Journal of Environmental Biology **May 2008,** 29(3) 299-302 (2008)

Changes in nutritive value of fish, *Channa punctatus* after chronic exposure to zinc

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(Received: January 13, 2006; Revised received: July 15, 2006; Accepted: August 12, 2006)

Abstract: *The present investigation was undertaken to assess the effects of sublethal concentrations of zinc (0.1 and 0.2 mgl^{-1}) on the nutritional value of fish Channa punctatus after exposure for 135 days. The parameters studied were, levels of total proteins, glycogen, total lipids, cholesterol and vitamins (A and D) in the muscle. Total proteins, glycogen, total lipids and vitamin D show highly significant decline from day 90 to 135, while cholesterol and vitamin A, show no significant changes upto 105 days. This study signifies a drastic reduction in the nutritive value of fish, which is compounded by the fact that under natural conditions fish are exposed to these levels of zinc for prolonged periods.*

Key words: *Channa punctatus, Zinc, Nutritional value*
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Introduction

Nutrients nourish the body, promote growth, maintain and repair body parts. Fishes are the richest source of an essentially healthy diet. They are however, endangered by diet-borne pollutants transferred along the food chain (Agrawal and Srivastava, 2003; Jat and Kothari, 2006; Gupta and Srivastava, 2006; Ayas *et al.,* 2007). Among contaminants, heavy metals have been recognized as strong biological poisons because of their persistent nature and cumulative action (Joshi *et al.,* 2003; Hoo *et al*., 2004; Loganathan *et al.,* 2006). Zinc has been recognized to play a vital role in almost all aspects of living systems either directly or indirectly (Alabaster and Lloyd, 1982; Shukla *et al*., 2002). When zinc occurs at higher levels than normal, it can act as a pollutant (Agrawal and Srivastava, 2003; Gupta and Srivastava, 2006). However, very few reports are available on the extent of changes in the nutritive value of fish after prolonged exposures to zinc.

Keeping the above facts in mind, present study has been undertaken to examine the changes in nutritive value of fish, *Channa punctatus* after chronic exposure to such levels of zinc, which are normally present in water bodies around Jaipur (Srivastava *et al.*, 2002).

Materials and Methods

Live specimens of adult *Channa punctatus* measuring 18-20 cm and weighing 65-70 g were procured from local freshwater resources and acclimatized to laboratory conditions. They were exposed to 0.1 mg/l (group II) and 0.2 mg/l of zinc (group III); this is the range of zinc normally reported in water bodies around Jaipur Srivastava *et al.* (2003). Fish kept in normal water served as control (group I). Fish were autopsied at day 90,105,120 and 135. Ten replicates were run for each set of experiment. Glycogen, total proteins and cholesterol were estimated in muscles, removed from the same area, by methods as given by Oser (1965). Total lipids were determined by chloroform - methanol extraction method and vitamins (A and D) were estimated by spectrophotometric method.

Results and Discussion

Changes in all parameters studied for all groups are depicted in Table1 and presented graphically in Fig. 1-6.

The value of proteins at different intervals shows a highly significant decrease in both the treated groups, in comparison to control. Jana and Bandyopadhyay (1987) have also noted a fall in the total protein level of several tissues after exposing *Channa punctatus* to Hg, As, Pb, Cu, Cd and Cr. Jha (1991) similarly reported a decline in protein content of tissues after exposure of *Channa punctatus* to lead nitrate for 30 days. Srivastava *et al*. (2002) observed a declining trend in proteins of muscle and liver after exposure of *Channa punctatus* to zinc for 15 days. Thus, it appears that the above mentioned metals have a similar proteolytic effect whether exposed for chronic or sub-chronic durations. The progressive decrease in protein content of the muscle with duration of exposure indicates a gradual accumulation of toxicant resulting in gradual increase in toxicity, leading to increased proteolysis.

The depletion in muscle glycogen of both treated groups is also highly significant, indicating greater conversion of glycogen to glucose in an effort to compensate for energy requirement by tissues under a stress condition. Kasthuri and Chandran (1997) made a similar suggestion after working with *Mystus gulio* exposed to lead for 21 days. Maruthi and Subba Rao (2000) also subscribe to the above view after treatment *of Channa punctatus* to distillery effluent. It is thus evident that zinc treatment disturbs the carbohydrate metabolism and promotes glycogenolysis.

Total lipid content shows a highly significant decrease in both treated groups at all intervals. Lipid is an important fuel reserve of the fish during stress situation so glycogenolysis, proteolysis and hydrolysis of lipids have been reported to generate more energy through gluconeogenesis in order to cope with the increased energy demands occurring due to metal toxicity in fish (Gunstone,1960). Since lipids form rich energy reserves whose caloric value is reported

Fig. 1

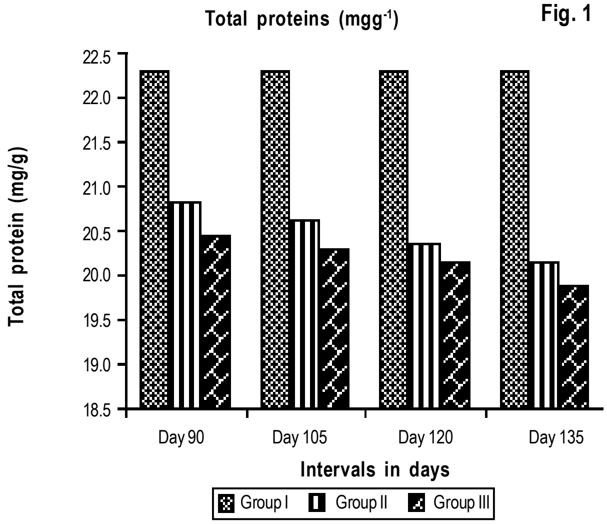

Fig. 2

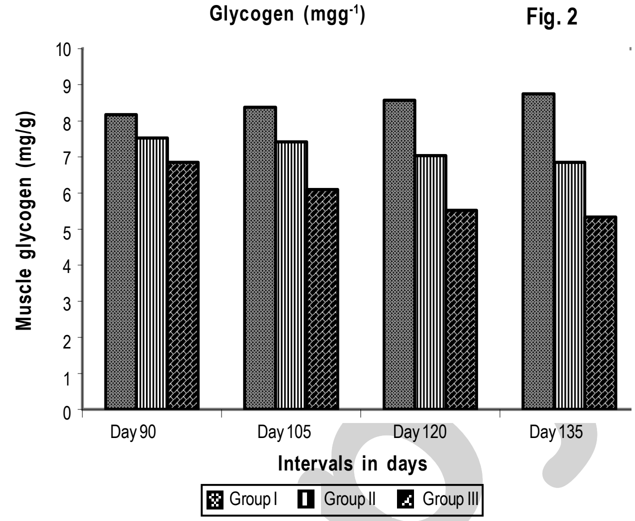

Fig. 3

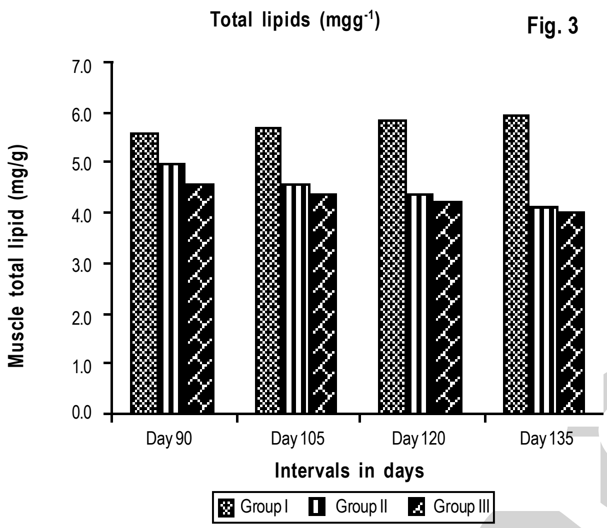

Fig. 4

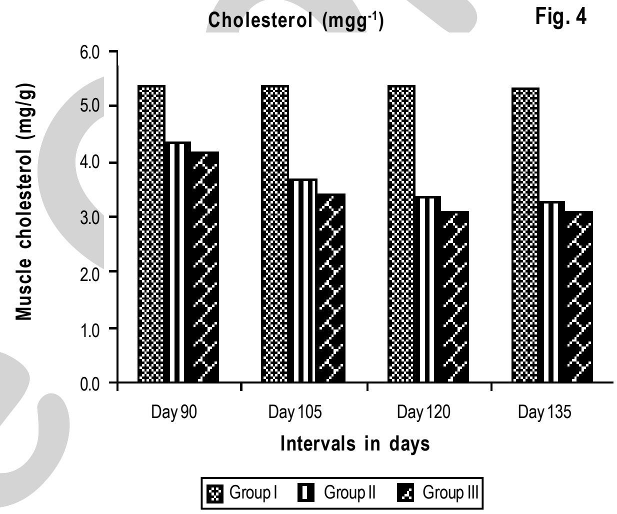

Fig. 5

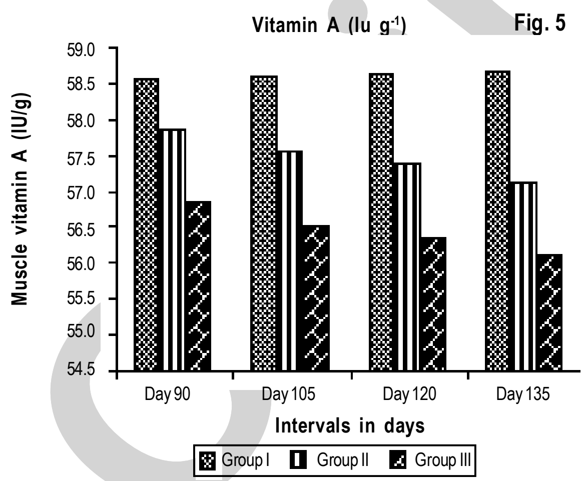

Fig. 6

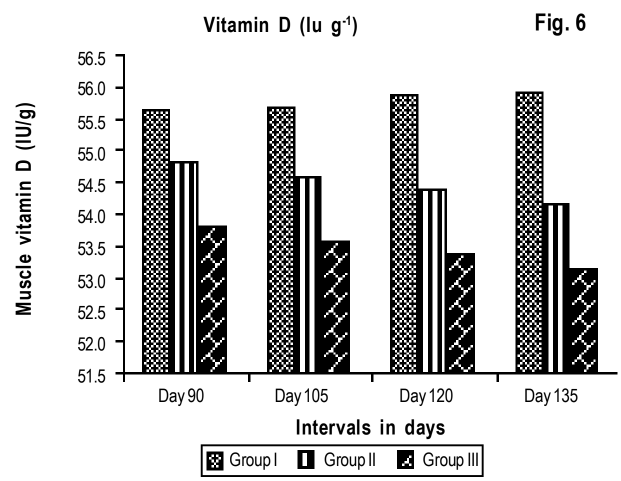

Fig. 1-6: Effects of zinc on biochemical parameters of *Channa punctatus* (Bloch)

Table - 1: Biochemical changes in muscles during long term exposure to different concentrations of zinc

Days	Doses	Total proteins ($mg\ g^{-1}$)	Glycogen ($mg\ g^{-1}$)	Total lipids ($mg\ g^{-1}$)	Cholesterol ($mg\ g^{-1}$)	Vitamins ($Iu\ g^{-1}$) A	D
90 Days	Control	22.281±0.302	8.186±0.236	5.572±0.122	5.366±0.473	58.58±0.487	55.63±0.175
	0.1 mgl^{-1}	20.287±0.196**	7.52±0.020*	4.962±0.122**	4.338±0.812^{NS}	57.87±0.576^{NS}	54.83±0.162**
	0.2 mgl^{-1}	20.453±0.176**	6.85± 0.190**	4.598±0.242**	4.165±0.661^{NS}	56.85±0.366*	53.80±0.224**
105 Days	Control	22.286±0.306	8.378±0.192	5.694±0.149	5.384±0.476	58.61±0.549	55.68±0.030
	0.1 mgl^{-1}	20.627±0.210**	7.42±0.190**	4.598±0.242**	3.678±0.403*	57.56±0.592^{NS}	54.59±0.167**
	0.2 mgl^{-1}	20.302±0.201**	6.09±0.233**	4.356±0.297**	3.412±0.570*	56.52±0.372*	53.57±0.201**
120 Days	Control	22.305±0.315	8.57±0.301	5.816±0.149	5.398±0.478	58.63±0.440	55.88±0.195
	0.1 mgl^{-1}	20.355±0.199**	7.04±0.300**	4.356±0.297**	3.384±0.379**	57.39±0.225*	54.40±0.199**
	0.2 mgl^{-1}	20.150±0.050**	5.52±0.190**	4.236±0.382**	3.116±0.455**	56.36±0.353**	53.38±0.195**
135 Days	Control	22.308±0.316	8.758±0.188	5.938±0.122	5.314±0.482	58.65±0.455	55.91±0.199
	0.1 mgl^{-1}	20.160±0.051**	6.85±0.190**	4.114±0.297**	3.266±0.370**	57.12±0.240*	54.15±0.022**
	0.2 mgl^{-1}	19.874±0.189**	5.33±0.233**	3.994±0.364**	3.076±0.456**	56.11±0.317**	53.13±0.020**

± Standard error, Levels of significance - NS = Non significant, * = Significant at $p<.05$, ** = Significant at $p<.01$

to be twice that of the equivalent weight of carbohydrates and proteins, the mobilization of lipid reserves testifies the imposition of high energy demands (Shukla *et al*., 2002). Similar to the above studies, in the present study too a significant decline in total lipid content of muscle has been observed which shows that zinc also has hypolipidemic effects.

Contrary to the above parameters, depletion in muscle cholesterol is highly significant only at later intervals. A reduction in both circulating and tissue levels of cholesterol was observed by Tewari *et al.* (1987) in *Barbus conchonius* (Ham) as an impact of chronic lead poisoning. Toxicant induced changes in this parameter may be related to either a disruption of plasma membrane and/or altered steroidogenesis. Srivastava *et al*. (2002) have attributed the lowering of cholesterol in the muscles and liver of *Channa punctatus,* exposed to zinc for 15 days, to an increase in lipid utilization for meeting additional energy requirements under stress condition.

Vitamins serve as chemical partners for enzymes. Vitamins A and D are both fat soluble vitamins. Vitamin A content in the muscle follows the declining trend noted in cholesterol; it is also highly significant at later intervals. This indicates that the vitamin is not immediately mobilized after zinc treatment. Dube and Trung (1993) and Roberts (2001) have emphasized the significance of vitamin A in fish. They reported that hypovitaminosis A causes poor growth, depigmentation, anemia and haemorrhages at the base of the fins, indicating that vitamin A plays an important role in growth, pigmentation and blood physiology of fish.

In contrast to vitamin A and vitamin D shows a declining trend similar to that of proteins, glycogen and total lipids; the decrease is highly significant at all intervals. Vitamin D is required for the absorption of calcium and its utilization in the body; thus prolonged zinc exposure could be hampering calcium utilization by the fish.

Judging from the loss of proteins, glycogen, cholesterol, total lipid and vitamins (A,D) of muscles, it can be inferred that the nutritive value of fish decreases, after prolonged exposure to notably safe levels of zinc, these effects may biomagnify on human consumption. Besides calcium utilization by the body, growth, pigmentation, and blood physiology of the fish may also be reduced.

Acknowledgments

The authors are thankful to Professor P.P. Bakre, Head, Department of Zoology, University of Rajasthan, Jaipur for providing necessary facilities.

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