www.nesa-india.org • E-mail: nesapublications@gmail.com
International Journal on Biological Sciences

International Journal on Biological Sciences 12 (2), July-December 2021, pp 106-109
ISSN No.: 0976-4518

DETERMINATION OF MEDIAN TOLERANCE LIMIT (LC_{50}) OF *CHANNA PUNCTATA* (BLOCH) FOR CADMIUM CHLORIDE

[1]Amaresh Chandra and [2*]Ashok Kumar Verma

[1]Department of Zoology, Swami Vivakanand University, Sagar, M.P. India
[2]Department of Zoology, Govt. P. G. College, Saidabad, Prayagraj, U.P., India

Research Paper

Received: **15.10.2021** Revised: **28.10.2021** Accepted: **10.11.2021**

ABSTRACT

The present investigation was undertaken to investigate the acute toxicity of cadmium, a heavy metal widely detected in the aquatic environment due to natural effects and anthropogenic activities, in freshwater teleost, *Channa punctata* (Bloch). The experiments for the bioassay were performed in semi-static test condition according to the standard guidelines. The behavioural changes in the fish were observed for all tested concentrations of the metal. The data obtained for bioassay were analyzed for median lethal concentrations (LC_{50}) of the metal by SPSS computer software. The LC_{50} values, estimated by SPSS, with 95% confidence level were found to be:20.589 (18.326-23.221), 17.133 (14.840-19.734), 11.815 (9.696 – 13.850) mg/L and 9.908 (7.635-12381) mg/L for cadmium chloride at 24, 48, 72 and 96 h exposure, respectively.

Keywords: Acute toxicity, Behavioural alterations, Cadmium, LC_{50}.

INTRODUCTION

Aquatic life is strongly influenced by physical properties of a water body. It is known that heavy metals as well as agro-pollutants are potentially harmful to the aquatic lives. All industries discharge their effluents indiscriminately in the adjoining water bodies and frequently cause serious hazards to aquatic life. Industrial effluents are the major sources of heavy metal pollution that is released into water bodies and causes water pollution. Pollution of aquatic ecosystem with heavy metals has become a serious health concern in recent years. These metals are introduced into the aquatic ecosystem through various routes such as industrial effluents and wastes, agricultural runoff, domestic garbage dumps and mining activities (Srivastava and Prakash, 2018).

These heavy metals cause several ill effects to aquatic organisms and ecosystem. The metals which has a relatively high density and toxic at low concentration or dose is known as 'heavy metals' such as arsenic (As), lead (Pb), mercury (Hg), cadmium (Cd), thallium (Ti), etc. Some 'trace elements' are also known as heavy metals, such as copper (Cu). Selenium (Se) and Zinc (Zn). They are essential to maintain the body metabolism, but they are toxic at higher concentrations, and have their toxic effects on living organisms via metabolic interference and mutagenesis.

Fish are an important component of human nutrition, and those from contaminated sites present a potential risk to human health. The nutritive need of different tissues of fish depends on their biochemical configuration like mineral contents, amino acids, protein and vitamins, etc. Science fish occupy the top of the aquatic food chain, they are suitable bioindicators of metal contamination (Thangam *et al*., 2014). These heavy metals can enter the bodies to a small extent via food, drinking water and air. The excess quantities of heavy metals are detrimental as these

*Corresponding author: *akv.gdcz@gmail.com*

destabilize the ecosystems because of their bioaccumulation in organisms, and elicit toxic effects on biota and reduces the fitness, interference in reproduction leading to carcinoma and finally death. Arsenic toxicity in *Mystus vittatus* was studied by Prakash and Verma (2019, 2020a & 2020b) Verma and Prakash (2019& 2020).

Cadmium is the non-essential and most toxic heavy metal which is widely distributed in the aquatic environment and earth's crust. In the list of heavy metals such as lead, mercury and cadmium are considered to cause public health hazards (Sastry and Gupta, 1979). Burning of fossil fuels and municipal waste are known to be largest sources of cadmium release to the environment (such as coal or oil) (Nriagu, and Pacyna, 1988). Cadmium may also enter into the atmosphere from zinc, lead or copper smelter. It can enter into the fresh water by disposal of industrial and household waste. Fertilizers often contain some cadmium. Reproduction rate of aquatic organisms may also be affected due to Exposure to heavy metals and can lead to a gradual extinction of their generations in polluted waters (Sridhara *et al*., 2008). These heavy metals accumulate in tissues and body of aquatic organisms like fishes in higher concentration than concentrations in water and biomagnified in food chain that cause physiological damages at higher trophic levels and in human consumers. Human being takes Cd mainly through food. Food materials contains higher Cd can significantly increase the Cd concentration in human bodies.

Short term toxicity tests had been designed for the estimation of lethality of the xenobiotics to the test specimens. The most widely adapted technique for short term bio assay is the evaluation of a Medium Tolerance Limit (TLM). Determination of 24, 48, 72 and 96h TLM value by probit analysis (static bio assay) procedure is generally applied to determine the toxicity levels of the xenophobic materials to various aquatic organisms under laboratory conditions. These toxicity tests are necessary to predict the safe concentration of the chemicals in the environment. Probit analysis is a type of regression used to analyze binomial response variables. Probit method is widely accepted and most accurate method for calculating LC_{50}. Therefore the present investigation aimed to evaluate the acute toxicity bioassay of heavy metal, Cadmium against fresh water fish, *Channa punctata*, by using SPSS software.

MATERIALS AND METHODS

Fresh water snake headed fish, *Channa punctata* (average length 8.0-8.5 cm and average weight 7.0-7.5gm) was collected from local fresh water bodies and dip in 1.0 % of potassium permanganate solution for 2 minute to get rid of dermal infection. The fishes were acclimatized in laboratory conditions for 10 days. During acclimatization the fishes were fed with commercial fish feed. The feeding of Fishes was stopped before 24 hours of experiment start. The mortality was recorded after a period of 24, 48, 72 and 96 h and dead fishes were removed from aquarium. Stock solution of cadmium chloride than various concentrations of cadmium chloride were prepared from stock solution than 10 fishes was kept in each rectangular glass aquaria separately to estimate mortality between 0% and 100%. For 96h LC_{50} test, separate 10 concentrations of cadmium chloride was taken to find out the narrow range of lethal concentration. The mortality was recorded after a period of 24, 48, 72 and 96h. Mortality of fishes were monitored at regular intervals throughout the test and dead fishes were immediately removed which did not responded even to strong tactile stimuli. Percent mortality was calculated and the values were transferred into probit scale. Probit analysis was carried out as suggested by Finney (1971). Regression lines of probit against logarithmic transformations of concentrations were made. Confidential limits (upper and lower) of the regression line with chi-square test were calculated by SPSS software 26 version.

RESULT AND DISCUSSION

The percent mortality observed for each concentration was calculated and converted to probit by means of SPSS software. Acute toxicity test *i.e.* LC_{50} values show susceptibility of fish to particular pollutant and reflect their survival potential. In the present study, the LC_{50} values and the 95% confidence limits of heavy metals, cadmium chloride for snake headed fresh water fish, *Channa punctata* for 24, 48, 72 and 96 hrs are presented in Table 1 and Fig. 1-4.

The LC_{50} values with 95% confidence level of cadmium chloride for *Channa punctata* were found to be:20.589 (18.326- 23.221), 17.133 (14.840- 19.734), 11.815 (9.696 – 13.850) mg/L and 9.908 (7.635-12381) mg/L for cadmium chloride at 24, 48, 72 and 96 h exposure, respectively. However, fishes exposed to dechlorinated tap-water were observed to be healthy and normal. In the present study the result revealed that the mortality rate increased with increasing concentration of distillery effluent and for a particular concentration the mortality rate increase with increasing period of exposure.

Table 1: LC_{50} values with 95% confidence limits for *Channa punctata* exposed to $CdCl_2$.

Exposure Period (hr)	LC^{50} values of $CdCl_2$ (mg/l)	95% Confidence limits (mg/l)		Regression Equation	Chi-Square value	Coefficient of determination (R_2 Linear)
		Lower Limit	Upper Limit			
24	20.589	18.326	23.221	Y = - 7.53 + 2.46 X	3.159	0.958
48	17.133	14,840	19.734	Y = -5.99 + 2.08 X	2.786	0.965
72	13.985	11.904	16.251	Y= -5.00 + 2.03 X	6.695	0.977
96	9.908	7.635	12.381	Y= -3.04 + 1.32 X	5.047	0.868

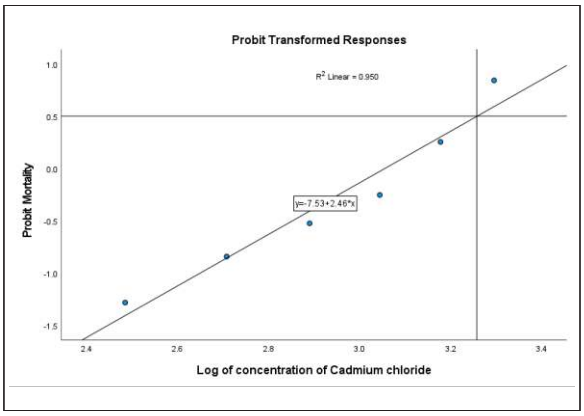

Fig. 1: Relationship between Probit mortality at 24 hrand Log Concentration of Cadmium Chloride for *Channa punctata.*

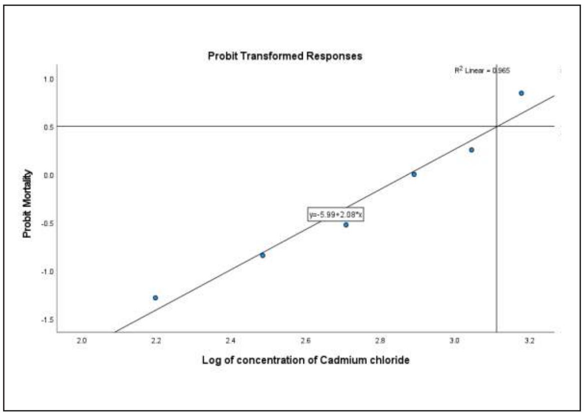

Fig. 2: Relationship between Probit mortality at 48 hr and Log Concentration of Cadmium Chloride for *Channa punctata*.

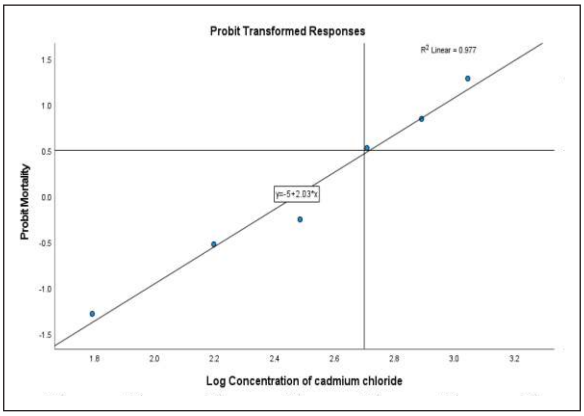

Fig. 3: Relationship between Probit mortality at 72 hr and Log Concentration of Cadmium Chloride for *Channa punctata*.

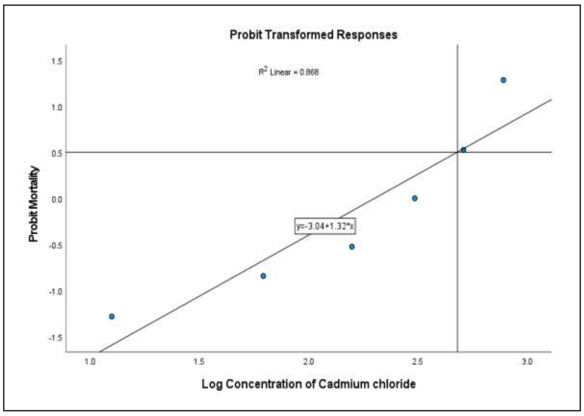

Fig. 4: Relationship between Probit mortality at 96 hr and Log Concentration of Cadmium Chloride for *Channa punctata*.

The death of fish could be due to the lethal action of pollutant like heavy metal that causes alterations in physiological and biochemical process related to cellular metabolic pathway. The toxicity of any toxicant for fish depends on species, sex, age, weight, dose or concentration, exposure period, organic or inorganic form etc. (Tiwari and Prakash, 2021). However, sublethal concentrations of heavy metals also induce substantial changes in the biological organization of fish (Srivastava and Prakash, 2018; Kumar *et al*., 2019).

Previous studies showed level 96h LC_{50} of Cadmium for aquatic species depending on the aquatic species type or metal type is different; for example, Spehar (1976), reported level 96h LC_{50} of Cadmium for *Mugil cephalus* and *Jordanella floridae* had set 28.0 and 2.5 ml/l, respectively. Das and Banerjee (1980), stated 96h LC_{50} of Cadmium 300.0 and 175.0 ml/l for *Lebeo rohita* and *Heteropneustes fossilis*, respectively; finally, the results of our study showed cadmium was highly toxic for snake headed fish, *Channa punctata*. The lethal concentrations (96h LC_{50}) of cadmium for Snake headed fish was 9.908 mg/L and was more sensitive to cadmium toxicity.

It is well known that toxicity will depend upon (a) the chemical form of the metal (b) the presence of other metals (c) the physiological status of the organisms and (d) the environmental, physico-chemical parameters like temperature, dissolved oxygen and the pH of the water. The toxicity of the metal is also dependent upon the residence time of the metal concerned. Generally cadmium on *Channa punctata* offers a rapid method for assessing the heavy metal impact on this fish. This type of preliminary investigations can be useful for deriving the safe level of heavy metal concentration (especially cadmium) that can be released into the aquatic environments.

REFERENCES

1. **Das, K.K. and Banerjee, S.K.** (1980). Cadmium toxicity in fishes. *Hydrobiol*., 75, 117-121.
2. **Finney's, D.J.** (1971). Probit Analysis. Cambridge University Press, London, 333p.
3. **Kumar A., Prakash S., Parmar A. and Bajpeyee A. K.** (2019). Effect of cadmium on fresh water teleost, *Heteropneustes fossilis* (Bloch). *International Journal of Biological Innovations*. 1 (1):14-17. https://doi.org/ 10.46505/ IJBI. 2019.1103.
4. **Nriagu, J.O. and Pacyna, J.M.** (1988). Quantitative assessment of worldwide contamination of air, water and soils by trace metals. *Nature*. 333:134-139.
5. **Prakash S. and Verma A.K.** (2019). Impact of Arsenic on lipid metabolism of a fresh water cat fish, *Mystus vittatus*. *Journal of Fisheries and Life Sciences*. 4 (1): 33-35.
6. **Prakash S. and Verma A.K.** (2020a). Toxicity of arsenic on Organic Reserves of Liver of *Mystus vittatus* (Bloch). *Journal of Experimental Zoology, India*. 23 (2): 1799-1802.
7. **Prakash S. and Verma A.K.** (2020b). Arsenic toxicity on Respiratory Physiology and organic reserves of gills of *Mystus vittatus* (Bloch). *Indian Journal of Biology*. 7(1): 09-13.
8. **Sastry, K. and Gupta, P.** (1979). The effect of cadmium on the digestive system of the teleost fish, *Heteropneustes fossils, Environ. Res*. 19:221-230.
9. **Spehar, R.L.** (1976). Cadmium and zinc toxicity in flag fish, *Jordanella floridae*. J. *Fish. Res. Board Can*., 33, 1939-1945. 24.
10. **Sridhara, C.N., Kamala, C., Samuel, S. and Raj, D.** (2008). Assessing risk of heavy metals from consuming food grown on sewage irrigated soils and food chain transfer. *Ecotoxicol. Environ Saf*. 69:513-524.
11. **Srivastava, N. and Prakash, S.** (2018).Effect of Sublethal concentration of zinc sulphate on the serum biochemical parameters of freshwater cat fish, *Clariasbatrachus*.*Indian Journal of Biology*, 5(2): 113-119.
12. **Thangam, Y., Jayaprakash, S. and Perumayee, M.** (2014). Effect of copper toxicity on haematological parameters to fresh water fish, *Cyprinus carpio* (Common carp). *IOSR Journal of Environmental Science, Technology and Food Technology*. 8(9 Ver I): 50-60.
13. **Tiwari, S.K. and Prakash, S.** (2021). Toxicity and ethological responses of *Mystus vittatus* (Bloch) exposed to distillery wastewater. *Bulletin of Pure and Applied Sciences-Zoology*. 40 A(1):140-147.
14. **Verma A.K. and Prakash S.** (2019). Impact of Arsenic on haematology, condition factor, hepatosomatic and gastrosomatic index of a fresh water cat fish, *Mystus vittatus*. *International Journal on Biological Sciences*. 10(2):49-54.
15. **Verma A.K. and Prakash S.** (2020). Toxicity of arsenic on Organic Reserves of Intestine of *Mystus vittatus* (Bloch). *Indian Journal of Scientific Research*. 11(1): 01-05.