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Acute Toxicity of Mercuric Chloride to the Freshwater Catfish, *Heteropneustes fossilis*

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Abstract: The present study was designed to investigate the toxic effect of mercuric chloride on a freshwater catfish *Heteropneustes fossilis*, in terms of fish mortality test. After exposure to various concentrations of mercuric chloride, the LC₅₀ values of mercuric chloride for *H. fossilis* at 24, 48, 72 and 96 h are 0.96, 0.91, 0.81 and 0.70 mg/L, respectively. Toxicity of mercuric chloride to *H. fossilis* has been compared with other fish species and it is concluded that *H. fossilis* is hardy fish.

Keywords: Heavy metal, Mercuric chloride, LC₅₀, *Heteropneustes fossilis*

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Introduction

Pesticides have been used by the human beings for control of insect vectors of diseases and increased yields of many crops. Use of these pesticides causes problems to organisms including human beings. Pesticides may have dual actions – they are important in controlling injurious pests but they may also present a hazard to species not considered to be pests in the environment. The hazard

becomes more serious when pesticides directly affect populations of economically important non-target organisms or poison organisms which are eaten by economically important animals and human beings.

Fishes, both freshwater and marine, are the most important non-target inhabitants of the aquatic ecosystem which are affected by toxicants. Fish are economically very

important and influence the human beings in various ways. Their food value is now well known as it provides the much needed protein, vitamin A and D, and other elements.

Mercury (Hg) is particularly of great concern due to its high toxicity (Guedenon *et al.*, 2012). Naturally it is present as a mineral and is distributed throughout the environment as a result of natural or human activities. Natural mercury occurs due to the degassing of the earth's crust through volcanos, and also by evaporation from the oceans (Boening, 2000). The other source of mercury is by burning of fossil fuels. The largest consumers of mercury, amounting to 55% of total consumption, are chloralkali, electrical equipments, paint and wood pulping industries. Mercury is also being used in agriculture principally as fungicides, batteries, medicine and dentistry. However, due to strict regulations the use of mercury has been reduced in recent years. Inorganic mercury can be microbiologically converted into methyl-mercury (Joshi *et al.*, 2011, 2012, 2013; Guedenon *et al.*, 2012). Mercury exposure to fish produced haematological, histopathological and reproductive effects (Shah and Altindag, 2004; Arabi, 2004; Sarmiento *et al.*, 2004; Drevnick and Sandheinrich, 2003; Crump and Trudeau, 2009; Gupta, 2014).

The present study was designed to investigate the toxic effect of heavy metal-mercuric chloride on a freshwater catfish *Heteropneustes fossilis*, in terms of fish mortality test.

Materials and Methods

Collection and handling of the fish:

Stinging catfish, *Heteropneustes fossilis* were used as test fish in this study because this

species is hardy, readily available, easy to handle, can be held in captivity for long period, and form an important species in many water resources.

Adult *H. fossilis* (both sexes, body weight 29-36 g) were collected locally and inspected for external signs of injury and diseases. Those, which showed such symptoms, were discarded and only the healthy ones were selected for experiments. These fish were acclimatized to the laboratory conditions (under natural photoperiod and temperature 28.4 ± 1.2 C) for two weeks in plastic pools containing 500 L of dechlorinated tap water. During acclimatization the fish were fed daily with wheat flour pellets and ground dried shrimps, 2-3 times per day. Water was renewed daily after cleaning the fecal matter and leftover food. All care was taken to avoid giving stress to the fish. The fish were not fed 24 h before and during the experimental period so that excretory substances may not influence the toxicity of test solutions. The mortality rate during acclimatization was less than 4%.

Determination of LC₅₀:

Four-day static renewal acute toxicity test (APHA *et al.*, 1998) was used for the determination of LC₅₀ values for mercury. Six replicates each containing ten fish (kept in glass aquarium containing 30 L of the test solution) were subjected to each concentration of the toxicant- mercuric chloride (0.5, 0.6, 0.7, 0.8, 0.9, 1.0 and 1.1 mg/L) for the test. Mercuric chloride were firstly dissolved in distilled water and then the desired volume of the solution was mixed in tap water to obtain the above mentioned toxicant concentration. A control group with six replicates (each containing 10 fish) kept in

30 L tap water was also run. The solutions of all the aquaria (control and experimental) were renewed daily. Precautions were taken to remove the dead fish immediately because dead fish deplete dissolved oxygen which greatly affects toxicity data (Schreck and Brouha, 1975). Death in fish was confirmed when the movement of the operculum was stopped and the fish remain unresponsive when gently prodded at the caudal peduncle. The concentration of the toxicant and degradation products were not measured during the course of bioassay as the facilities for it were not available in the department.

The LC₅₀ values at different exposure periods as well as their upper and lower confidence limits and slope functions were calculated by PoloPlus software version 2.0 Computer programme.

Results and Discussion

After exposure to various concentrations of mercuric chloride, the per cent mortality of *H. fossilis* at 24, 48, 72, and 96 h has been shown in Fig. 1. The LC₅₀ values of mercuric chloride for *H. fossilis* after 24, 48, 72 and 96 h are 0.96, 0.91, 0.81 and 0.70 mg/L, respectively (Table 1).

In the present study, the LC₅₀ values of mercuric chloride for the fish *Heteropneustes fossilis* are 0.96 mg/L for 24 h, 0.91 mg/L for 48 h, 0.81 mg/L for 72 h and 0.70 mg/L for 96 h. Kumar and Gupta (2006) have reported 96 h LC₅₀ value for mercury for fingerlings of Indian major carp at 270 mg/L water hardness and temperature 35 °C as 43.922 µg/L for catla; 194.612 µg/L for rohu and 268.141 µg/L for mrigal, whereas at 16 °C temperature the 96 h LC₅₀ values were 52.755 µg/L for catla; 228.15 µg/L for rohu and

308.456 µg/L for mrigal. Similarly at water hardness of 560 mg/L and temperature 35 °C the LC₅₀ values were 47.707 µg/L for catla; 222.069 µg/L for rohu and 281.449 µg/L for mrigal. Whereas at 16 °C temperature the LC₅₀ values were 72.729 µg/L for catla; 278.347 µg/L for rohu and 312.909 µg/L for mrigal. They have concluded that both water hardness and temperature played significant role in mercury toxicity. They have further stated that the test fishes were found most resistant with water hardness of 560 mg/L at 16 °C and water hardness of 270 mg/L at both temperature- 35 and 16 °C.

Fig. 1: Per cent mortality of the fish *Heteropneustes fossilis* after 24, 48, 72, and 96 h exposure to different concentrations of mercuric chloride.

Delvin (2006) have reported 96 h LC₅₀ value for methyl mercury (continuous flow condition) for fathead minnow embryo as 39 µg/L. Krishnani *et al.* (2003) have found 96 h LC₅₀ value for mercury as 0.085 mg/L (for 11 ± 3 mm size) and 0.20 mg/L (for 24 ± 4 mm) for fry of *Lates calcarifer*. Alam and Maugham (1992) have recorded 96 h LC₅₀ value for mercury for common carp (*Cyprinus carpio*) as 0.16 ppm (for smaller fish, size 3.5 cm) and

Table 1: LC₅₀ value, slope function and confidence limits for mercuric chloride at different exposure periods for the fish *H. fossilis*

Exposure periods	Effective dose (mg/L)	Limits(mg/L)*		Slope Function	't' ratio	Heterogeneity
		LCL	UCL			
24 h	LC ₁₀ =0.803	0.598	0.880	13.268	9.411	3.236
	LC ₅₀ =0.969	0.896	1.043	±		
	LC ₉₀ =1.134	1.056	1.345	1.410		
48 h	LC ₁₀ =0.678	0.292	0.786	9.441	8.806	3.979
	LC ₅₀ =0.911	0.812	1.037	±		
	LC ₉₀ =1.144	1.023	1.595	1.072		
72 h	LC ₁₀ =0.559	0.425	0.635	8.504	9.817	1.498
	LC ₅₀ =0.818	0.765	0.872	±		
	LC ₉₀ =1.076	0.998	1.215	0.866		
96 h	LC ₁₀ =0.454	0.373	0.510	8.618	9.533	0.729
	LC ₅₀ =0.709	0.675	0.741	±		
	LC ₉₀ =0.964	0.915	1.033	0.904		

0.77 ppm (for longer fish, size 6.5 cm). For *Notopterus notopterus* the 96 h LC₅₀ value has been reported as 0.44 mg/L (Verma *et al.*, 1983). The 96 h LC₅₀ value for several fish species has been given by Boening (2000) which ranged from 24 to 2000 µg/L.

Guedenon *et al.* (2012) have reported the toxicity of mercury (HgCl₂) to African catfish, *Clarias gariepinus*. They determined the 96 h LC₅₀ value of mercury which is 0.60 mg/L for the fish *Clarias gariepinus*. Zakaria *et al.* (2016) reported LC₅₀ values for 24, 48 and 96 h for *Poecilia reticulata* as 342.3, 179.2 and 95.8 µg/L and for *Rasbora sumatrana* as 156.7, 134.4 and 93.8 µg/L, respectively. LC₅₀ values of mercury in *Oreochromis mossambicus* were 0.73, 0.69, 0.63 and 0.58 ppm for 24, 48, 72 and 96 h, respectively (Vasanthi *et al.*, 2019).

Conclusion

It is concluded that *H. fossilis* is hardy fish when compared to other fish species regarding the toxicity of mercury. Toxicity of mercury to different fish species is difficult to compare as they are influenced by various factors such as temperature and environmental conditions.

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