UTTAR PRADESH JOURNAL OF ZOOLOGY

42(12): 38-41, 2021
ISSN: 0256-971X (P)

TO STUDY THE EFFECT OF HEAVY METALS ON VARIOUS TISSUES OF TILAPIA (*Oreochromis mossambicus*) AT MOLECULAR LEVEL

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Osama Anwer Saeed, University of Anbar, Iraq.
Reviewers:
(1) M. Moslen, Rivers State University, Nigeria.
(2) Santoshkumar Abujam, Rajiv Gandhi University, India.

Received: 22 March 2021
Accepted: 28 May 2021
Published: 01 June 2021

Original Research Article

ABSTRACT

This study was conducted to assess the effect of metal pollutants at molecular level in selected fish tissues. Effect of sub lethal concentrations of zinc and lead on total protein and nucleic acid content in gills and liver of Tilapia was determined. There was an increase in protein content in the gills by 16.25% and 11.25%, while in liver tissue a decrease was seen by 33.3% and 11.85% when fish were exposed to sub-lethal concentrations of zinc chloride and lead nitrate. RNA content increased in gill by 38.79% and 29.3%, while DNA content increased by 13.66% and 39.33%. There was a decrease in both RNA and DNA content in the liver. The results show that heavy metal like zinc and lead cause changes at molecular level in the tissues of fishes.

Keywords: Nucleic acid; protein; zinc; lead.

1. INTRODUCTION

Contamination of aquatic ecosystems with various substances has become a major concern all over the world. Aquatic environment gets contaminated due to various pollutants and is a major area of study due to its deleterious effects on aquatic environment, man and other organisms [1,2]. Among the various pollutants, pesticides and heavy metals are of concern for aquatic ecosystem due to their toxicity, and bioaccumulation [3,4] and these are one of the major environmental contaminants of aquatic ecosystem. These pollutants not only put a threat to the flora and fauna of the aquatic ecosystem but also adversely affect the ecological balance leading to unwanted mortality of aquatic fauna including fishes.

There has been an increase in metal pollution due to rapid technological advancement in the world. Industry, mining, domestic waste, advanced

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agriculture and petroleum fuels are the major sources of metal pollution. Metals tend to accumulate in aquatic organisms, and persist in the water and the sediments [5,6]. Fish are useful bio indicators of any toxicant as they are on the top of the aquatic food chain and hence used for toxicity bioassays [7,8,9, 10]. These metals enter the fish body through the gills, digestive tract and body surface [11]. It has been reported that heavy metals have a harmful effect on all relevant parameters and caused damage both at biochemical and histo-pathological levels in fishes.

Zinc and lead are also major environmental pollutants. Zinc is an essential micronutrient and a toxicant in aquatic system at high concentration. Zinc plays a very important part in biological system as it plays a functional role in more than 300 enzymes and other proteins [12]. Hence, a deficiency of zinc in fish can lead to physiological disturbances in these fishes. The effect of this metal on various parameters of fish has been studied [13]. It effects by causing structural damage, which affect growth, development and survival [14]. Sublethal level of zinc has been known to affect hatchability [15,16].

Lead gets accumulated in the aquatic ecosystem and can induce damage in aquatic organisms [2,17,18]. Lead toxicity in fish is induced via the gills [19]. It causes lipid peroxidation in fishes and increase MDA levels [12,20].

Only a few reports are there to show the effect of heavy metal pollutants on nucleic acid content in fishes [21]. Not much data is available of the effect of zinc and lead on Tilapia {*Oreochromis mossambicus*) at molecular level. This study is aimed to find out the effect of zinc and lead induced changes in nucleic acid and protein content in Tilapia.

2. MATERIALS AND METHODS

2.1 Chemicals

Zinc as Zinc chloride [$ZnCl_2$] Lead as Lead Nitrate [$Pb(NO_3)_2$] Calf thymus DNA was purchased from SRL. All other chemicals used were of analytical grade.

2.2 Experimentation

Tilapia of similar size [6-7cms] in length and weight were collected from the local lake of Thane District. Fish were randomly distributed in glass tank in dechlorinated tap water at 28 ± 2^0C under a natural photoperiod [12h light-12h dark]. The aquaria were supplied with continuous aeration. Fish were allowed to acclimatize to their new environment for 10 days prior to treatment.

The fish acclimated were fed at a rate of 5% of live body weight daily for a week. Unconsumed feed and wastes were siphoned daily. After acclimatization, LC_{50} was determined. The group of ten fish were assigned to 3 treatment groups [Control, Zinc (4mg/L) and Lead (0.5mg/L)] respectively.

At the end of exposure period of a week, fish from each group were netted and gills and liver were removed and refrigerated till use. DNA was estimated by method of Schneider [22], RNA was estimated by Dische-orcinol method of Storoev and Makarovo [23] and protein was estimated by Lowry's method [24].

3. RESULTS

The effect of zinc chloride and lead nitrate on protein and nucleic acid content in the Gills and liver of Tilapia is shown in Table 1.

The change in RNA content was in the order of Gill>Liver. Exposure of Tilapia to zinc caused an increase in RNA content in Gills by 38.79%. Similar results were seen when Tilapia was treated with lead nitrate, there was an increase RNA in the gills by 29.3%. The change in DNA content was in the order of Gill> Liver. Exposure of Tilapia to both zinc and lead caused an increase in DNA content in gills by 13.66% and 39.33 %.

A decrease in RNA content was seen in liver by 16.4% and 17% when treated with zinc and lead respectively. DNA content also showed a decrease in liver by 5.8% when fishes were treated with zinc and 17.5% when exposed to lead. Protein content in the

Table 1. Shows the changes in the RNA, DNA and Protein content in the gill and liver of fish, Tilapia exposed to Zinc chloride and Lead Nitrate

Group	RNA (mg/g b.w)		DNA (mg/g b.w)		Protein (mg/g b.w)	
	Gill	Liver	Gill	Liver	Gill	Liver
Control	1.16±0.14	1.71±0.27	4.83±0.47	13.81±0.87	16.00±1.13	11.21±0.29
Zinc	1.61±0.10	1.43±0.24	5.49±0.16	13.01±0.46	18.60±0.41	16.80±0.22
Lead	1.50±0.06	1.42±0.52	6.73±0.71	11.40± .82	17.80±0.35	14.81±0.42

gills of fishes exposed to zinc chloride and lead nitrate increased as compared to control. The increase in protein content was by 16.25% and 11.25% in the gills, while a decrease was seen in liver tissue by 33.3% and 11.85% in fishes treated with zinc and lead as seen in the above Table 1.

4. DISCUSSION

Nucleic acid and protein level act as biochemical indices of an organism and plays a major role in biological activities. The RNA/DNA levels indicate the degree of protein synthesis [25,26]. Increase in RNA content in gills of fishes treated with different toxicants has been reported by some authors. Devi and Banerjee [2] have shown an increase in RNA in gills of *Channa striata* exposed to lead nitrate. Similar increase in RNA in gills has also been seen in *Cyprinus carpio* [27]. An increase in RNA and DNA in gills of *Channa punctata* treated with cypermethrin has also been reported [28,29]. Gills form the major route for entry of toxicants in fish and an increase in DNA and RNA in gills may be due change in metabolic activity with the increased synthesis of proteins that would act as a defence against the toxicant [21].

Holbrook [30] has reported a decreased level of RNA in liver of fish. The results of the present study shows a decrease in the RNA content of liver of Tilapia fish exposed to sublethal concentration of zinc and lead. Decrease RNA in liver indicates metabolic activity in the form of proteolysis [21,28]. An increased protein is an adaptation of organism to a toxic environment and also acts as a means to induce tolerant stress [31]. Increased ratio of protein content was also reported in fishes treated with heavy metals [32].

5. CONCLUSION

The study shows that heavy metal like zinc and lead bring about changes at molecular level in fishes. Contamination of aquatic bodies with these heavy metals can cause mortality and loss of fishes. Consumption of these fishes can also lead to toxicity in humans. So there is a need to check and monitor these pollutants in aquatic systems.

ACKNOWLEDGEMENT

The first author would like to thank University of Mumbai for Minor Research grant. Authors would like to thank the principal of G. M. Momin Women's College, for the support rendered.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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