Protection by zinc against mercury toxicity in the intestine of a Catfish- 
*Heteropneustes fossilis*-A Biochemical study

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Abstract

Present study deals with the investigation of toxic effects of Mercury and zinc and the role of zinc in the simultaneous 
treatment of mercury and zinc, in the intestine of a catfish *H. fossilis*. Biochemical studies had shown decrease in 
glucose and protein level and increase in alkaline phosphatase due to Hg (0.01 mg/l) treatment for 30 days. When 
treated with Hg and Zn simultaneously, values for all these parameters were comparable to that of control group, 
suggesting protective role of Zn against Hg toxicity.

Keyword:- Mercuric chloride, Zinc sulphate, Intestine, Toxicity

Introduction

Environmental pollution due to heavy metals as a result 
of rapid industrialization has been reported in different 
parts of globe including India (Ansari *et al.*, 1991; 
Long *et al.*, 1991; Adrienne and Ressmann, 1998; 
Govil *et al.*, 1999). The toxicity of mercury was 
known as early as 16th century and it has been found 
highly toxic to both humans and animals (Clarkson, 
1997). Mercury is widely used in electrical apparatus, 
chlorine industry, caustic soda and caustic potash 
industry, chloro-alkali industry, in ayurvedic medicines 
and also in dentistry (Margaret *et al.*, 2001)
Accumulation of mercury in different tissues in 
various fishes has been reported (Dhanekar *et al.*,
1987; Mason *et al.*, 2000; Lima *et al.*, 2005). Hg is 
corrosive to the intestinal tract and can damage liver, 
kidney, if taken in sufficient amount (Gold water, 1971; 
Hommond, 1971).
Protection against heavy metal toxicity by herbal 
compound (Geed, 1992; Kothari *et al.*, 1999), essential 
metal (Bhoraskar and Kothari, 1993; Chen *et al.*,
2001) antioxidants (Potdar, 2007) has been reported. 
Zn is an essential metal and its pretreatment is known 
to provide protection against Cadmium (Peter, 1984). 
With this view in mind, present study was undertaken 
to assess protective role of zinc against mercury 
toxicity in the intestine of *Heteropneustes fossilis*.

Materials and Method

Living and healthy specimens of *H.fossilis* were 
purchased from local market of Indore. Fish were 
acclimatized to laboratory conditions for 7 days. 
Analytical grade mercury chloride (BDH) and zinc 
sulphate (BDH) were used. 96 hrs LC$_{50}$ for mercury 
chloride and zinc was found to be 0.5 mg/l and 
600 mg/l respectively. Fishes were divided into four 
groups. Group 1 served as control group. Details of 
experimental groups are given in Table-1.

<table>
<thead>
<tr>
<th>Table-1: Experimental groups of Fish</th>
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</thead>
<tbody>
<tr>
<td><strong>Group No.</strong></td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
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<tr>
<td>IV</td>
</tr>
</tbody>
</table>

The duration of experiment was 30 days. The water 
of all aquarium was changed every 4th day and heavy 
metal salts were introduced into 2nd 3rd & 4th groups 
immediately after the water was renewed. Chopped 
prawns were given daily at a fixed time. No artificial 
aeration was done during experiment. Fishes from 
each group tissue was used for assaying level of total

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protein (Lowery et al., 1951), total glucose (Trinder, 1969) and alkaline phosphatase (ALP) activity (Wooton, 1964). Student “t” test was used to determine statistical significance of protein, glucose and ALP.

Results and Discussion

During this study reduced protein level was recorded due to mercury as compared to the control group in the intestine of H. fossilis. Zn alone enhanced the protein level, while Hg and Zn in combination maintained protein level near normal level (Table-2 Fig. 1). Depletion in protein content under the mercury stress has been reported earlier (Ramalingam and Ramalingam, 1982; Sharma, 1997) finding of this study are in accordance with the earlier reports.

Table-2: Protein concentration (mg/ml) in intestine of H. fossilis

<table>
<thead>
<tr>
<th>Groups</th>
<th>Protein concentration (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7.13 ± 0.41</td>
</tr>
<tr>
<td>II</td>
<td>3.98 ± 0.20*</td>
</tr>
<tr>
<td>III</td>
<td>8.91 ± 0.43*</td>
</tr>
<tr>
<td>IV</td>
<td>8.01 ± 0.81*</td>
</tr>
</tbody>
</table>

Note: Data are means ±SEM. (n=7); a, p<0.01 as compared to the respective values of Hg groups; b, p<0.001 and c, p<0.05 as compared to the respective control value.

Depletion in glucose content in intestine may be attributed to depletion of normal food intake due to Hg poisoning (Geed, 1992) and disturbed carbohydrate metabolism. Depletion in the level of glucose due to Zn (Kothari and Soni 2004) has been reported in the past. Protective effect of Zn against Hg toxicity also been reported by Fukino et al., 1986 in rats.

During this study Hg enhanced the ALP activity, while exposure to Zn inhibited enzyme activity. However catfish exposed to Hg and Zn simultaneously was able to maintain ALP activity near normal (Table-4, Fig-2).

Table-3: Glucose concentration (mg/ml) in intestine of H. fossilis

<table>
<thead>
<tr>
<th>Groups</th>
<th>Glucose concentration (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>15.20 ± 0.60</td>
</tr>
<tr>
<td>II</td>
<td>10.20 ± 0.41</td>
</tr>
<tr>
<td>III</td>
<td>18.31 ± 1.02</td>
</tr>
<tr>
<td>IV</td>
<td>13.98 ± 0.88</td>
</tr>
</tbody>
</table>

Note: Data are means ±SEM. (n=7); y, p<0.01 as compared to the respective values of Hg groups; a, p<0.001; b and c, p<0.05 as compared to the respective control value.

Depletion in glucose content in intestine may be attributed to depletion of normal food intake due to Hg poisoning (Geed, 1992) and disturbed carbohydrate metabolism. Depletion in the level of glucose due to Zn (Kothari and Soni 2004) has been reported in the past. Protective effect of Zn against Hg toxicity also been reported by Fukino et al., 1986 in rats.

During this study Hg enhanced the ALP activity, while exposure to Zn inhibited enzyme activity. However catfish exposed to Hg and Zn simultaneously was able to maintain ALP activity near normal (Table-4, Fig-2).

Duration dependent effect of Hg poisoning on ALP activity has been reported in intestine of H. fossilis. Both rise in ALP activity due to Hg in fish (Potdar,
2007) and fall in ALP activity due to Zn poisoning (Kothari and Soni, 2004) are known to occur. Findings of this study are in accordance with the earlier reports. It is known that alkaline phosphatase in intestinal brush border plays a critical role in the absorption of various macromolecules from the lumen to the tissue interior (Sinha, 1979; Chakrabarty and Sinha, 1982). Both the loss (Rodin and Crowson, 1962) and increase (Jeelani and Shaffi, 1986) in the ALP activity have associated with tissue necrosis and structural damage. The result of this study clearly revealed that alteration in the value of protein, glucose & ALP activity caused due to mercury intoxication were maintained near normal in the presence of zinc sulphate. This suggests that zinc provided protection against mercury caused disturbances in biochemical parameters.

References


Table-4: Alkaline phosphatase (KA unit) activity in intestine of *H. fossilis*

<table>
<thead>
<tr>
<th>Groups</th>
<th>Organ</th>
<th>Intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.33±0.05</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>2.01±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>0.99±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1.30±0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
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</tbody>
</table>

Data are means SEM. (n=7).<br><br><sup>a</sup> p<0.001 and <sup>b</sup> p<0.01 as compared to the respective values of Hg group.<br><br><sup>x</sup> p<0.001; <sup>y</sup> p<0.01 and <sup>c</sup> p<0.05 as compared to the respective control values.


