OUTREACH Volume IX 2016 247 – 250
A Multi - Disciplinary Refereed Journal
ISSN (Print) : 0975 1246
ISSN (Online) : 2321 8835
www.voccoutreach.in

Sub-lethal cadmium toxicity induced changes in the hepatosomatic index of freshwater catfish, *Heteropneustes fossilis*

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1. Abstract :

The present study aimed at investigating the effects of sub-lethal (SL) toxicity of cadmium (Cd) on the liver of the freshwater stinging catfish, *Heteropneustes fossilis* through determination of Hepatosomatic Index (HSI) as liver is the major organ of detoxification in fish. Adult catfishes of both male and female were exposed to five different SL concentrations of Cd *viz.*, 1.11, 2.21, 4.41, 8.82 and 17.64 mg/l for 28 days under Static Renewal regime. On 14th and 28th days of experiment, fishes were taken from each tank and liver was dissected out and measured to determine HSI. A control experimental set up was also maintained for comparison. Statistical analysis of the data showed significant differences in HSI between control and Cd treated fishes.

Key words: Sub-lethal, Toxicity, Cadmium, Hepatosomatic Index, *Heteropeneustes fossilis*

2. Introduction

Heavy metal pollution in the aquatic environment is a potential threat due to their high toxicity and bioaccumulation in the organisms. Among the different heavy metal pollutants, Cadmium is a non-essential and non-corrosive heavy metal in nature and highly toxic metal which is released into the aquatic environment by various industrial sources. The application of eco-toxicological studies on vertebrates is rapidly expanding; and for aquatic system, fish have become valuable indicator for the evaluation of the effects of various pollutants. Cadmium is known to affect various tissues like kidney, liver, gill, gonad, intestine *etc.* of fishes. Hepatosomatic Index (HSI) is a general measurement of the overall condition of fish or the growth status of liver and can be an excellent predictor of adverse health in fish. The present study was carried out to understand the sub-lethal effects of heavy metal, Cadmium on the HSI of both male and female *Heteropeneustes fossilis*.

3. Materials and Methods

The freshwater catfish (*H. fossilis*) with an average length of 18.36 ± 0.25 cm and weight of 38.86 ± 1.41 gm were obtained from a fish market in Tirunelveli, Tamil Nadu. The fishes were stocked in 500 L FRP tanks containing 140 L water and acclimatized in laboratory conditions for one month before beginning experiments. The acclimated fishes were divided into five experimental groups of 10 fishes (5 male and 5 female) in each tank. They were exposed to five sub-lethal test concentrations of Cd (1.11, 2.21, 4.41, 8.82 and 17.64 mg/l) for 28 days under static renewal regime as prescribed by APHA (1995). The sub-lethal concentrations were selected based on 96 hrs LC_{50} for Cd to *H. fossilis* (44.13 mg/l) obtained in our previous study (Jayakumar *et al.,* 2016). The metal compound (Cadmium chloride monohydrate) was used for the preparation of test medium and the bioassay result was expressed as metal (Cadmium) concentration only, following the formula used by Devi (2010). Control experimental set up was also run in water without Cd. Experimental test solutions were renewed every 24th hour. A duplicate experimental set up was also maintained. During the study, male and female fishes were taken from control and each experimental tank on 14^{th} and 28^{th} day. Then, the length and weight of each fish were measured and liver was dissected out to determine Hepatosomatic Index (HSI). The HSI was calculated as per the following formula successfully used by Kumar *et al.* (2007).

$$\text{Hepatosomatic Index} = \frac{\text{Liver Weight (g)}}{\text{Total Body Weight (g)}} \text{ x } 100$$

4. Result and discussion

Effects of SL concentrations of Cd on mean HSI of male and female *H. fossilis* after 14 and 28 days of exposure is presented in Table 1. In male control fish, the mean HSI was estimated to be 2.06±0.05 after 14 days and it increased to 2.26±0.11 after 28 days of exposure to control medium. Conversely, in treated fishes, the mean HSI was observed to decrease from 2.06±0.05 to 1.54±0.04 after 14 days and from 2.26±0.11 to 1.39±0.07 after 28 days of exposure to the highest concentration of Cd (17.64 mg/l) in male *H. fossilis*. Likewise, in female control fish, HSI was estimated to be 2.64±0.04 after 14 days and it increased to 2.73±0.06 after 28 days of exposure to control medium. On the contrary, in treated fish, the mean HSI was observed to decrease from 2.64±0.04 to 2.18±0.03 after 14 days and from 2.73±0.06 to 1.77±0.01 after 28 days of exposure to the highest concentration of Cd (17.64 mg/l) in female *H. fossilis* (Figure 1). The changes in mean HSI were

noted to be dose and time dependent. Further, the changes in the mean HSI of treated fish were assessed to be statistically significant for both male and female at 5% level ($P<0.05$). In addition, Post Hoc multiple comparisons made by LSD method showed that there was a significant difference between treatments at 5% level ($P<0.05$).

The present study revealed decreased HSI in both male and female *H. fossilis* exposed to Cd in a dose and time dependent manner (Figure 1and Table 1). These findings are corroborated by investigations of Khan *et al.,* 1991who reported that hill stream teleost, *Garra mullya* exposed to Cd exhibited significant decrease in HSI. Cadmium exposure decreased HSI in winter flounder (Pereira *et al.,* 1993) and female zebrafish (Wall, 1999) also. In contrast to this, there was an increase in the HSI values of *Oreochromis niloticus* exposed to Aluminium in a dose dependent manner (Authman, 2011). The changes in HSI might be attributed to the change in proximate composition of liver or change at cellular level which would affect the overall health of fish as the liver is the main organ of detoxification in fish.

5. Conclusion

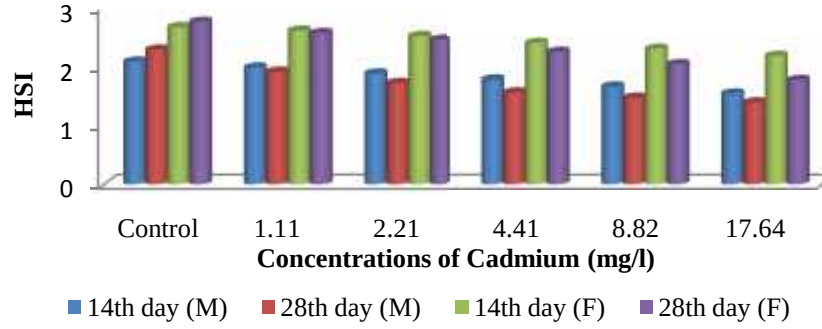
Catfishes exposed to SL doses of Cd showed changes in the liver which is evident from the reduction in HSI. Hence, it is suggested that utmost care needs to be taken while dealing with various sources of Cd so as to avoid contamination of the nearby aquatic systems.

Table 1. HSI of *H. fossilis* (male and female) after 14 and 28 days of exposure at SL concentrations of Cd

Conc. (mg/l)	HSI Male		HSI Female	
	14 day	28 day	14 day	28 day
Control	2.06 ± 0.05	2.26 ± 0.11	2.64 ± 0.04	2.73 ± 0.06
1.11	1.96 ± 0.05	1.89 ± 0.07	2.58 ± 0.04	2.54 ± 0.04
2.21	1.86 ± 0.05	1.70 ± 0.06	2.49 ± 0.03	2.43 ± 0.03
4.41	1.78 ± 0.05	1.56 ± 0.09	2.40 ± 0.03	2.25 ± 0.02
8.82	1.66 ± 0.04	1.47 ± 0.10	2.30 ± 0.03	2.04 ± 0.01
17.64	1.54 ± 0.04	1.39 ± 0.07	2.18 ±0.03	1.77 ± 0.01

*Values are given as Mean ± Standard Error of Mean (SEM)

Fig. 1. HSI of *H. fossilis* (male and female) after 14 and 28 days of exposure at SL concentrations of Cd



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