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Research Article

ZINC-A POLLUTANT IN THE AQUATIC ENVIRONMENT

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ABSTRACT

Fish, *Channa punctatus* were exposed to sublethal concentrations of 10, 15 & 25 mg/ 1 zinc for 8, 10 and 15 days. Behavioural changes, body weight, liver weight and hepatosomatic index were noted at each interval. Exposed fish showed reduced swimming activity and fin movements along with increased surfacing frequency, mucus secretion and opercular movements. A non-significant decline was noted in body weight which was accompanied by a significant decline in liver weight and hepato-somatic index. These changes were reversible and dose and time dependent. For post exposure recovery these fish were transferred back to normal tap water for fifteen days. Behavioural changes return towards normal though body weight continues to decline. Liver weight and hepato-somatic index show A marginal increase. Since behaviour of fish is immediately influenced by exposure to zinc, it can act as a good indicator of pollution. Liver weight and HSI are also sensitive indices.

INTRODUCTION

Discharge of industrial effluents leads to heavy-metal accumulation in the aquatic environment. These metals create severe *Pallavi Gupta and Neera Srivastava* health hazards in aquatic organisms. Although normal levels of zinc are essential to sustain life processes (Srivastava and Sharma, 1996 Shukla *et al*., 2002; Srivastava, 2004) if the levels exceed physiological limits, it can act as a toxicant (Srivastava and Sharma, 1996; Srivastava and Kaushik, 2001; Srivastava *et al*., 2002;Gupta and Srivastava,2006; Siddiqui and Arifa,2011;Rani *et al*,2015).

Exposure to zinc has been reported to have adverse effects on growth (Shukla and Pandey, 1986;Ranbhare and Bakare,2012;Afshan *et al*,2014) physiological activities and structure of organs (Sharma and Sharma, 1994; Singh and Gaur, 1997; Agrawal and Srivastava, 2003; Tyagi, *et al*., 2004) Since fish have great importance in the food chain; their exposure to pollutants and consequent toxicity may, in turn, create health hazards for man(Ashraf *et al*,2011;Afshan *et al*,2014). Hence, the effects of zinc on the body weight, liver weight and hepato-somatic index of a fish *Channa punctatus* have been studied. Behavioural changes have also been monitored regularly as they are good indicators of aquatic pollution. Available literature contains very few attempts on recovery studies after restoration of normal conditions. Recovery study has also, therefore, been undertaken.

MATERIALS AND METHODS

Live specimens of *Channa punctatus* were collected from local water bodies and acclimatized under laboratory conditions. The physicochemical characteristics of water were analysed by using standard methods (APHA, 1989) (Table -1).

Table 1 Physico- chemical characteristics of water

'Temperature	25°C to 27°C
pH	7-7.2
Dissolved oxygen	7-7.5 mg/1
Hardness	210-215 mg/1
Chloride content	3 5-3 8 mg/1
Alkalinity	67-69 mg/1

Three groups of fish were exposed to three sub-lethal concentrations of zinc i.e. 10 mg/ 1, 15 mg/1 and 25 mg/ 1 (below 50 %.)

Aquatic Pollution by zinc

of LC_{50}) for 8, 10 and 15 days respectively. For assessing the ability of fish to recover after exposure to zinc, fishes of pre-exposed groups (groups II, III and IV) were transferred back to fresh water and studied at intervals of 8, 10 and 15 days. Group I remained as control.

Behavioural changes i.e. swimming activity, fin movements, surfacing frequency, mucus secretion and opercular movements were observed every 6 hrs. following the grid method. Body weight and length was recorded at each interval along with

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weight of the liver; hepatosomatic index was calculated. Data obtained were subjected to statistical analysis.

RESULTS AND DISCUSSION

Swimming activity of exposed fishe gradually declined and fish showed a tendency to settle at the bottom of the aquarium. Increased surfacing frequency was accompanied with gulping of air at the surface. Increased opercular movements and mucus secretion were observed in exposed groups. Fishes of treated groups showed slow fin movements. Behavioural changes coincide with the dose and duration of the experiment. Results indicate that exposure to zinc alters normal behaviour of fish.

Body weight registered an apparent decrease by day 15 but statistically it was non significant. Liver weight and hepato-somatic index, however, show a significant decrease in comparison to control (Table 2).

Table 2 Effects of sub-lethal concentrations of zinc on body weight, liver weight and hepato somatic index of fish *Channapunetatus*

Groups	*Parameters Studied*	*Day 8*	*Day 10*	*Day 15*
Group I	Body weight	62 ± 2.85	62 ± 4.18	63 + 3.47
	Liver weight	0.531 ± 0.008	0.512 ± 0.01	0.504 ± 0.01
	Hepato somatic index	0.87 + 0.03	0.83 ± 0.02	0.83 ± 0.03
Group II	Body weight	63 ± 1.36	61 ± 3.25	58 ± 1.36
	Liver weight	0.490 + 0.01*	0.450 ± 0.01**	0.410 ± 0.02**
	Hepato somatic index	0.77 ± 0.01*	0.74 ± 0.01**	0.70 + 0.02**
Group III	Body weight	61 ± 2.09	60 ± 3.53	55 + 1.76
	Liver weight	0.459 ± 0.01**	0.439 ± 0.01**	0.30+ 0.008**
	Hepato somatic index	0.75 ± 0.01**	0.75 ± 0.01**	0.71 ± 0.01**
Group IV	Body weight	58 ± 1.36	59 ± 2.73	54 + 2.09
	Liver weight	0.423 ± 0.02**	0.414 ± 0.02**	0.377 ± 0.01**
	Hepato somatic index	0.72 ± 0.02**	0.69 ± 0.02**	0.69 ± 0.01**

**Significat at P <. 05*
*** Significant P < .01*

On return of fish to normal tap water after pre-exposure to zinc, behavioural changes quickly tend to reverse towards normalcy within 3

-5 days. Fish resume normal swimming activity shortly after restoration of normal conditions and show a decline in their tendency to settle at the bottom of the aquaria. Surfacing frequency and.opercular movements also decrease. Simultaneously, decline in mucus secretion is noted with increased fin movements. Pale body colour and transparency of fins is no longer visible.

Body weight of pre-exposed fish continues to decline till the termination of the experiment and a significant reduction is noted in group IV at day 15 (Table-3). Results suggest that zinc may have a delayed but prolonged effect on the weight of fish. Liver weight on the other hand shows a marginal increase but these values are still significantly lower than the control value. Hepato somatic index shows definite, signs of recovery and reaches near control levels in all groups by day 15. Recovery in group II and III is noted by day 10 where as in group IV it is noted by day 15 (Table-3).

Behavioural changes are a good index of alterations in the environment and fish are excellent bioindicators (Srivastava and Kaushik, 2001). On exposure of fish to pollutants like pesticides and heavy metals, a change in behaviour has earlier been recorded (Verma *et al*.,1992; and Maruthi and Subba Rao, 2000;Scott andSloman,2004;Afshan *et al*,2014) . In the present investigation zinc probably affects the motor behaviour in *Channapunctatus* as seen by decreased swimming activity. A similar opinion was put forward in young Salmon and gold fish (Hoar *et al*., 1955); they implicated the thyroid gland and sex hormones in HSI activity.Siddiqui and Arifa(2014) also revealed various abnormal behavior in fish due to toxicity of copper. Increased surfacing frequency and opercular activity is related to procuring more oxygen from the atmosphere ; these are suggestive of a hypoxic condition. Increase in mucus secretion by the gills is regarded.

Table 3 Changes in body weight, liver wieght and hepato somatic index of fish *Channa punctatus* pre-exposed to sub-lethal concentrations of zinc

Groups	*Parameters Studied*	*Day 8*	*Day 10*	*Day 15*
Group I	Body weight	62.40 + 2.78	61.60 ± 3.27	61.80 ± 3.09
	Liver weight	0.517 ± 0.01	0.523 + 0.01	0.515 ± 0.01
	Hepato somatic index	0.88 ± 0.02	0.85 ± 0.02	0.85 ± 0.02
Group II	Body weight	57.80 ± 3.34	57 + 3.79	56.20 ± 2.96
	Liver weight	0.439 ± 0.02**	0.462 ± 0.02*	0.476 + 0.009*
	Hepato somatic index	0.73 + 0.007**	0.81 + 0.04	0.86 ± 0.02
Group III	Body weight	54 ± 3.70	53.80 ± 3.49	52.50 ± 2.83
	Liver weight	0.417 + 0.02**	0.434 ± 0.01**	*i* 0.450 + 0.01**
	Hepato somatic index	0.76 ± 0.01"	0.80 + 0.04	0.85 + 0.02
Group IV	Body weight	53.20 ± 2.79	52.20 ± 2.32*	51.60 ± 2.98*
	Liver weight	0.390 ± 0.008**	0.407 ± 0.02**	0.421 ± 0.02**
	Hepato somatic index	0.73 ± 0.02**	0.77 ± 0.01**	0.81 ± 0.01 *J*

**Significat at P <. 05*
*** Significant P < .01*

Aquatic Pollution by zinc

To be an excretory mechanism (Skidmore and Tovell, 1972; Stokes, 1979; Gupta and Rajbanshi, 1981) caused by metal stress. Increased mucus secretion acts as a diffusion barrier to oxygen, thereby contributing to hypoxia.

Shukla *et al*., (1987) reported decreased in body weight of *Channapunctatus* exposed to arsenic for 31 days. A linear correlation between weight reduction and exposure period was also noted by Collvin (1985) after exposing *Percafluvialitis*to copper for 40 days.Decline fish growth was also dected by Rambhare and Bakare(2012) and Afshan*et al*(2014)due to heavy metals. In the present study body weight of exposed fish showed a mild decline but the decrease is statistically non significant; this indicates that zinc has a non significant bearing on appreciable alterations in body weight at an exposure of 15 days. Probably because the period of exposure is short as compared to earlier reports. The decrease in body weight also concides with an increase in zinc concentration as well as duration of the experiment.

A significant reduction in liver weight and hepato somatic index is in agreement with earlier studies (Dange, 1986; Vijayram *et al*., 1989; Sharma, 1994; Environ. Protec. Department, 2005; Sadekarpawar and Parikh, 2013). Dange (1986) reported reduction in liver weight and hepato somatic index in fresh water fish *Tilapia mossambicus* exposed to aromatic hydrocarbons for 96 hrs. Similarly a significant decrease in weight of liver and hepato somatic index was also reported by Vijayram *et al*., (1989) in *Anabas testudineus* exposed to cadmium for a short period (3 days).

Sadekarpawarand Parikh (2013) also noticed adverse effects on HIS in fish when treated with plant nutrients rich in N,P,K,S and Zn.

Dange (1986) and Vijayram *et al*., (1989) suggested that decrease in the liver weight may be caused by a decline in protein and glycogen content of the liver. Present work is in agreement with the above results since a, reduction in glycogen content of liver has been noted in the treated groups (Srivastava *et al*., 2002). Hormonal changes which are closely linked to metabolism, may also be responsible for influencing the liver weight and hepato somatic index (Sharma, 1994).

After withdrawal of zinc treatment, fish return to normal behaviour within a period of 2-5 days. Earlier studies have also shown that various fish species have a quick tendency to return to normalcy on withdrawl of pollutants or adverse environmental conditions (Rani and Ramamurthi, 1987; Norrgren *et al*., 1991; Sharma, 1994). It can, therefore, be suggested that behavioural changes of the fish can act as important indicators of the polluted/suitable conditions prevailing in its habitat. Further the changes observed at the present dose levels and duration are reversible.

A decline in body weight of fish during recovery, suggests that zinc treatment tends to have an antagonistic effect on body weight of fish. A slight decline in body weight of Channa punctatus pre-exposed to zinc in an acidic medium has earlier been reported by Sharma (1994). When Channa punctatus, pre-exposed to zinc in an acidic medium were transferred to normal conditions, liver weight was significantly lower than control, however, HSI values reached near control levels (Sharma, 1994). Sharma (1994) suggested that fat depletion may cause a reduction in liver weight and the changes were correlated with histological damage in the liver. In the present study, similarly a marginal increase in liver weight shows an effort towards recoupment though HSI values reach near normal levels only by the end of the experiment.

Aquatic Pollution by zinc

It can thus be suggested that pre-treatment with zinc for 15 dayhas a persistent influence on the body weight. Though withdrawl of treatment checks further decline in liver weight and HSI and enables the tissue to return towards control values, a per.iod of 15 days is not sufficient in achieving normalcy. Thus behavioural changes, changes in body weight, liver weight and HSI can be used as sensitive indices for assessing metal pollution in water bodies.

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