.28	0.00026402	0.76229225

Table 1 .2. Relative toxicity, fiducial limits, lethal dose, safe concentration of heavy metal salts ($HgCl_2$ and $CdCl_2$) to *Bellamya bengalensis*

Sr. No.	Name of Heavy Metal salt	Exposure time in Hrs.	Fiducial limits (ppm)		Lethal dose (ppm)	Safe Conc. 'C'(ppm)
			M_1	M_2		
1	$HgCl_2$	24	0.47913523	0.52326476	76.08	0.4929
		48	0.38585021	0.42632978	121.92	
		72	0.16327950	0.21329999	117.36	
		96	0.12442098	0.154179012	131.52	
2	$CdCl_2$	24	0.61973622	0.65767975	50.24	1.8717
		48	0.53416119	0.56943880	152.16	
		72	0.4047485	0.45145148	192.24	
		96	0.34379543	0.37503656	218.88	

Table 1. 3. Comparison of safe concentration, LC_{10} values and LC_{50} values of heavy metal salts Hg Cl_2, $CdCl_2$.

	Name of heavy metal salt	Safe concentration 'C' (ppm)	Lc_{10} Value ppm				Lc_{50} Value ppm			
			24 hrs.	48hrs.	72 hrs.	96 hrs.	24 hrs.	48hrs.	72 hrs.	96 hrs.
	$HgCl_2$	0.04929	2.675	2.189	0.01096	0.01103	3.171	2.547	1.634	1.378
	$CdCl_2$	1.8717	3.784	3.097	2.246	1.780	2.266	3.176	2.673	2.288

The LC_{10} values for 24, 48, 72 and 96 hours exposure to Mercuric chloride (H_gCl_2) are 2.675, 2.189, 0.01096 and 0.01103 ppm respectively. The LC10 values for 24, 48, 72 and 96 hours exposure to Cadmium chloride ($CdCl_2$) are 3.784, 3.097, 2.248 and 1.780 ppm respectively.

The LC50 values for 24, 48, 72 and 96 hours exposure to Mercuric chloride ($HgCl_2$) are 3.171, 2.909, 1.634 and 1.378 ppm respectively. The LC_{50} values for 24, 48, 72 and 96 hours exposure to

Cadmium chloride ($CdCl_2$) are 4.266, 3.176, 2.673 and 2.288 ppm respectively. The Lc_{50} values for Mercuric chloride ($HgCl_2$) are very low as compaired to Cadmium chloride ($CdCl_2$).

The accuracy of standard error or variance values for 24, 48, 72 and 96 hours for Log LC_{50} for Mercuric chloride ($HgCl_2$) were 0.000126732, 0.000106635, 0.000651304 and 0.000221385 respectively. The accuracy of standard error or variance values for 24, 48, and 72 and 96 hours Log LC50 for Cadmium chloride ($CdCl_2$) were 0.000064404, 0.000080988, 0.000141944 and 0.00026402 respectively.

Fiducial limits for Mercuric chloride ($HgCl_2$) for 24, 48, 72 and 96 hours exposure were 0.47913523 to 0.52326476, 0.38585021 to 0.42632978, 0.16327950 to 0.213299990 and 0.12442098 to 0.0.154179012 ppm respectively. Fiducial limits for Cadmium chloride ($CdCl_2$) for 24, 48, 72 and 96 hours exposure were 0.61973622 to 0.65167975, 0.53416119 to 0.56943880, 0.4047485 to 0.45145148 and 0.34379543 to 0.37503656 ppm respectively

The safe concentrations values for Mercuric chloride ($HgCl_2$) and Cadmium chloride ($CdCl_2$) are 0.4929 and 1.8717 ppm respectively.

The lethal dose values for heavy metals Mercuric chloride ($HgCl_2$) and Cadmium chloride ($CdCl_2$) for 24, 48, 72 and 96 hours exposure were 76.08, 121.92, 121.92, and 50.24, 152.16, 192.24, 218.88 respectively.

The order of toxicity in decreasing manner is Mercuric chloride ($HgCl_2$) > Cadmium chloride ($CdCl_2$)

Discussion:

The evaluation of lethal concentration (LC_{50}) of pollutants is an important step before carrying out further studies on physiological changes in animals. Pollutants at very low concentrations might be perceived by organism's sensory system. If the stimulant is recognized harmful, avoidance may follow leading to escape in motile organisms, but in those forms with little or no mobility such as fresh water bivalves and gastropods, avoidance may take in the form of reducing exposure of external body surface through mucous production, which is used in locomotion and feeding (patil , 1999).

Shuhaimi *e .al.* (2012) studied the toxicity of metals to a fresh water snail , *Mellanoid tuberculata* and noted that the LC50 values for 96 hours exposure to Cu, Cd , Zn, Pb, Ni, Fe Al and Mn were0.14, 1.49, 3.90, 6.82, 8.46, 8.49, 68.23 and 45.59 mg/lit. The order of toxicity in decreasing manner is cu > cd > Zn > Pb > Ni > Fe > Mn > Al. In present investigation also the order of toxicity is Hgcl2 > Cdcl2 > PbNo3.The comparison of LC50 values for the metals for this species with those of the other gastropods revels that *Bellamya bengalensis* is equally sensitive to metals.

Pansiri *et al.* (2008) studied the comparative toxicity of mercury and cadmium to the juvenile fresh water snail, *Filopaludina martiensi martiensi* and observed that the 96 hours Lc_{50} value for Hg was 0.61 ppm and the 96 hours LC_{50} value for Cd was 2.35 ppm. This indicates that Mercury is more toxic than Cadmium.

Preecha (1979) studied the heavy metal toxicity to calm *Donax Faba cheminitz* and found that 96 hours LC_{50} value for Mercury to the calm was 0.16 ppm and also noted that Mercury is more toxic to calm *Donax faba* than Cd, Cu, and Zn.

Ramakritinan *et al.* (2012) studied the acute toxicity of metals: Cu, Pb, Cd, Hg and Zn on marine mollusc Cerithedia cingulata G., and Modiolus philippinaram H. The 96 hours LC_{50} of C. cingulata for Cu, Cd, Pb, Zn and Hg were 0.521, 9.193, 15.507, and 8. 990 , and 0.053 mg/lit. The 96 hours LC_{50} for M. philipanarium noted were 0.023, 0.221, 2.826, and 0.007 mg/lit in respective metals. This study indicates that the mercury was highly toxic to both C. *cingulata* and M. *philipanarium,* while lead was resistant metal to both marine mollusc tested. The order of incressing toxicity of metals to C.*cingulata* was Hg > Cu > Zn > Cd > Pb and M.philipanarium was Hg > Cu > Cd > Zn > Pb.

Mullajkar *et al.* (2012) noted the 96 hours LC_{50} for lead nitrate was 6.81 ppm and it seems to be less toxic than other heavy metals Mercury and Cadmium. Kamble *et al.* (2013) noted the 96 hours LC_{50} of Copper sulphate for *Bellamya bengalensis* was 0.40 ppm. Mahajan (2012) noted the 96 hours LC_{50} values of Lead nitrate for *Bellamya bengalensis* was 6.753 ppm.

The consequent information revealed that the decreasing rank order toxicity of heavy metals was Hg > Cd > Pb. The toxicity rank order of these heavy metals is correlated with the toxicity studies of heavy metals to some other fresh water animals. The toxicity rank order of some selected heavy metals to daphnia magna was Hg > Ag > Cu > Zn > Cr > Cd > Pb > Ni (Khangarot et al., 1987). The rank order toxicity for amphibian tadpoles, Bufo mellanosticus was Ag > Hg > Cu > Cd > Zn > Ni > Cr > Pb (Khangarot *et a.l,* 1987).

The rank order toxicity for pulmonate snail lymnea luteola was Ag > Hg > Cu > Ni > Cd > Zn > Cr (Khangarot and Ray 1988). Eilser and Hennkey (1977) conducted static bioassays using starfish, sand worm, hermit crab, soft shell calm, mud snail and mummi chog. They observed that mercury was the most toxic metal. The rank order toxicity for some heavy metals was Hg > Cd > Zn > Cr > Pb > Ni.

However, the Lc_{50} values of heavy metals mercuric chloride ($HgCl_2$) and cadmium chloride ($CdCl_2$) for *Bellamya bengalensis* in present study could not be compaired with those of other species because there were various factors influenced bioassay such as temperature, dissolved oxygen , pH and water hardness (Macek *et al.* 1969., Verma et al. 1977, Siriwan Jantame *et al.* 1966) , species succiptablity (Mack et al., 1970) or the variability in bioassay technique (Sudarat , 2004).

In present investigation also the gastropod species Bellamya bengalensis (L.) shows same rank order toxicity for the metals Mercuric chloride ($HgCl_2$),and Cadmium chloride ($CdCl_2$) as Hg > Cd However the degree of pollutant resistant of the organism varied with the species (Spraque, 1969).

In present investigation it was noted that the toxicity and succiptablity of Bellamya bengalensis varies significantly. The heavy metals mercuric chloride ($HgCl_2$), cadmium chloride ($CdCl_2$) showed fatal effects over the taste animals. Mercuric chloride ($HgCl_2$) was proved to be more toxic as compaired to Cadmium chloride ($CdCl_2$) while cadmium chloride ($CdCl_2$) is least toxic as compaired to mercuric chloride ($HgCl_2$), The LC_{50} values for mercuric chloride ($HgCl_2$) at 96 hours 1. 387 ppm was relatively less than values of cadmium chloride ($CdCl_2$) .During the present study of toxicity evaluation of the heavy metals to Bellamya bengalensis (L.). It was observed that the LC_{50} values were decreased as the time of exposure was increased.

Conclusion:

Among the two heavy metal pollutants salts Mercuric chloride ($HgCl_2$)and Cadmium chloride ($CdCl_2$), Mercury chloride is most toxic and Cadmium chloride ($CdCl_2$)is least toxic to gastropod snail Bellamya bengalensis (L.) The toxicity of heavy metals Mercuric chloride ($HgCl_2$) and cadmium chloride ($CdCl_2$) to gastropod snail *Bellamya bengalensis* (L.) were found to increase with exposure period. The rank order toxicity for the two heavy metals Mercuric chloride ($HgCl_2$)and Cadmium chloride ($CdCl_2$) was $HgCl_2$ > $CdCl_2$.

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