The Bioscan 2 (1) : 67-69, 2007
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

BIOACCUMULATION OF ARSENIC IN THE FRESHWATER FISH *LABEO ROHITA* (HAM.)

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KEY WORDS
Labeo rohita
Bioaccumulation
Arsenic

Received on :
26.07.2006
Accepted on :
03.10.2006

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ABSTRACT

Bioaccumulation of arsenic in the fish- *Labeo rohita,* was investigated after exposure to two sub lethal concentration of arsenic trioxide (1/10th - 0.27 ppm and 1/3rd - 0.91 ppm of the 96 h LC_{50}) for 7th, 14th, 21st & 28th days. The highest / maximum level of accumulation of arsenic was seen in the liver whereas the lowest level of arsenic had been accumulated in the muscle tissues at the end of 28 days of exposure period. It is clear that arsenic has been accumulated primarily in the liver tissues of *L. rohita* exposed to sublethel concentration of arsenic. The present investigation indicates that the rate of accumulation of arsenic was found to be dose and time dependent.

INTRODUCTION

Study of toxicology pertaining to aquatic animals have become important in water pollution studies. Heavy metal contaminants in aquatic ecosystems pose a serious environmental hazard because of their persistence and toxicity. Among the heavy metal pollutants, arsenic receives a special attention due to its potential health hazard to aquatic fauna and human life in particular. The presence of arsenic in industrial wastes and its high toxicity along with considerable bioaccumulation in freshwater fishes make it a toxicant that should be given due consideration in aquatic toxicology. The term bioaccumulation refers to the wastes which have been reconcentrated in organisms often having undergone initial dilution in environment producing toxic effects in fishes (Dallinger *et al*., 1987) Availability of heavy metals in the aquatic ecosystem and its impact on the flora and fauna had been reported by many investigators (Nayak, 1999; Shrinivas and Balaparamaeswaran, 1999).

The accumulation of heavy metals in the tissues of fishes may cause various physiological defects and mortality (Torres *et al*., 1987). Heavy metals accumulated in the tissues of aquatic animals may become toxic when accumulation reaches a substantially high level (Kalay and Canli,2000). The pattern of bioaccumulation of metals in animals differs from metal to metal and organ to organ during their functional status. Most of the investigations pertaining to heavy metals contaminants in aquatic systems are dealt either with toxicity or with accumulation (Rushforth *et al*., 1981; Khadiga *et al*., 2002) Heavy metals have been shown to be concentrated in the liver of various fishes (Sorensen, 1991; Rao *et al*. 1998) In the present study, the bioaccumulation of arsenic in the liver and muscle tissues is evaluated in the fish, *Labeo rohita* exposed to sub-lethal concentration of arsenic for 7th ,14th ,21st , and 28th days.

MATERIALS AND METHODS

Freshwater fish, *Labeo rohita* ranging from 10-12 cm in length and weighing between 9 and 14 g were collected from fish farm located in Puthur, Chidambaram, Tamil Nadu campus and was acclamatized under laboratory conditions (29 $\pm$ 1^0 C). The fish were fed daily on oil less groundnut cake. The unused food was removed after 2 hours and water was changed daily. Prior to experimentation *L. rohita* were acclimatized in experimental tanks for at least one week. The LC_{50} values were determined (Finney,1971) which was found to be 2.7 ppm. Sublethal studies are helpful to assess the response of the test organism under augmented stress caused by metals. According to Konar (1969) and Sprague (1971) one-tenth (0.27 ppm) and one-third (0.9 ppm) of the 96h LC_{50} values of arsenic trioxide were selected for the present investigation as sublethal concentration, respectively. The fishes were exposed to lower and higher sublethal concentrations for a period of 7,14,21 and 28 days. *L. rohita* were sacrificed after each exposure period and the tissues like liver and muscle were taken out from the experimental and control groups for the estimation of the heavy metal.

Table 1: Accumulation of arsenic (mg/g wet wt., M ± S.E.) in different tissues of *Labeo rohita* exposed to lower and higher sublethal concentration of arsenic.

Tissues	Group	Exposure period in days 7	14	21	28
Liver	C	ND	ND	ND	ND
	LC	0.23 ± 0.0025	0.42 ± 0.0051	0.67 ± 0.0036	0.81 ± 0.0073
	HC	0.32 ± 0.0053	0.64 ± 0.0045	0.72 ± 0.0014	1.00 ± 0.0034
Muscle	C	ND	ND	ND	ND
	LC	0.10 ± 0.0096	0.16 ± 0.0255	0.23 ± 0.0182	0.47 ± 0.0035
	HC	0.17 ± 0.0081	0.24 ± 0.0035	0.31 ± 0.0268	0.53 ± 0.0010

C – Control; ND – Not Detected, LC – Lower sublethal concentration; HC – Higher sublethal concentration.

The liver and muscle tissues of control and treated fish were isolated and dried in an oven at 110^0 C for 24 hours. The known amounts of dried tissues were digested with 3:1 ratio of nitric acid and perchloric acid. After the accomplishment of complete digestion, the digested samples were made-up to 25ml with metal free double distilled water and stored for the analysis, (Topping, 1973). The measurements were made using Atomic Absorption Spectrophotometer. Values were expressed as mg / g wet wt.

RESULTS AND DISCUSSION

The levels of arsenic accumulation in the liver and muscle tissues of *Labeo rohita* exposed to lower and higher sub – lethal concentration of arsenic to different periods of 7,14, 21 and 28 days are shown in Table 1. In the present investigation, the highest level of arsenic accumulation (1.00 ± 0.0034) was found in the liver when compared to muscle tissues (0.53 ± 0.0010) of *Labeo rohita* when exposed to higher (0.9 ppm) and lower (0.27 ppm)sublethal concentrations of arsenic exposure for different time intervals. Similar pattern of accumulation of As in the liver tissues of *Mugil cephalus* was found to be significantly greater than in any other tissues (Maher *et al*., 1999).

Heavy metals have been shown to be concentrated in the liver of various teleosts fishes (Noel – Lambot *et al*., 1978; Thiruvalluvan *et al*., 1997). The accumulation of copper in the liver has been well documented (Pugazhendy, 2000). High values of cadmium accumulation were reported by Hilmy *et al*., (1985) in the liver of *Mugil cephalus*. Kumuda *et al*. (1973) and Rao *et al*., (1998) have found a steady accumulation of heavy metal in the liver and kidney of most of the fishes. Further the liver exhibited higher concentration of metal accumulation than any other organ/ tissue (Coombs, 1979). In the present study, the arsenic concentration in liver tissue was found to be dose and time dependent. Similar findings were reported by Karuppasamy (1999) who has described the bioaccumulation as dose and time dependent in phenyl mercuric acetate exposed fish *Channa punctatus*.

In the present study, the muscle of *Labeo rohita* has showed a lower degree of arsenic accumulation when compared to liver tissues at lower and higher sublethal concentration of arsenic intoxication. The observations of the present study are in good agreement with Maher *et al*., (1999), who have suggested the least quantum of arsenic in the muscle of *Mugil cephalus*. Accumulation of heavy metals (As, Cd, Hg, and Zn) in muscle tissues of fishes have been well described by several investigators (Gupta and Sharma, 1994; Karuppasamy,1999). Kalay *et al*., (1999), have stated the lower levels of lead in the muscle of treated fish, *Mullus barbatus*. Windom *et al*., (1987), have found lower concentration of cadmium, copper, lead and nickel in the muscle of fish *Corphalnoids armatus* sp., Vincent and Ambrose (1994) have reported low levels of cadmium and zinc in the muscles of *Catla catla*. Prafullach *et al*., (1997) have found the lowest concentration of lead in muscle of *Clarias batrachus*. In the field study it appears to accumulate less concentration of arsenic in the muscle and gill tissues than liver and kidney (Sorensen, 1991; Maher et al. 1999). Similar pattern of arsenic accumulation has also been found in the present study. In the present study the rate of accumulation was found to be concentration and time dependent.

ACKNOWLEDGEMENT

The authors are grateful to the Department of Zoology, Annamalai University for providing necessary facilities to complete this work.

REFERENCES

Coombs, T.L. 1979.Cadmium in aquatic organism, in the chemistry, biochemistry and biology of cadmium (M.Webbed), pp. 93-139, Elsevier/ North Holland Biomedical Press.

Dallinger, R., Prosi., F, Segrner, H. and Back,H. 1987. Contaminated food and uptake of heavy metals by fish: A review and a proposal for further research. *Ocelogia* (Berl.), **73(1)**: 91-98.

Finney, D.J. 1971. *Probit analysis.*, University Press Cambridge, p.333.

Gupta, A.K. and Sharma, S.K. 1994. Bioaccumulation of zinc in *Cirrhinus mrigala* (Hamilton) fingerlings during short terms static bioassay. *J.Environ. Biol.*, **15(3)**: 231 – 237.

Hilmy, A.M., Shabana, M.B. and Daabees, A.Y. 1985. Bioaccumulation of cadmium toxicity of *Mugil cephalus*. *Comp. Biochem. Physiol.* **81**C: 139-143.

Kalay, M., Ay, O. and Canli, M. 1999. Heavymetal concentrations in fish tissues from the Northeast Mediterranean sea. *Bull. Environ. Contam. Toxicol*. **63**: 673-681.

Kalay, M. and Canli, M. 2000. Elimination of essential (Cu, Zn) and non-essential (Cd, Pb) metals from tissues of a freshwater fish *Tilapia zilli*. Turk. *J. Zool*. **24**: 429-436.

Karuppasamy, R. 1999. The effect of phenyl mercuric acetate (PMA) on the physiology, biochemistry and histology of selected organs in a freshwater fish, *Channa punctatus* (Bloch). Ph.D Thesis, Annamalai University, India.

Khadiga, G.A., Sherifa, S.H, Hama, M.I. and Ramadan, A.S. 2002. Impaired function in *Nile tilapia, Oreochromis niloticus* from polluted waters. *Acta Hydrochemica et Hydrobiologica*. **29**: 278-288.

Konar, S.K. 1969. Histopathological effects of the insecticide heptachlor and nicotin in the gills of the catfish *Heteropneustes fossilis*. *Jap.J.Ichtyol*. **15(4)** : 156 - 159

Kumuda, H., Kimura.S., Yokote, M. and Matida, Y. 1973. Acute and chronic toxicity uptake and retention of cadmium in freshwater organisms. *Bull. Freshwater. Fish. Res. Lab.*, Tokyo. **22**: 157 – 165.

Maher, W., Goessler, W., Kirby, J. and Raber, B. 1999. Arsenic concentrations and speciation in the tissues and blood of sea mullet *(Mugil cephalus)* from lake Macquarie NSW, Australia. *Marine Chemistry*. **68**: 169-182.

Nayak, L. 1999. Heavy metal concentration in two important penacid prawns from chilka Logoon. *Poll. Res*. **18(4)**: 373-376.

Noel - Lambot, F., C.Gerday and Disteche, A. 1978. Distribution of Cd, Zn and Cu in liver and gills of the Eel, *Anguilla anguilla* with special reference to metallothionein. *Comp. Biochem. Physio*. **61**C: 177 - 187.

Prafullach, Rout., Naik, B.N. and Choudhury, S. 1977. Lead accumulation in various tissues of *Clarias batrachus* during experimental plumbism. *J.Appl.Zoo. Res*. **8(2)**: 157 – 158.

Pugazhendy, K. 2000. Studies on the impact of industrial pollutants (SIPCOT – Cuddalore) of the uppanar estuary in a mullet fish, *Mugil cephalus* (Linn). Ph.D.Thesis, Annamalai University.

Rao, L.M., Vani, S. and Ramaneswari, R. 1998. Metal accumulation in tissues of macrobrachium from mehadrigedda stream, Visakhapatnam. *Poll. Res*. **17(2)**: 137-140.

Rushforth, S.R., Brotherson, J.D., Funglada, N. and Evenson, W.E. 1981. The effects of dissolved heavymetals on attached diatoms in the unitah basin of Uttab, USA. *Hydrobiologia*. **83(2)**: 313-323.

Shrinivas, V. and Balaparamaeswara, R. 1999. Chromium induced alterations in the oxygen consumption of the freshwater fish. *Labeo rohita* (Hamilton) *Poll. Res*. **18(4)**: 377-380.

Sorensen, E.M.B. 1991. Metal Poisoning in Fish. Chap. 2, Arsenic. CRC Press, Boca Raton, FL.pp. 61-64.

Sprague, J.B. 1971. Measurement of pollutant toxicity of fish. III. Sublethal effects and 'safe' concentrations. *Water. Res*. **5**: 245-266.

Thiruvalluvan, M., Nagendran, N. and Charles monoharan, A. 1997. Bioacumulation of cadmium and methylparathion in *Cyprinus carpio* var, communis (Linn.) *J. Environ & Poll*. **4(3)**: pp 221-224.

Topping, G. 1973. Heavymetals in fish from scottish waters. *Aquaculture*. **1**: 373-377.

Torres, P., Tort, L. and Flos, R. 1987. Acute toxicity of Copper to Mediterranean Dogfish. *Comp. Biochem. Physiol*. **86C(1)**: 169-171.

Vincent, S. and Ambrose, T. 1994. Uptake of heavy metals, cadmium and chromium in tissues of Indian major carp. *Catla catla* (Ham). *Indian J.Environ. Hlth*. **Vol. 36, No.3**, 200-204.

Windom, H, Stein. D., Sheldon, R. and Smith, R. Jr. 1987. Comparison of trace metal concentrations in muscle tissue of a benthopelagic fish (*Coryphaenoides armatus*) from the atlantic and pacific oceans. *Deep Sea Research*. **34**: 213-220.

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