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Research Article

A STUDY ON THE TOXICITY OF PESTICIDE CYPERMETHRIN ON THE BIOCHEMICAL COMPOSITION OF FRESHWATER FISH *MYSTUS VITTATUS*

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ABSTRACT

The freshwater fish *Mysstus vittatus* was exposed to 10% and 30% sublethal concentrations of (LC_{50} for 96 h - 0.0036 ppm) cypermethrin for a period of 10, 20 and 30 days to study the effect of cypermethrin on the biochemical composition of various organs such as muscle and liver. After stipulated time, the carbohydrate, protein and lipid content in the various tissues of *Mystus vittatus* under pesticide stress were found to be decreased when compared with control.

Keywords: Cypermethrin, Toxicity, Biochemical composition, *Mystus vittatus.*

INTRODUCTION

Pesticides are one of the major xenobiotic substances that have been extensively used in India for the management of pests in agricultural fields and control of vectors in public health operations. Most of the insecticides are hydrophobic that they can be easily absorbed by soil particles and can migrate to natural water systems such as rivers, lakes and ponds through the run-off causing aquatic pollution. Consequently these xenobiotic molecules have been found in natural systems and they have a great impact on the environmental quality as they result in a toxicity risk to non-target organisms especially fishes. They can enter the food chain when they become accumulated in aquatic organisms (Madhab Prasad *et al*., 2002). Hence, this study is aimed to find out the biochemical changes, if any, in *Mystus vittatus* exposed to sublethal concentration of cypermethrin.

MATERIALS AND METHODS

Mystus vittatus were collected form ponds in and around Adirampattinam brought to the laboratory, then introduced into the glass tank (200 liters) containing aerated tap water. Fish were screened for any pathogenic infections to avoid fungal contamination. Glass aquaria were washed with 1% $KmNO_4$ and then sun dried. Healthy specimen were then transferred to glass aquaria (35 x 20 x 20 cm) and acclimated to laboratory conditions for 15 to 20 days prior to experimentation. LC_{50} of monocrotophos for 96h was found out by using Probit method (Finney, 1971). For biochemical studies fishes were reared in sublethal concentration (10% of 96 hours LC_{50}) for a period of 10, 20 and 30 days. The total carbohydrate, protein and lipids were estimated by Roe (1955), Lowery *et al.* (1951) and Folch *et al.* (1957) respectively.

RESULTS AND DISCUSSION

Carbohydrate content present in the tissues

The total carbohydrate content of the liver and muscle in control and experimental fishes are shown in table 1 and Exposure of *M. vitattus* to the pesticide reduced the level of carbohydrate in the liver and muscle at all days of exposure.

The percentage decreased over the control were -11.95%, -31.22 % and -48.57 % respectively at 10, 20 and 30 days of exposure at 10% sublethal concentration (Table).

The percentage decreased over the control were -20.57 %, -41.32% and -48.98% respectively at 10, 20 and 30 days of exposure at 10% sublethal concentration (Table 1).

The carbohydrate of fishes comprised mainly glycogen and total free sugars and the fluctuations in the carbohydrate content may be due to accumulation and utilization of glycogen and total free sugars at different

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phases of life like growth, gametogenesis and spawning. In fishes, generally the carbohydrate reserves may be rapidly utilized under unfavourable conditions and the great variations found in the tissues indicate that the level of mobilizable carbohydrate reserves may fluctuate widely and rapidly in response to fluctuations in the nutritional state of the animal. In the present study the carbohydrate content decreased in the liver and mussel tissues of *M. vittatus* exposed to sublethal concentrations of pesticide (Table 1). Tilak and Yacobu (2002) have observed that the fenvalerate exposed *Ctenopharyngodon idellus* showed a decrease in the carbohydrate content in the various tissues. The decrease in total carbohydrate level signifies its utility possibly to meet the higher energy demands of the fish reeling under pesticide toxicity. The synthesis and utilization of carbohydrate are therefore, altered in the organism subjected to pesticide stress.

Carbohydrates which supply the major portion of the metabolities for the energy requirements in a normal individual is oxidized for the energy requisites. Carbohydrates may be converted to glycogen or shunted in the metabolic pathway to supply the carbon chain for amino acids or converted in to fat (Priscilla, 1985). At sublethal concentration, when the liver carbohydrate content decreased the blood sugar level increased which suggests the breakdown of liver glycogen (glycogenolysis). The mobilization of glucose from the liver to the blood and its availability for utilization by the needy tissues for ensuring normal metabolic processes in the body appears inevitable when the fish is exposed to toxic medium. Many authors have reported decreased carbohydrate level in various tissues of fishes. Sapna Shrivastava *et al*. (2002) observed decreased carbohydrate in the brain of *Heteropneustes fossilis* exposed to carbaryl. Murthy and Devi (1982) reported decrease in glycogen content of brain in *C. punctatus* after the exposure of endosulfan. Visvanathan *et al*. (2009) reported that in *C. punctatus*, quantative variations in the sugar content of liver and muscle tissues due to pesticidal exposure.

In the present study the muscle carbohydrate content of *M. vittatus* showed a decrease when it was exposed to sublethal concentration of pesticide (Table 1). Muley *et al*. (2007) observed a fall in muscle carbohydrate level in *L. rohita* when exposed to tannery, electroplating and textile effluents. Sastry and Dasgupta (1991) have shown that a high concentration of Nuvacron caused a decline in muscle carbohydrate level in *C. punctatus*. These obsevations were in conformity with the reports on the fall in muscle glycogen level in *C. punctatus*, when exposed to organophosphate pesticide, Dimethoate (Tripathi *et al*., 2003).

Studies in general have suggested that exposure to pesticide treatement interferences with the carbohydrate metabolism. A greater decrease of carbohydrate content indicates greater utilization of carbohydrate to cope with enhanced metabolism under stressful situations. Despite a continuous and rapid release of glucose by glycogenolysis in the liver, to meet the energy requirement for the increased muscular activity, a fall in the overall of carbohydrate content in fishes subjected to pesticidal treatment is imminent.

Protein content present in the tissues

The protein content decreased over the control by -13.31, -38.98% at the 10% sublethal concentration of 10, 20 and 30 days of exposure respectively (Table 2).

The percentage changes over control, after 10, 20 and 30 days of exposure were -12.82%, -49.98% and -71.69% at 10% sublethal concentration, which is found to be dependent upon the duration of exposure (Table 2).

Proteins are mainly involved in the architecture of the cell. During chronic period of stress, they are also a source of energy (Umminger, 1977). Behavioural responses of fish exposed to sublethal concentrations of pesticides showed that they were under stress condition; fish needed more energy to detoxify the toxicants and to overcome stress. Since fish have a very little amount of carbohydrates, the next alternative source of energy is the protein to meet the increased energy demand. The depletion of protein content in liver, muscle and gill tissues may have been due to their degradation and possible utilization of degraded products for metabolic purposes. Other workers such as Malla Reddy and Basha Mohideen (1995) and Singh *et al*. (1996) have also reported decline in protein constituent in different fish tissues exposed to sublethal concentrations of insecticides.

Protein is the most important constituent in living tissues, which is of considerable metabolic and structural value. Therefore, any change in this constituent indicates the stress inflicted on the metabolic functions required for maintaining a healthy physiological state. In this work the protein content of *M. vittatus* at sublethal concentration decreased in all exposure periods (Table 2). The depletion in tissue protein of *M. vittatus* indicated rapid utilization of energy stores to meet the energy demands warranted by the environment. The observed depletion in tissue protein on treatment with sublethal doses of pesticides was suggestive of proteolytic activity, possibly to meet the excess energy demands under toxic conditions.

Jha and Verma (2002) reported depletion in the protein content in stomach and intestine of *Clarias batrachus* exposed to pesticides endosulfan, malathion and agrofen. Jebakumar *et al*. (1990) recorded decrease in protein content of *Lepidocephalichthys thermalis* exposed to sublethal concentrations of fenvalerate. A significant decrease has been reported in the protein content of the liver and kidney in *L. rohita*, when exposed to 20% active ingredient EC. Fenvalerate (Annamani, 1986). A similar decrease in the total and soluble protein content has been observed with fenvalerate in fish (Malla Reddy and Basha Mohideen, 1988; Radaiah, 1988 and Tilak and Yacobu, 2002). The total protein level of muscle and liver of *M. vittatus* were decreased after all the three periods of exposure to the sublethal concentration of pesticide. The investigations of Koundinya and Ramamurthy (1979) revealed a decrease in protein content in *T. mossambica* exposed to different pesticides. Sastry and Siddique (1984) reported that the protein content is decreased in liver, muscle, kidney, intestine, brain and gill when *C. punctatus* has been treated with quinaphos. Yeragi *et al.* (2000) observed the decreased levels of proteins in gills, testis, ovaries and muscles of marine crab *Uca marionis* exposed to acute and chronic levels of Malathion. Aruna Khare *et al.* (2000) observed that the sublethal concentrations of Malathion showed a significant increase in the protein content in kidney of exposed fish during the first week and thereafter, a gradual decrease in protein content has been observed in the later periods of exposure.

Lipid content present in the tissues

The lipid content decreased in the liver and muscle tissues at all the exposure periods, when the fish exposed to sublethal concentration.

The percentage decrease in the lipid content over the control were -17.13%, -20.16% and -37.46% at 10% sublethal concentration after being exposed to 10, 20 and 30 days respectively (Table 3).

The lipid content decreased over the control by -14.94%, -23.19% and -20.86% at the 10% and 30% sublethal concentration of 10, 20 and 30 days of exposure respectively (Table 3).

Lipid is an important constituent of animal tissue, which plays a prime role in energy metabolism. Lipids are also important in cellular and sub-cellular membranes. A gradual decrease in lipid content in various tissues of *M. vittatus* after chronic treatments of pesticide of various periods of exposure are shown in Table 3. Earlier researchers like Anusha *et al.* (1996) also suggested that the decrease in lipid content in *C. carpio* may be either due to the uptake of lipid by the tissue for utilization at cellular levels or due to increased lipolysis or mitochondrial injury, which affect the fatty acid oxidation mechanism as suggested by Ware (1980) and Rao *et al.* (1986).

Shivprasad Rao and Raman Rao (1979) studied the considerable decrease in total lipid in tissues might be due to drastic decrease in glycogen content in the same tissue which is an intermediate source of energy during toxic stress conditions. After glycogen, lipid content may be used for energy production to overcome toxic stress. Some workers support these results in which lipid content decreased in animals after exposure to pollutants. Hameed and Muthukumaravel (2006) reported significant decrease in lipid of *L. rohita when* exposed to heavy metal cadmium.

Amudha *et al.* (2002) observed the effect of dairy effluent on *O. mossambicus* and reported that lipid content was decreased. Similar decrease in lipid content level has also been observed by Raj Narayan Ram and Sathyanesan, (1987) in *C. punctatus* when exposed to mercurial fungicide. Reduction of lipid content of *M. vittatus* in this study may have been due to the utilization of lipids for energy demand under stress condition (Harpert *et al.*, 1977).

Table 1. Effect of cypermethrin on carbohydrate content (mg/g) of *Mystus vittatus.*

S.No.	Tissue	Experimental group	Exposure Periods (days)		
			10	20	30
1.	Muscle	Control	8.4 ± 0.52	8.62 ± 0.14	8.36 ± 0.36
		Treated	6.45 ± 0.72	5.08 ± 0.24	4.25 ± 0.67
		% Variation	-20.58%	-43.32%	-48.98%
2.	liver	Control	25.17 ±0.35	25.12 ± 0.61	23.61 ±0.32
		Treated	22.41 ±0.67	17.21 ± 0.51	12.61 ±0.13
		% Variation	-13.31%	-38.98%	-61.57%

Table 2. Effect of cypermethrin on the protein content (mg/g) of *Mystus vittatus.*

S.No.	Tissue	Experimental group	Exposure Periods (days)		
			10	20	30
1.	Muscle	Control	35.14 ±0.42	37.67 ± 0.41	36.49 ±0.72
		Treated	30.64 ±0.72	19.41 ± 0.37	10.47 ±0.69
		% Variation	-12.82%	-49.98%	-71.69%
2.	liver	Control	30.22 ±0.47	31.95 ± 0.72	31.47 ±0.26
		Treated	26.17 ±0.41	19.38 ± 0.43	12.24± 0.32
		% Variation	-13.31%	-38.98%	-61.57%

Table 3. Effect of cypermethrin on the lipid content (mg/g) of *Mystus vittatus*.

S. No.	Tissue	Experimental group	Exposure Periods (days)		
			10	20	30
1.	Muscle	Control	10.7 ± 0.88	11.22 ± 0.14	10.97 ±0.16
		Treated	9.14 ± 0.21	8.47 ± 0.69	8.66 ± 0.54
		% Variation	-14.94%	-23.19%	-20.86%
2.	liver	Control	14.62 ±0.21	13.96 ± 0.16	15.14 ±0.42
		Treated	12.13 ±0.16	11.14 ± 0.47	9.44± 0.28
		% Variation	-17.17%	-20.16%	-37.46%

CONCLUSIONS

The present study revealed that the pesticide cypernethrin is potent cause toxic responses, even biochemical alterations, in aquatic organism like fish. A number of studies have elucidated the aquatic toxicity of different kinds of pesticides. These reports bring discussions on the deteriorating nature and lethal effects of the pesticides on ecosystem. Pesticides especially the non – degradable ones, even in minute levels, are causing a stress to aquatic organisms. The toxic responses are reflected by the behavioral, biochemical, hematological and pathological changes. But an agricultural effort reducing the use of pesticides and implementing natural remedies for pest-encroachment can become one solution for pesticide pollution.

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