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EFFECT OF SODIUM FLUORIDE ON ORGANIC RESERVES OF SOME TISSUES OF *HETEROPNEUSTES FOSSILIS*

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ABSTRACT

After 90 days exposure of *H. fossilis* to different sub-lethal concentrations of sodium fluoride (25 mg/L, 50 mg/L and 75 mg/L), glycogen, total protein and cholesterol in kidney, brain and gill tissues were significantly decreased. None of these changes was observed in the control group.

KEY WORDS: Fluoride, Biochemical parameters, *H. fossilis.*

INTRODUCTION

Fluoride is an essential trace element that helps in mineralization, development and functions of bones and teeth. Fluoride in very low levels has been found to help in the prevention of dental caries as well as to lower osteoporosis. However, excessive ingestion of fluorine and its compounds found in water cause a crippling disease known as 'fluorosis' of its profound affinity for calcified tissues. Thus, fluoride toxicity is becoming a matter of grave concern, as many countries have been declared endemic for fluorisis. This makes it imperative for scientists to focus on precise toxic effects of fluoride on skeletal and non-skeletal tissues, so that effective therapeutic agents can be developed. The permissible limits of fluorides in drinking water as suggested by Bureau of Indian Standards (BIS, 1983) vary between 0.6 to 1.2 ppm while World Health Organization (WHO, 1984) permits a maximum of 1.5 ppm of it. Hence the present study was taken to investigate the toxic effects of sodium fluoride on certain biomolecules in kidney, brain and gill tissues of freshwater Catfish *Heteropneustes fossilis*.

MATERIALS AND METHODS

Healthy, male fishes of equal size (15.0 ± 0.5 cm) and weight (38 ± 2.0 gm) were collected from local fresh water resources and maintained under standard laboratory conditions for 15 days. The fish were divided into four groups with 10 fish per group. Group 1 served as control. While group II, III and IV exposed with 25 mg/L, 50 mg/L and 75 mg/L sodium fluoride, respectively. The water of all groups was changed on alternate days. After 90 days, all the fish were sacrificed for sampling. The kidney, brain and gill tissues in each group were dissected out and homogenized. The homogenate was centriguged at 3500 rpm for 20 minutes. The supernant was used for the estimation of glycogen, total protein, total lipid and cholesterol by Caroll *et al.* (1956), Lowery *et al.* (1951), Folch *et al.* (1957) and Rosenthal *et al.,* (1957) methods, respectively. The data were analysed by student's 't' test to determine the significance of the changes from control.

RESULTS AND DISCUSSIONS

After 90 days of exposure of Heteropneustes fossilis to sublethal concentrations of sodium fluoride, the glycogen, total protein, total lipid and cholesterol contents in kidney, brain and gills were decreased significantly in all groups of fluoride exposed fishes (Table 1).

After 90 days exposure to sodium fluoride, the glycogen content was significantly reduced in kidney, brain and gill. Glycogenolysis in kidney, brain and gill in fluoride induced fishes suggests enhanced conversion of glycogen to glucose which increases the blood glucose content to meet an increased energy requirement under stress conditions. During stress condition fish need more energy to detoxify the toxicant and to overcome stress. Storochkova and Zhavoronkov (1983) reported that fluoride act as activator many glycolytic enzymes, consequently, the decrease in glycogen content in fluoride exposed fishes. Depletion of glycogen stored in kidney, brain and gill may be inhibition of AChE activity in brain and gill of exposed fishes. Due to inhibition of AChE, concentration of acetylcholine (Ach) increases which stimulate the secretion of catecholamine that brings about glycogenolysis and hyperglycemia through raised levels of cyclic AMP (Gopal and Khanna, 1993; Natrajan, 1984; Nilsson *et al.,* 1976; Terrier and Perrier, 1975 and Begum, 2004). Sharma and Gopal (1995) have also

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observed a significant rise in lactic acid concentration in blood and decrease in the activity of succinic dehydrogenase (a key enzyme of TCA cycle) in *C. batrachus* chronically exposed to carbaryl. They suggested that it is an indication of the inhibition of Krebs cycle and/or a favour of anaerobic metabolism over aerobic one due to intoxication of pesticide to meet out the immediate energy demand. Thus significant decline in tissue glycogen to meet an increased energy requirement of treated fish might be due to enhanced secretion of catecholamine under the stress of effluents.

In the present study, protein content was significantly decreased in kidney, brain and gills. Kidney and gills are the main sites of degradation and detoxification of Xenobiotics (Rao *et al.,* 1983) and the biochemical effects recorded seem to be the result of greater stress on these organs. Gill *et al.,* (1988) reported that during the initial phase of exposure to toxicant loss of enzymes due to tissue necrosis and increased metabolic activity for detoxification of the toxicant might necessitate enhanced synthesis of enzyme proteins. Proteins are mainly involved in the architecture of the cell. During chronic period of stress are also sources of energy. During stress conditions fish need more energy to detoxify the toxicant and to overcome stress. Since fishes have less amount of carbohydrate so next alternative source of energy is protein to meet increased demand of energy. Decrease in protein of gill, kidney and brain may be due to inhibition of protein synthesis (Reddy *et al.,* 1995) in the cells of these tissue and interference of amino acid metabolism. Another possible reason may be depletion of protein for its catechization in conversion to glucose (Srivastava *et al.,* 2002).

The decreases lipid content in gill, kidney and brain of fluoride in exposed fishes may be due to inhibition of lipid synthesis as well as increased utilization of stored lipid as a source of energy to conduct regular metabolic activity. Bat Enbury and Vanden Bergh (1972) reported that fluoride act as inhibitor of various enzymes like lipases, phosphatase and esterase. It interferes with fatty acid oxidation and also inhibits the enzyme acetyl co-A synthetase involved in fatty acid oxidation. Thus decreased lipid content in various tissues may be due to the inhibition of these enzymes.

The cholesterol contents were significantly reduced in kidney, brain and gills of effluent treated fishes. Gluth and Hanke (1985) reported that hypocholesteremia in pesticide treated *Cyprinus carpio* was due to accumulation of water in plasma. Begum and Vijagraghavan (2001) have also observed a decline in cholesterol content accompanied with increase in free fatty acids in toxicant treated fishes. They suggest that decreased level of cholesterol in these tissues may be probably due to increased breakdown of cholesterol into free fatty acids which are being fed to TCA cycle to meet out the energy demands during effluent stress.

Thus it can be concluded that fluoride have induced an energy crisis and altered carbohydrate, protein and lipid metabolism by exerting their toxic manifestations in *Heteropneustes fossilis* that are important in their physiological activities, survival, growth and reproduction. The observed biochemical response of present study could be used as suitable biomarkers of fluoride stress to aquatic animals.

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Table 1: Effect of sodium fluoride on organic reserve of *H. fossilis* after 90 days exposure.

Tissues	Control Mean ± SD	25 mg/L Mean ± SD	50 mg/L Mean ± SD	75 mg/L Mean ± SD
		Glycogen (mg/gm wet tissues)		
Kidney	7.70 ± 0.32	7.50 ± 0.60	6.90 ± 0.80*	6.40 ± 0.11*
Brain	8.30 ± 0.70	7.80 ± 0.80	6.30 ± 0.82*	5.80 ± 0.60**
Gill	5.20 ± 0.45	4.70 ± 0.50*	3.80 ± 0.40**	3.40 ± 0.30**
		Total protein (mg/gm wet tissues)		
Kidney	125.10 ± 1.38	113.80 ± 6.70	109.00 ± 2.98	102.90 ± 3.80*
Brain	62.00 ± 0.72	58.90 ± 1.32	54.18 ± 1.34*	51.50 ± 42.60*
Gill	57.25 ± 2.32	51.50 ± 1.60*	41.80 ± 1.80*	33.60 ± 0.50**
		Total lipid (mg/gm wet tissues)		
Kidney	8.10 ± 0.31	6.70 ± 0.48	5.55 ± 1.12*	4.10 ± 0.32**
Brain	65.38 ± 1.31	57.15 ± 1.30	41.10 ± 1.25**	33.12 ± 1.15**
Gill	9.18 ± 0.41	8.05 ± 0.32	7.25 ± 1.11*	6.80 ± 1.02**
		Cholesterol (mg/gm wet tissues)		
Kidney	32.30 ± 1.32	29.18 ± 1.32	27.32 ± 1.48	25.18 ± 1.38*
Brain	42.38 ± 0.78	38.18 ± 1.15*	35.38 ± 3.18*	31.48 ± 1.47**
Gill	1.48 ± 0.18	1.28 ± 0.04	0.98 ± 0.08*	0.88 ± 0.06**

* $P < 0.05$; ** $P < 0.001$

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