Environment & Ecology 29 (1) : 238—241, 2011
 ISSN 0970-0420

Effect of Heavy Metals on Physical and Behavioral Characteristics of Fresh Water Fish (*Cirrhinus mrigala*)

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Abstract

In the present experiment the fresh water fish *Cirrhinus mrigala* were exposed to two sublethal concentrations of zinc and lead at 0.01, 0.02, 0.04 ppm. The fish were found swimming actively with sufficient resting stage in the control treatment but the symptoms like abnormality in behavior i. e. body color, descaling, fin color, hemorrhage, operculum movement and the swimming pattern were changed. The body color changed from reddish to light reddish and whitish with zinc treatment but dark blackish in lead treatment. Descaling was moderate in both treatments of zinc and lead. The black patches were observed in lead treatment. The operculum movement and abnormal swimming were observed in both treatment of lead and zinc.

Key words : Heavy metals, Behavior, Descaling, Body color, Fin erosion.

The natural water is one of the most precious and vital component of the environment and is essential for all forms of life. The effects of water pollution are not only devastating to people but also to the animals, fish and birds as it makes the water unsuitable for drinking, agriculture and the industry. The contaminated water destroys the aquatic life and reduces its reproductive ability. Eventually, it is a hazard to human health and the aquatic bodies. Gheorghiu et al. (1) studied that pollutants in the surrounding macro-environment directly influenced the population dynamics, distribution and the dispersal of fish ectoparasites and lead to an increase in the parasitism. The heavy metals adversely affect various physiological, histological and the biochemical functions of fish (2, 3). Loss of equilibrium, uncoordinated swimming movements and easily excitable conditions were observed after treatment with lead nitrate (4). Niel (5) also observed the whirling movements when exposed to the cyanide. Chromium, zinc and lead at sublethal concentrations have been found to increase the oxygen consumption, locomotion of fishes and swimming pattern (6). Kaur (7) reported that skin color became dark with an exposure of metals. Similar morphological aberrations have been reported by Ghosh and Mukhopadhyay in *Rita rita* (8). Chromium resulted in cellular erosion in fish edges and discoloration of body from grayish black to yellowish. Oozing gills and fin bases were commonly observed and such effects were intensified with an increased concentration of metals. Loss of pigmentation was also observed in *Heteropneustes fossilis* after chromic treatment with 2.8 mg /liter of lead nitrate (4). Keeping these points in view, present investigation was carried to study the effect of heavy metals (viz. zinc and lead) on physiological and behavioral characteristics of fish of fresh water.

Methods

The experiment was carried out in laboratory of Department of Zoology and Aquaculture in CCS HAU, Hisar. The material for the present study including 15—20 cm inch long fingerlings of *Cirrhinus mrigala* which were collected from the local fish farm and acclimated in large tanks in lab conditions for about two weeks. These were exposed to the sublethal concentrations (<0.1 ppm) of zinc and lead during 2007-08. The treatments were given in small plastic tanks of 40 liter capacity.

A replicated control without metal treatment conducted and the metal treatments at three levels (0.01, 0.02 and 0.04 ppm). Each tank contained 8—10 fish per replicate. The fish in each treatment was fed with

Table 1. Effects of different doses of zinc chloride and lead nitrate on various physical and behavioral changes in *Cirrhinus mrigala.*

Treatment dose (ppm)	Physical characteristics			Behavioral changes		
	Body color	Descaling	Fin erosion and color	Hemorrhage	Operculum movement/min	Swimming pattern
Control	Shiny Reddish	Nil	Normal	Nil	65	Normal swimming
Lead 0.01	Slight Black color	Slight	Black patches were observed	Mildred patches on the body	79	Abnormal swimming
0.02	Dark Blackish	Moderate	Fin blackening were observed	Mild blood oozing	84	Fast swimming
0.04	Dark Blackish	Moderate	Fin became black and fin erosion	Blood oozing from different part of body	90	Fast swimming
Zinc 0.01	White color appeared	Few	Fin color became white	Mild blood oozing	72	Aggression
0.02	Much more white color	Moderate	Raddish to white	Blood oozing from different part of body	78	Fast swimming
0.04	Much more white color	Moderate	Raddish to white	Blood oozing from different part of body	88	Fast swimming

normal standard diet on alternate days at the rate of 2% of total fish body weight per replicate. Treated fish were exposed to the heavy metals at the most effective dose level and was then fed with diet supplemented with ascorbic acid at the rate of 400 mg/kg of diet to find out the ameliorating effects of the ascorbic acid.

The acclimatization tanks and the treatment tanks were filled up with the chlorine free tap water and aeration was provided continuously throughout the day with aeration unit.The fish was observed for various physical and behavioral changes like body color, descaling, fin color, hemorrhages in all the treatment replicates. Three fish from each treatment replicate were taken at the end of 45 days of the treatment and were analyzed for the estimation of various biochemical parameters in their tissues. The observation was recorded on physically.

Results and Discussion

In the present studies, 15—20 cm long fingerlings of *Cirrhinus mrigala* were exposed to sublethal concentrations of zinc and lead for 45 days to evaluate the behavioral changes and feeding responses.

In the control fish were found swimming actively with sufficient resting stage but when treatment of heavy metals (zinc and lead) was given to fish for 45 days, the symptoms like abnormality in behavior and body color, descaling, fin color, hemorrhage, operculum movement and the swimming pattern were observed (Table 1). Body color changed from reddish to light reddish and whitish with zinc treatment as compared to the control treatment but in lead treatment body color at 0.02 ppm and 0.04 ppm became dark blackish. Descaling was moderate in both cases of treatments of zinc and lead at 0.02 ppm and 0.04 ppm. Descaling was found in control as well as at 0.01 ppm concentration of these metals. Black patches were observed at 0.01 ppm, 0.02 ppm and 0.04 ppm of lead. Mild red patches were observed on the body of fish at 0.01 ppm and 0.02 ppm but at 0.04 ppm large red patches or mild blood oozing were observed in the zinc and lead treated fish. Operculum movements per minute were observed 65/min in control, 79/min at 0.01 ppm, 84/min at 0.02 ppm and 90/min at 0.04 ppm while in zinc treatment operculum movements per minute were observed 72/min at 0.01 ppm, 78/min at 0.02 ppm and 88/min at 0.04 ppm. Abnormal swimming was observed at 0.01 ppm of zinc and a fast swimming was found at 0.02 ppm and at 0.04 ppm of lead while in the control normal swimming was observed.

In the present study the fish were treated with

sublethal dose of heavy metals viz., zinc and lead (<0.01 ppm) with the normal standard diet. The fish showed a distinct behavior and biochemical changes. Their feeding response, swimming movements, body color changed in presence of heavy metals viz., zinc and lead. The body color became dark blackish in lead treatment and white in zinc treatment along with mild red patches, descaling, hemorrhage and the changes in operculum movement. These changes could be used as an analytical tool to determine the level of toxicity effects of metals or other chemicals in fish compared to fishes exposed to non-toxic condition. This is further evident from other similar studies by Sharma and Sharma (9) who reported that *Cirrhinus mrigala* behavior charged during zinc treatment.

Loss of equilibrium, uncoordinated swimming movements and easily excitable conditions were observed after treatment with lead nitrate (4) and Niel (5) also observed the whirling movements when exposed to the cyanide. Chromium, zinc and lead at sublethal concentrations have been found to increase the oxygen consumption, locomotion of the fish and the swimming pattern (6). James et al. (10) also reported that the presence of sublethal concentration of mercury reduced the rates of feeding, absorption, conversion and metabolism in *Heteropneustes fossilis.* Kaur (7) reported that skin color became dark after an exposure to the metals. In *Rita rita* similar morphological aberrations have been reported by Ghosh and Mukhopadhyay (8). Cellular erosion in fish edges and decoloration of body from grayish black to yellowish, Oozing gills and fin bases were commonly observed and such effects intensified with an increase in the concentration of heavy metals. Fishes exposed to copper were seen with protruded eyes prior to death (4). Mukhopadhyay (11) studied effects of Cu and Zn on *Tilapia mossambicus* and explained the process of excessive mucus secretion as defence mechanisms for protecting the fish from metallic contacts. Kanabur and Sangli (12) reported the damage of gills and skin on the ventral side of abdomen and near pectoral fins of fishes on an exposure to paranitrophenol. Hemorrhagic effects are signs of severe damage caused by heavy metals and pesticides.

Changes in the fish body when exposed to lethal concentration of free cyanide showed an increase in operculum movement, loss of equilibrium, change in body color, increase in secretion of mucus, irregular swimming activity, rapid jerk movement, partial jerk and aggressiveness. The major metals i. e., Cd, Pd, Hg and As have been reported to result in the abdominal cramps, salvation, diarrhoea and hypertension in fish (3). Sharma (13) and Loganathan et al. (14) studied the effects of zinc metal toxicity (5 and 10 ppm) for a duration of 5 and 15 days in *Labeo rohita* fingerlings. The histological changes in the brain and liver of the treated fish were observed. The brain tissues showed enlarged pyramidal cells with extensive vacuolation while severe necrosis, hemorrhage and the degeneration of hepatocytes were witnessed in the liver tissues.

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