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Research Article

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Bioaccumulation study of mercury chloride in selected tissue of fresh water crab, *Barytelphusa guerini* from Aurangabad region

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ABSTRACT

Fresh water crabs are economically important because crabs are used as an alternative source of food by the people (Paithan region) residing near Godavari river and Nathsagar dam. The crabs serve as delicious food and hence it acts as significant human dietary constituents. Heavy metal and their salts containing effluents are directly discharged into the aquatic environment by many industries from Paithan and Aurangabad region. In the present investigation acute toxicity test was carried out to determine the LC_{50} values (lethal conc.) of mercury chloride by using static bioassay method. The LC_{50} values for 24, 48, 72 and 96 hrs of exposure were recorded as 2.820, 2.480, 2.257 and 1.980 ppm respectively. In the present study the mercury content in different body parts of fresh crab, B. guerini was studied. The mercury content was found high in all the tissues as compared to control group. The observations in the present study showed marked variation. The highest concentration of mercury encountered in gill.

Keywords: Mercury chloride, LC_{50}, Hepatopancreas, Muscle, Gills, Ovary, Testis.

INTRODUCTION

Heavy metal pollutants are a major problem in aquatic environment because of their toxicity, their persistency and tendency to accumulate in organisms and undergo food chain amplification. Heavy metal from man-made pollution sources are continually released into aquatic ecosystem [1]. Heavy metals can affect the aquatic organism as toxic substances in water and sediment or as a toxicant in the food chain [2,3]. Some heavy metals, which occur naturally in trace amounts in aquatic environments, are essential for the normal metabolism of aquatic organisms; hence, such certain metals are accumulated by the organisms for their physiological functions and use them as structural components. Other heavy metals such as cadmium, lead and mercury have no known beneficial effect and their consumption over the time in animals body can cause illness [4].

There are many reports in literature on metal accumulation usually differs between tissue and species. For example, in *Homarus americanus* cadmium accumulated mainly in the digestive gland, followed by the gills [5], but in *Callinects sapidus* cadmium accumulated mostly in the gills [6].

The present investigation was undertaken to know the effect of heavy metal on different tissues and determine the potential use of the freshwater crab, *Barytelphusa guerini*, as a bioaccumulative indicator of mercury pollution in aquatic ecosystems.

EXPERIMENTAL SECTION

Crabs were collected seasonally from Godavari River, (Paithan region) near Aurangabad. Experimental crabs were acclimatized for 2-4 days at laboratory condition and subjected to acute and chronic toxicity test with different concentrations of heavy metal ($HgCl_2$), which is prepared from stock solution. The static bioassay method is used to run the experiment of toxicity evaluation upon 96 hrs as described by Finney [7]. The mortality was recorded for the crab at 24, 48, 72 and 96 hrs exposure to mercury chloride were corrected for natural response by Abbott's formula [8].

Table 1: Relative toxicity of $HgCl_2$ to freshwater crab, *Barytelphusa guerini*

Heavy metal	Exposure period	Regression equation $Y = \bar{Y} + b(x-\bar{x})$	LC_{50} Value	Variance 'V'	$\chi 2$ Value	Fiducial limit (ppm)		Lethal dose	Safe conc. (ppm)
						m_1	m_2		
$HgCl_2$	24 hrs	8.686x(+4.6217)	2.820	0.0005	0.092	0.348	0.438	67.680	
	48 hrs	7.044x(+4.7407)	2.480	0.0007	0.295	0.292	0.400	119.04	0.38
	72 hrs	7.0219x(+4.6934)	2.257	0.0007	0.128	0.238	0.349	162.50	
	96 hrs	7.0770x(+4.6888)	1.980	0.0008	0.257	0.177	0.289	190.08	

Similarly chronic toxicity test were also run. However, animals were exposed for long duration at low dose i.e. $1/10^{th}$ of 96 hrs LC_{50} values taken for 10, 20, and 30 days and is referred as sub lethal concentration of $HgCl_2$.

In order to determine the heavy metal concentrations from different body tissues, 0.5 gm of dry weight of crabs were digested with 10 ml mixture of Nitric acid and perchloric acid (4:1) at 100^0C temperature till the clear solution obtained. Then it was cooled, filtered and diluted with distilled water. These solutions were analyzed for Hg metal by Atomic absorption spectrophotometer (Perkin Elmer). The data obtained were statistically analyzed for confirmation of the results. Metal toxicity from different tissues was calculated by using regression equation and results were expressed in µg /gm dry weight.

Table 2: Bioaccumulation of Hg content in different body parts of freshwater crab, *Barytelphusa guerini* during chronic exposure

Tissue	Control	10 days exposure	20 days exposure	30 days exposure
		LC_{50}	**LC_{50}**	**LC_{50}**
Gill	0.129 ±0.0015	0.221 ±0.001 (-71.31%)***	0.220 ±0.001 (-70.54%)***	0.238 ±0.003 (-84.49%)***
Muscle	0.118 ±0.001	0.195 ±0.001 (-65.25%)***	0.168 ±0.002 (-42.37%)***	0.193 ±0.001 (-63.55%)***
H.P.	0.103 ±0.002	0.152 ±0.001 (-47.57%)***	0.163 ±0.0015 (-58.25) ***	0.176 ±0.001 (-70.87%)***
Testis	0.095 ±0.001	0.130 ±0.002 (-36.84%)***	0.142 ±0.002 (-49.47%)***	0.149 ±0.001 (-56.84%)***
Ovary	0.098 ±0.001	0.138 ±0.001 (-40.81%)***	0.153 ±0.002 (-56.12%)***	0.175 ±0.0015 (-78.57%)***

Each value is the mean of three observations ± S.D.
*Values are significant at *** P< 0.001*
(Bracket value compared with control (*) and it indicate percent variation)

RESULTS AND DISCUSSION

Mercury Toxicity:
In the present investigation toxicity evaluation and bioaccumulation of heavy metal mercuric chloride was conducted on freshwater crab, *Barytelphusa guerini* and LC_{50} values were calculated during exposure period. The determination of LC_{50} values is highly useful in evaluation of safe level or tolerance of pollutant and it provides fundamental data for the design of more complex disposal models. It is [9] stated that the use of LC_{50} as a starting point in studies of sub lethal effects would be its most significant contribution.

The present investigation reveals that the LC_{50} values decreased as period of exposure increased. [10] reported that the LC_{50} values and the exposure period showed inverse relation. [11] Studied heavy metal ($HgCl_2$, $CuSO_4$ and $ZnSO_4$) toxicity to marine crab, *Ozius rugulsus*. [12], [13] and [14] showed toxicity of the prawn, *Caridina weberi* after exposure to $CuSO_4$ and TBTO and suggested that the relative toxicity of the pollutants increased with increase in time of exposure and concentration, thus resulting in the mortality of the animals.

Bioaccumulation:
Gills: When the crab was exposed to sublethal concentration (1.980ppm) of mercury chloride, the bioaccumulation in gill was 0.221, 0.220 and 0.238 μg/g dry weight of tissue for 10, 20 and 30 days exposure respectively.

Muscle: When the crab was exposed to sublethal concentration (1.980ppm) of mercury chloride, the bioaccumulation in gill was 0.195, 0.168 and 0.193 μg/g dry weight of tissue for 10, 20 and 30 days exposure respectively.

Hepatopancreas: When the crab was exposed to sublethal concentration (1.980ppm) of mercury chloride, the bioaccumulation in gill was 0.152, 0.163 and 0.176 μg/g dry weight of tissue for 10, 20 and 30 days exposure respectively.
Testis: When the crab was exposed to sublethal concentration (1.980ppm) of mercury chloride, the bioaccumulation in gill was 0.130, 0.142 and 0.149 μg/g dry weight of tissue for 10, 20 and 30 days exposure respectively.

Ovary: When the crab was exposed to sublethal concentration (1.980ppm) of mercury chloride, the bioaccumulation in gill was 0.138, 0.153 and 0.175 μg/g dry weight of tissue for 10, 20 and 30 days exposure respectively.

10 days exposure: LC_{50} group when compared with the control group, the percent increase in gill (71.31%; $P<0.001$), muscle (65.25%; $P<0.001$), hepatopancreas (447.57%; $P<0.001$), ovary (40.81%; $P<0.001$) and testis (36.84%; $P<0.001$). LC_{50} group compared with LC_0 group, the percent increase in muscle (43.38%; $P<0.001$), gill (33.93%; $P<0.001$), hepatopancreas (23.57%; $P<0.001$), ovary (23.21%; $P<0.001$) and testis (19.26%; $P<0.001$).

20 days exposure: LC_{50} group compared with the control group, the percent increase in mercury was (70.54%; $P<0.001$) in gill followed by hepatopancreas (58.25%; $P<0.001$), ovary (56.12%; $P<0.001$), testis (49.47%; $P<0.001$) and muscle (42.37%; $P<0.001$). LC_{50} group compared with LC_0 group, the percent increase in mercury in gill (27.16%; $P<0.001$), hepatopancreas (19.85%), ovary (19.53%), testis (15.44%) and muscle (5.66%).

30 days exposure: LC_{50} group compared with the control group, the percent increase in gill (84.49%; $P<0.001$) followed by ovary (78.57%; $P<0.001$), hepatopancreas (70.87%; $P<0.001$), muscle (63.55%; $P<0.001$) and testis (56.84%; $P<0.001$). LC_{50} group compared with LC_0 group, the percent increase in mercury in ovary (28.67%; $P<0.001$) followed by gill (22.05%; $P<0.001$), muscle (16.96%; $P<0.001$), hepatopancreas (16.55%; $P<0.001$) and testis (12.03%; $P<0.001$).

CONCLUSION

From the results it is clear that the level of mercury content in different tissue varied according to the exposure period and concentration of metal in the external environment. The safe concentration of Hg to fresh water organisms are of great practical importance for regulating and controlling the discharge of hazardous effluent into aquatic ecosystems. The animals like fresh water crab can be useful as bioaccumulative indicator for metal like mercury.

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