



Lead induced changes in protein contents of kidney, liver, muscles and ovary of tilapia, *Oreochromis mossambicus* (Peters)

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Abstract

The present study aims to investigate toxicological effects of heavy metal, lead on protein contents of some tissues such as kidney, liver, muscles and ovary of a freshwater teleost, *Oreochromis mossambicus*. After LC_{50} determination, fish was exposed to one-third of LC_{50} as sublethal concentration for 10 days, it showed remarkable changes in protein profiles of all these tissues. Diminution of total proteins in kidney, liver, muscles and ovary was significantly observed ($p < 0.05$). Compared to those in controlled fish, depletion of total proteins was found to be 6.85 % in kidney, 27.40% in liver, 45.23% in muscles and 6.60% in the ovary of experimental fish. Results showed that toxicity of lead to fish tissues was in the order muscles > liver > kidney > ovary. These alterations can be related to toxicological stress caused by heavy metal, lead.

Keywords: Contamination, heavy metals, Pb, pollution, toxicity.

Introduction

In recent years, pollution due to heavy metals has become a great environmental problem globally. Heavy metals are released by various cataclysm processes such as rock weatherings, volcanic eruptions, domestic, industrial (mining, electroplating, paints, dyes, battery makings etc.) and anthropogenic activities which increase their concentration into the environment¹⁻³. Increased level of heavy metals caused contamination of natural freshwater and may affect physiological, biochemical as well as the behavioral pattern of aquatic organisms⁴⁻⁶. Bioaccumulation of heavy metals in fishes causes adverse effects at different functional levels such as reproduction, growth, and development; ultimately leading to mortality of the organisms⁷⁻¹⁰. Among various heavy metal pollutants, lead (Pb) is reported to cause alterations in the hematologic system and inhibition of many enzymes activities involved in haem biosynthesis¹¹⁻¹². At sublethal concentrations, Pb can affect feeding energy, growth rate and biochemical contents of fish¹³. Pb is a cumulative body poison which can affect Central Nervous System (CNS), kidney, haem synthesis, DNA structure and functioning in organisms¹⁴.

The foremost objective is to evaluate toxicity of heavy metal Pb on protein contents in tissues viz. kidney, liver, muscles, ovary of commercially important freshwater fish, *Oreochromis mossambicus*.

Materials and methods

Freshwater tilapia fish, *O. mossambicus* was used in the experimentation. Healthy fishes were collected from Naik talao, a small freshwater pond situated at the urban locality of Nagpur

city in the Indian State of Maharashtra and brought to the laboratory for acclimatization. Fishes were acclimatized in a rectangular glass aquarium of 50L capacity for about 7 days. Physicochemical water quality parameters were analyzed by standard methods¹⁵. Important water quality parameters were monitored for acclimatization. These were temperature ($21.5 \pm 0.6^{\circ}\text{C}$), pH (7.3 ± 0.3), dissolved oxygen ($7.7 \pm 0.2\text{mg/L}$) and total hardness ($141 \pm 2\text{mg/L}$). Average weight of the fish was 30-40g. To determine the toxicity range of Pb, acute toxicity test within the short period was conducted by means of lead nitrate [$\text{Pb}(\text{NO}_3)_2$] salt. The stock solution of Pb (1000mg/L) was prepared by dissolving 1.60g of lead nitrate in 1:1 conc. HNO_3 with ultrapure deionized water and finally volume make upto 1L using volumetric flask. From the main stock solution, the required test concentrations were prepared. Then fishes were exposed to different test concentrations of Pb viz. 40mg/L, 60mg/L, 80mg/L, 100mg/L and 120mg/L. During experiments, fish mortalities were recorded for median lethal concentration (LC_{50}) determination. From mortality data, LC_{50} value was calculated according to Finney¹⁶ and it was found to be 109.46mg/L. In order to determine protein contents of kidney, liver, muscles and ovary, the fishes further exposed to one-third (36.49mg/L) of LC_{50} as a sub-lethal concentration for 10 days. The control (without toxicant i.e. Pb) was set separately. After the exposure period, fish was sacrificed from control and experimental groups to obtain desired tissues such as kidney, liver, muscles and ovary. Total proteins in these tissues were determined using standard protocol according to Lowry *et al.*¹⁷ and minor modification according to Tambe¹⁸.

Data obtained was processed and analyzed using computerized application software Microsoft Office Excel version 2010 and was presented as mean, standard deviation, and percent change.

Student's "t" test was used for statistically significant at $p < 0.05$.

Results and discussion

Total protein contents in kidney, liver, muscles and ovary of control and experimental fish are depicted in following table and represented in Figure-1.

Results showed significant variations in total proteins. Mean concentration with standard deviation of total protein contents in

wet weight of controlled tissues was found to be 1.16 ± 0.48 mg/g in kidney, 1.26 ± 0.51 mg/g in liver, 1.13 ± 0.44 mg/g in muscles and 1.46 ± 0.58 mg/g in ovary whilst in case of experimental tissues it was found to be 1.08 ± 0.11 mg/g in kidney, 0.91 ± 0.07 mg/g in liver, 0.62 ± 0.32 mg/g in muscles and 1.37 ± 0.53 mg/g in ovary. The depletion of total protein contents due to Pb toxicity was found to be 6.85% in kidney, 27.40% in liver, 45.23% in muscles and 6.60% in the ovary. Statistically, the variation in total protein contents was tested significant at $p < 0.05$ (Table-1).

Table-1: Variation in protein contents due to the toxicity of Pb in kidney, liver, muscles and ovary of freshwater fish, *O. mossambicus*.

Exposure group		Protein contents of fish tissues (mg/g)				p-value
		Kidney	Liver	Muscles	Ovary	
Control (without Pb)	I	1.48	1.60	1.36	1.82	$p < 0.05$
	II	1.39	1.50	1.41	1.78	
	III	0.61	0.67	0.61	0.79	
	Mean \pm SD	1.16 ± 0.48	1.26 ± 0.51	1.13 ± 0.44	1.46 ± 0.58	
Experimental (with Pb)	I	1.19	0.97	0.99	1.31	$p < 0.05$
	II	1.08	0.93	0.46	1.92	
	III	0.97	0.83	0.40	0.87	
	Mean \pm SD	1.08 ± 0.11	0.91 ± 0.07	0.62 ± 0.32	1.37 ± 0.53	
	Percentage change	-6.85	-27.40	-45.23	-6.60	

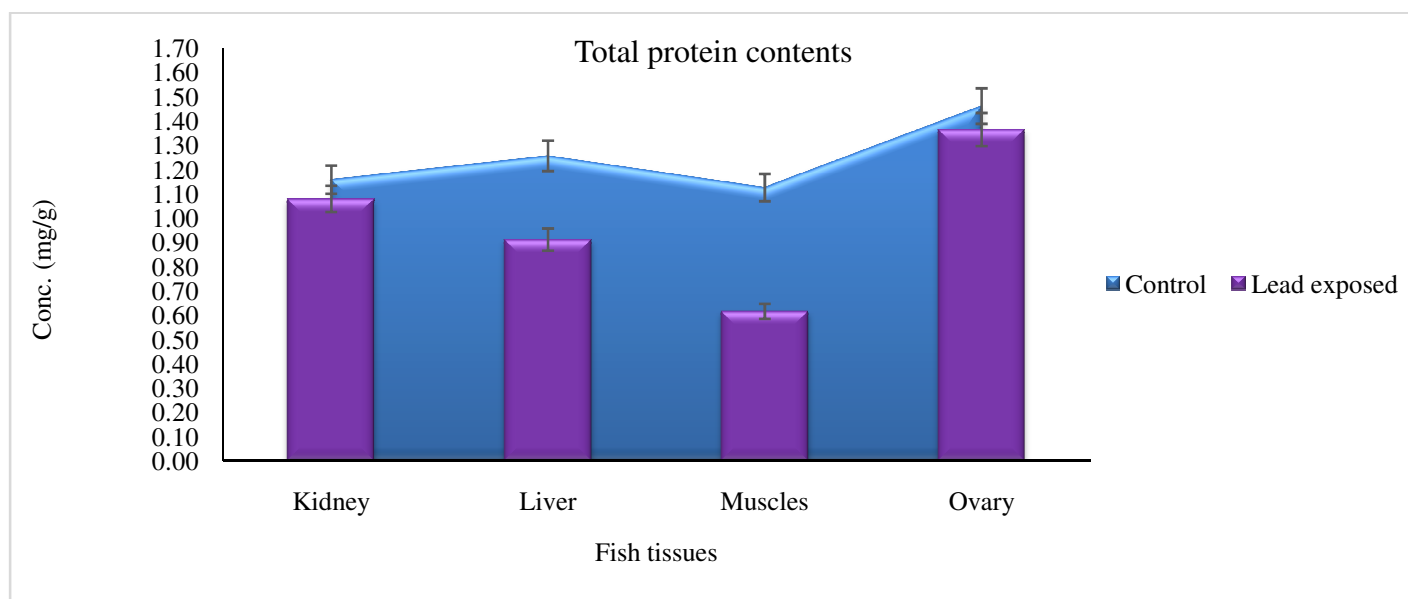


Figure-1: Variation in total protein contents due to Pb toxicity in different tissues of fish, *O. mossambicus*.

During lifetime, biochemical composition of fish tissues determines their specific physiological demands. Among different biochemical compositions, proteins are the important group performing most of the physiological functions. They act as nutrient and energy sources needed for physiological responses¹⁹⁻²⁰. According to Borah and Yadav²¹, proteins and its metabolism are highly sensitive to environmental stresses. Previous studies revealed that depletion of total proteins arrests metabolism to combat stress. Under pollutants stress, degradation of proteins, destruction of cells due to impairment of protein synthesis and impending energy demands are some of the major causes for depletion in total proteins²²⁻²⁴. Depletion of total proteins due to heavy metal toxicity in vital organs of different fishes have been reported by many researchers^{3,8,25-28}.

During study, a significant decline in total protein contents of kidney, liver, muscles and ovary of *O. mossambicus* was observed (Table-1 and Figure-1). This may be due to the difference in metabolic calibers (impaired rate of protein synthesis, utilization of proteins in cell repair, uptake of amino acids into polypeptide chains) of these tissues during the exposure period. Reduction of proteins in ovary due to Pb exposure reported in the present work may result in impairment of reproductive process.

Kidney is an important tissue associated with excretion and maintaining homeostasis in fish²⁹. Liver is rich in proteins and is considered as a centre for various metabolisms. Muscles form mechanical tissue which play an important role in movement of organisms. They also contain more proteins but has no participatory role in metabolisms. After exposure of heavy metal cadmium on freshwater fish *Catla catla* (Hamilton), these tissues showed depletion in total protein contents³. Same is noted in *O. mossambicus*.

Conclusion

Significant changes in total protein contents of kidney, liver, muscles and ovary of *O. mossambicus* would be due to the toxicological effect of heavy metal Pb. This might be related to the adaptive response by fish towards metal toxicity in an aquatic environment. Data obtained from this study can be useful for further research explaining the physiological response of fishes under heavy metal toxicological stress.

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