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Lethal Effect of Cadmium Chloride Pent-Hydrated on Snakehead, *Channa punctatus* (Bloch, 1793)

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Abstract: Heavy metals cause aquatic pollution and affect the aquatic biota by various ways. In the present study, the cadmium chloride proved lethal to freshwater snake headed murrel, *Channa punctatus* at 22.275 ppm. At this concentration fish showed 50% mortality for 96 hrs. However the fish showed substantial ethological changes that included biting behavior, continuous uneasy movement and opening and closing of mouth, increase in operculum movement, aggregation at the corner of aquarium, jumping behavior and with the passage of time fish became fade. It is concluded that, 22.275 ppm concentration of cadmium is dangerous to *C. punctatus.* Above this concentration entire community of *C. punctatus* can be destroyed.

Key words: Cadmium · Lethal Concentration · Snakehead · *Channa punctatus*

INTRODUCTION

Among heavy metals, cadmium considered to have limited biological function [1]. It is widely distributed in the environment due to natural and anthropogenic activities, is an emerging global concern due to their potential hazards on the public health. It is proved to be poisonous to animals and exerts an extra stress on metabolically active tissues and organs [2].

Major sources of cadmium include nickel-cadmium and silver-cadmium batteries manufacturing plants, sewage sludge and lead mining and processing units [3]. However, the traditional toxicology testing has focused on determination of lethal doses and observations of gross effects following maximal exposures. More recently, toxicology testing has focused on lower, more relevant doses and monitoring for slight perturbations in the biochemistry, physiology, or behavior of the organisms.

Due to ample availability of the fish *Channa punctatus* an attempt was made to find out the exact lethal concentration of Cadmium in vitro.

MATERIALS AND METHODS

All the experimental fingerlings of *Channa punctatus* selected for present study were purchased from local fish market of Rajura, District-Chandrapur (M.S.) India. Fish were brought to the laboratory and separated according their size and weight. Fish selected for the experiment had an average length 25±4 cm and weight 80±5 g. Prior to acclimatization; fish were bathed in 0.01% potassium permanganate ($KMnO_4$) solution for 15 minutes for two consecutive days to neutralize possible external infectious pathogenic microorganisms. Fish were stocked in big aquarium (Fig. 1) containing 1000 liter of water and acclimatized for fifteen days. During this period, fish were fed with boiled eggs and rice bran at least once in a day in an alternated fashion.

The toxicant used in static bioassays was cadmium chloride ($CdCl_2H_2O$, Loba Chemical, Mumbai) in tap water. The fingerling of *C. punctatus* having the sizes 12-15cm were randomly distributed in small aquaria (20 liter capacity) filled with different concentrations of cadmium chloride solution (Fig. 2) i.e. 10, 20, 30, 40 and 50 mg/l and mortality was recorded at 24, 48, 72 and 96 h. Ten fishes were used per concentration and the experiment was conducted in triplicate. The aquaria were not aerated during experimentation. For calculating the exact death rate on exposure to cadmium chloride, the comparison was made with death of fish occurred in controlled aquarium since the beginning of exposure.

All experiments were carried out for a period of 96 h. The number of dead fish was counted every 12 h and removed immediately from the aquaria.

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Fig. 1: Acclimatization of *C. punctatus* fingerlings

Fig. 2: Exposure to various concentrations of $CdCl_2.H_20$

Percent mortality was calculated and the values were transformed into probit scale and analyzed [4]. Regression lines of probit against logarithmic transformation of concentrations were obtained. Slope function (S) was calculated.

RESULTS

Channa punctatus is sturdy fish and withstand even in polluted water containing low oxygen concentration. Heavy metal cadmium Heavy metals cause aquatic pollution and affect the aquatic biota by various ways. In the present study, the cadmium chloride proved lethal to fresh water snake headed murrel, *Channa punctatus* at 22.275 ppm (Fig. 3). At this concentration fish died at rate 50% in 96 hrs. However the fish showed the ethological changes that include biting behavior, continuous uneasy movement and opening and closing of mouth, increase in operculum movement, aggregation at the corner of aquarium, jumping behavior. However with the passage of time fish became fading. It is concluded that the said concentration of cadmium is dangerous to fish above this concentration entire community of *Channa punctatus* can be destroyed.

DISCUSSION

In the modern world, the heavy metal pollution is of great concern and is a common threat as far as metabolic disorders of many organisms are concerned. Due to multidimensional anthropogenic activities; industries have flourished in every nook of the world those results in the gradual increase in all kinds of pollution of atmosphere, hydrosphere, lithosphere and biosphere. Many researchers have suggested that, the discharge of heavy metals together with industrial, urban and rural wastes increase their levels in soil and surface water which in turn have negative effects on aquatic biota [5, 6]. Similarly, with the advent of agricultural revolution, most of the water sources are becoming contaminated [7].

Among the heavy metals, cadmium is known as the most dangerous environmental and industrial pollutant [8]. It has no biological function and even at low concentrations it accumulates mainly at metabolically active tissues which in turn cause tissue damages, vertebral abnormalities, respiratory disturbances and finally death [9].

The snakehead air breathing fish, *Channa punctatus*, is exclusively fresh water with a wide distribution and found as a valuable food fish. Singh and Goswami [10] have stated that, this fish is a useful bio-indicator organism of heavy metal contamination of water. The main objective of the present study was to determine the lethal concentration (LC_{50}) of cadmium chloride for 96 hrs in air breathing teleosts, *Channa punctatus*.

In the present investigation, cadmium chloride LC_{50} value for 96 hrs was found 22.275 ppm of water. The values slightly more than this were observed to cause severe death of fingerlings of *Channa punctatus*. Kaushal and Mishra [11] have reported that the different cadmium compounds ($CdCl_2$, $CdSO_4$ and $CdNO_3$) have different LC_{50} values even for the same species of fish. Kasherwani *et al.* [12] have reported 392.92 ppm LC_{50} values of cadmium chloride for catfish, *Heteropneustes fossilis.* However several workers have reported differential values of LC_{50} in different fishes [13-16]. This variation in the values of cadmium chloride LC_{50} for 96 hrs may be due to its tolerance capacity of individual species of fishes.

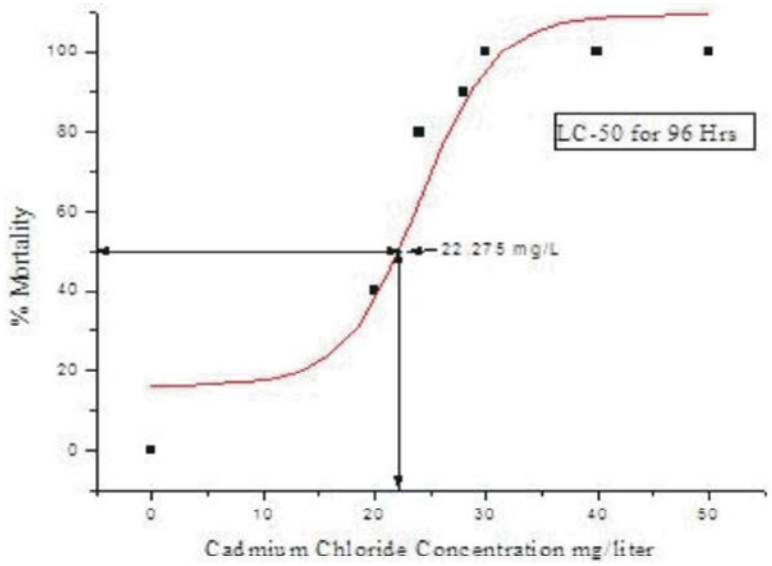

Fig. 3: Showing Cadmium chloride Lethal Concentration-50 (LC_{50}) in *C. punctatus*

The LC_{50} for fingerling could be minimum than for adult fish. The toxicity tolerance capacity depends not only on the size of fish but the age of fish may be one of the factors for determining the toxic values of xenobiotic substances. On exposure to cadmium LC_{50}, some fingerlings those were about to die later exhibited loss of balance and before death showing the spinning behavior. Some authors have suggested, the loss of balance of fish during swimming might be due to some neurological impairment in central nervous system as evident by inhibition of acetylcholine by cadmium and other metals [17-19]. The overall increase in opercular beats as observed in present study is in good conformity with earlier reports on different fishes in relation to various toxicants [20 & 21]. The increased opercular activity may be due to shock received by the fish in new toxic environment along with sensory stimulus to increase the opercular movement for proper ventilation of the gills to cope with hypoxia [22]. The increased gulping activity and opercular movement in fish may be the reflection of an attempt by the fish to extract more oxygen to meet the increased energy demand to withstand the cadmium toxicity. It may also be correlated to the formation of a hypoxic condition due to the interference in gaseous exchange caused by the accumulation of mucous on the gill epithelium. The present findings suggest that the cadmium produce respiratory distress in fishes and opercular beats per minute can be considered as good bio-marker to access the health status of these valuable and cherished fishes as well as worsening status of aquatic bodies in relation to metallic contaminants, particularly the cadmium. Therefore, it is concluded that the said concentration of cadmium is dangerous to *C. punctatus*. Above and under this concentration entire community of *C. punctatus* can be destroyed. But various physicochemical factors can also be responsible to determine the efficacy of metal ions in order to impart the effect at particular concentration. And hence, as far as the LC_{50} is concerned the same fish shows variable responsiveness at different places for the same metal ions. However, the genetic variability exists in the fish could also exhibit variation in response at different concentration. This genetic variability in the same fish species at different location can be proved by extensive study if made by employing the method of Random fragment length polymorphism (RFLP).

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REFERENCES

1. Lane, T.W. and F.M. Morel, 2000. A biological function for cadmium in marine diatoms. Proceeding of National Academy of Sciences, U.S.A., 97: 4627-4631.

2. Langston, R.W., 1989. Toxic effects of metals and incidence of marine ecosystem In Heavy Metals in the Marine Environment, Eds: R.W. Furness and P.S. Rainbow, CRC Press, New York, pp: 128-142.
3. Kumar, P., Y. Prasad, A.K. Patra and D. Swarup, 2007. Levels of cadmium and lead in tissues of freshwater fish (*Clarias batrachus* L.) and chicken in Western UP (India). Bulletin Environmental Contamination and Toxicology, 79(4): 396–400.
4. Finney, D.J., 1971. Probit Analysis, Cambridge University Press, London.
5. Simone, B., C. Franco and F. Valeria, 2006. Recovery of the olfactory receptor neurons in the African *Tilapia mariae* following exposure to low copper level. Aquatic Toxicology, 76: 321-328.
6. Van Dyk, J.C., G.M. Pieterse and J.H.J. van Vuren, 2007. Histological changes in the liver of *Oreochromis mossambicus* (Cichlidae) after exposure to cadmium and zinc. Ecotoxicolgy and Environmental Safety, 66: 432-440.
7. Khare, S. and S. Singh, 2002. Histopathological lessons induced by copper sulphate and lead nitrate in the gills of fresh water fish Nandus. Journal of Ecotoxicology, Environment Monitoring, 2: 105-111.
8. Mendez-Armenta, M. and C. Rios, 2007. Cadmium neurotoxicity. Environmental Toxicology and Pharmacology, 23: 350-358.
9. De Smet, H. and R. Blust, 2001. Stress responses and changes in protein metabolism in carp *Cyprinus carpio* during cadmium exposure. Ecotoxicolgy and Environmental Safety, 48: 255-262.
10. Singh, R.K. and N.D. Goswami, 2010. Changes in Bimodal Oxygen Uptake Due to Furadan Intoxication in a Facultative Air Breathing Fish, *Clarias batrachus* (Linn). Life Science Bulletin, 7(1): 127-128.
11. Kaushal, B.T. and A. Mishra, 2011. A comparative toxicity analysis of cadmium compounds on morphological and behavioral aspects in air breathing freshwater fish Channa punctatus. International J. Science and Nature, 2(2): 266-269.
12. Kasherwani, D., H.S. Lodhi, J.K. Tiwari, S. Shukla and U.D. Sharma, 2009. Cadmium Toxicity to catfish, *Heteropneustes fossilis* (Bloch). Asian Journal of Experimental Sciences, 23(1): 149-156.
13. Pundir R. and A.B. Saxena, 1992. Chronic toxic exposure of Cd on the pituitary gland of fish *Puntius ticto* and pattern of recoupment. Journal of Environmental Biology, 13: 69-74.
14. Srivastava, R.K. and S. Srivastava, 2002. Cadmium (Cd) induced hematological changes in a freshwater catfish, *Heteropneustes fossilis*. Journal of Advanced Zoology, 23(1): 23-29.
15. Dutta, H.M., S. Adhikari, N.K. Singh, P.K. Roy and J.S.D. Munshi, 1993. Histopathological changes induced by malathion in the liver of a freshwater catfish, *Heteropneustes fossilis* (Bloch.). Bulletin Environmental Contamination and Toxicology, 51: 895-900.
16. Drastichova, J., Z. Svobodova, V. Luskova and J. Machova, 2004. Effect of cadmium on haematological indices of common carp (*Cyprinus carpio*). Bulletin Environmental Contamination and Toxicology, 72(4): 725-735.
17. Devi, M. and M. Fingerman, 1995. Inhibition of acetylcholinesterase activity in the central nervous system of the red swamp crayfish, *Procambarus clarkii*, by mercury, cadmium and lead. Bulletin Environmental Contamination and Toxicology, 55: 746-750.
18. Lata, S., K. Gopal and N.N. Singh, 2001. Toxicological evaluations and morphological studies in a cat fish *Clarias batrachus* exposed to carbaryl and carbofuran. Journal of Ecophysiology and Occupational Health, 1: 121-130.
19. Patro, L., 2006. Toxicological effects of cadmium chloride on Acetyl cholinesterase activity of freshwater fish, *Oreochromis mossambicus* Peters. Asian Journal of Experimental Sci., 20(1): 171-180.
20. Srivastava, K., S.J. Agrawal and H.S. Chaudhry, 1979. Effect of chromium on the blood of a fresh water teleost. Ecotoxicolgy and Environmental Safety, 3(3): 321-324.
21. Rathore, H.S. and S.K. Kothari, 1986. Adaptive respiratory behavior of catfish exposed to $CdCl_2$ under experimental conditions. Pollution Research, 5(3&4): 129-146.
22. Lata, S., K. Gopal and N.N. Singh, 2001. Toxicological evaluations and morphological studies in a cat fish *Clarias batrachus* exposed to carbaryl and carbofuran. Journal of Ecophysiology and Occupational Health, 1: 121-130.