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Bioaccumulation of chromium in various tissues of *Labeo rohita*

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Abstract

The bioaccumulation of chromium was studied in various tissues of *Labeo rohita* including kidney, muscle, gills and liver. The order of accumulation in these tissues was as follows: kidney > gills > liver > muscle. There was however a decrease in tissue chromium level after few days of cessation of exposure.

Keywords: Chromium, *Labeo rohita*, bioaccumulation.

Introduction

Due to unplanned and indiscriminate waste disposal, both terrestrial and aquatic ecosystems are threatened by heavy metal contamination. Bioaccumulation of these metals adversely effects many tissues, disturbs metabolism and hampers growth and development. (Akram, *et.al.*, 1999). Heavy metals have longer biological half life that's why they accumulate. If the results of experimental research demonstrated on role of chemical agents in disease outbreak are taken into account, it become clear that a significant fraction of losses attributed to infections and invasive diseases is also due to contamination except that the effect is indirect. (Isayeva and Kozinenko, 1992). Chromium is an environmental contaminant that holds important position in toxicological literature. (Senft and Kohout, 1996). Oxidation state of chromium as well as its concentration in medium is important in determining its toxicity. Hexavalent chromium is found more toxic than trivalent chromium. (Dirilgn and Doan, 2002). The heavy metals present the phenomenon of biomagnification and aquatic organisms can accumulate heavy metals up to levels 100,000 times greater than those present in water in which they live. (Abate, *et .al.*, 2003). These metals can cause death and sub lethal effects on fishes in a variety of ways. Many metallic compounds or ions accumulate in body tissues especially liver, kidney, gills, heart, spleen, bone and muscles. (Post, 1987). In this experimental work the accumulation of chromium in various tissues of farmed fish *Labeo rohita* is monitored.

Materials and methods

The fish, *Labeo rohita* was procured from a local hatchery and the experiment was conducted in the experimental aquaria of zoology department, GCU Lahore. Hexavalent chromium was used in the form of potassium dichromate. The chromium was estimated in the following tissues of fish: liver, kidney, spleen, gills, and muscles. The chromium concentration was estimated by using Atomic Absorption Spectrometry. For this purpose the ash of each tissue was made separately in Muffle furnace at 550°C temperature. One gram of the ash was taken and dissolved in 15 ml of HCl (6N). It was then digested in the flask until the volume remained 2 ml. The volume was then raised to 50 ml with deionized water. The samples were then filtered with 0.45 micron Millipore filter paper with help of micro filtration vacuum pump. The sample was then ready for chromium estimation on atomic absorption spectrometer (SOLAAR, 969, Thermo Elemental, U. K.). The data was analyzed

by using ANOVA (Analysis of Variance) and L.S.D. (least significant difference) (Sokal and Rohlf, 1981). The probability less than 0.05 ($P < 0.05$) were considered as significant. An asterisk represents the significant values in tables. The standard error of mean is represented by S. D.

Results

Chromium accumulation was monitored in different tissues like kidney, liver, gills and muscle.

(i) kidney

There was no chromium present in group A as it received no toxicant. In group B which received two daily exposures of chromium the amount of chromium accumulated was 0.051 ± 0.00021 µg/mg of tissue. After two weeks this amount decreased to 0.042 ± 0.00012 µg/mg of tissue. After four and six weeks this amount further decreased to 0.026 ± 0.00017 µg/mg and 0.0148 ± 0.00015 µg/mg of tissue respectively, and after 8 weeks the amount remained was 0.011 ± 0.00025 µg/mg of tissue (Table 1).

(ii) Liver

In group A there was no chromium accumulation. Group B was exposed to two daily exposures of 12mg/lit. of chromium. The chromium estimated in the liver of this group was 0.032 ± 0.00012 µg/mg tissue which later on (after two, four, six and eight weeks) decreased to 0.0228 ± 0.00008 µg/mg, 0.018 ± 0.0004 µg/mg, 0.011 ± 0.00025 µg/mg and 0.0068 ± 0.00015 µg/mg of tissue respectively. (Table 2).

(iii) Gills

Gills had no chromium accumulation in groups A. However in group B which received two daily exposures of toxicant there was 0.035 ± 0.00028 µg/mg of tissue of chromium present. This amount after two and four weeks decreased to 0.0232 ± 0.00008 µg/mg and 0.018 ± 0.00013 µg/mg of tissue. After six and eight weeks chromium further reduced to 0.007 ± 0.00018 µg/mg and 0.0018 ± 0.00008 µg /mg respectively of gill tissue. (Table 3).

(iv) Muscle

In muscle tissue, there was no chromium in group A. In the group B which was bare to two daily exposures of 12mg/lit. of toxicant showed 0.0282 ± 0.00019 µg/mg tissue of chromium in muscle. After two, four, six and eight weeks this amount was reduced to 0.012 ± 0.00025 µg/mg, 0.009 ± 0.00051 µg/mg and 0.0048 ± 0.00049 µg/mg and 0.0024 ± 0.00016 tissue respectively. (Table 4).

Discussion

The chromium accumulation in tissues was in following order kidney > gills > liver > muscle. The amount of chromium accumulated in these organs decreased with passage of time. The increased accumulation of chromium in kidney might be due to diffusion process or it may have released the functional group in enzymes of kidney, as heavy metals are known to replace SH, amino, imino, carboxyl and phosphoryl groups in enzymes (Misra and Mani, (1992). Chromium may have come to the kidney from other parts to be excreted. With passage of time its accumulation decreased probably due to excretion of chromium by kidney. In gills chromium could have been accumulated directly by diffusion from surrounding water or it might have come from circulation. The decrease in chromium level may be due to the non-specific immune response present in gills. In the gills chromium might have been phagocytosed resulting in decreased values. Liver is the major detoxifying organ. Initially the chromium gets accumulated in it probably in the proteins

being bound to the enzymes. The diffusion of Cr in hepatocytes may also have contributed in its accumulation in organ. But as liver is a detoxifying organ so the metal concentration decreased with time. The dilution factor also may have contributed in decreased chromium. The chromium concentration in muscles was comparatively less than other organs. It is known that chromium is accumulated in aquatic species by passive diffusion (EPA US, 1978), and as muscles were in direct contact to skin so chromium might have diffused there. The decrease can be due to the reason that liver and components of immune system have not allowed the metal to reach muscles. The similar accumulation of chromium was reported

Table 1: Chromium accumulation in kidney of *Labeo rohita* after chromium exposure followed by antigen administration..

GROUP	Chromium accumulation (µg/mg TISSUE)					
	Toxicant	0 day	2 weeks	4 weeks	6 weeks	8 weeks
A	–	0.000± 0.00	0.000± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00
B	+	0.051± 0.00021	*0.042± 0.00012	*0.026± 0.00017	*0.0148± 0.00015	*0.011± 0.00025

* P < 0.05 Data expressed as Mean ± S.D.

by Hernandez, *et. al.*, (1990) in fish. Gbem, *et. al.*, (2001) showed concentration and accumulation of chromium in liver, gills, gut and muscle of fresh water *Clarias gariepinus*. In *Labeo umbratus*, Coetzee (2002) found the chromium accumulation in liver, gills, skin and muscle. Similar bioaccumulation results are reported by different authors like Sriwastwa, *et. al.*, (1987) Elwood, *et. al.*, (1980), Deb and Santra (1997) and Abete, *et. al.*, (2003); Jafriet *et. al.*, (1999) and Jafri *et al.*, (2003) in different fish species.

Table 2: Chromium accumulation in liver of *Labeo rohita* after chromium exposure followed by antigen administration.

GROUP	Chromium accumulation (µg/mg TISSUE)					
	Toxicant	0 day	2 weeks	4 weeks	6 weeks	8 weeks
A	–	0.000± 0.00	0.000± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00
B	+	0.032± 0.00012	*0.021± 0.00028	*0.018± 0.0004	*0.011± 0.00025	*0.0068± 0.00051

* P ‹ 0.05 Data expressed as Mean ± S.D.

Table 3: Chromium accumulation in gills of *Labeo rohita* after chromium exposure followed by antigen administration.

GROUP	Chromium accumulation (µg/mg TISSUE)					
	Toxicant	0 day	2 weeks	4 weeks	6 weeks	8 weeks
A	–	0.000± 0.00	0.000± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00
B	+	0.035± 0.00028	*0.0232± 0.00008	*0.018± 0.00013	*0.007± 0.00018	*0.0018± 0.00008

*P ‹ 0.05 Data expressed as Mean ± S.D.

Table 4: Chromium accumulation in muscle of *Labeo rohita* after chromium exposure followed by antigen administration..

GROUP	Chromium accumulation (µg/mg TISSUE)					
	Toxicant	0 day	2 weeks	4 weeks	6 weeks	8 weeks
A	–	0.000± 0.00	0.000± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00
B	+	0.0282± 0.00019	*0.012± 0.00025	*0.009± 0.00051	*0.0048± 0.00019	*0.0024± 0.00016

*P ‹ 0.05 Data expressed as Mean ± S.D

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