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Research Article

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Changes in the biochemical constituents of the freshwater fish, *Channa punctatus* (Bloch) exposed to the toxicity of cypermethrin

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ABSTRACT

Channa punctatus is commonly known as snake head fish of carnivore feeding habit. The cypermethrin pesticide is widely used in agricultural field for the control of insect pests and is coming under synthetic pyrethroids which have shown strong pesticidal activity in freshwater teleost fish, Channa punctatus. The fishes were exposed to sub lethal concentration, 0.04 mg/L (1/10th of LC_{50}=0.4 mg/L) of cypermethrin for a period of 15, 30 and 45 days. Changes on the protein and nucleic acid levels of gill, liver and kidney tissues of Channa punctatus were observed. The results showed that, the protein content in all the tissues (gill, liver and kidney) have decreased significantly ($p<0.05$) when compared to control with the increase in the period of exposure to the toxicant. In the case of nucleic acids, the DNA content was found to increase significantly ($p<0.05$) in gill and liver tissues, but in the kidney, it was found to be in a decreased trend. Whereas, the RNA content of all the tissues (gill, liver and kidney) have decreased significantly ($p<0.05$) when compared to control with the increase in the period of exposure to the toxicant. Biochemical changes induced by pesticidal stress lead to metabolic disturbances, retardation of growth and reduction in the fecundity and longevity of the organism.

Keywords: Cypermethrin, *Channa punctatus*, nucleic acids, and proteins.

INTRODUCTION

Pesticides usage in the agricultural fields to control pests is extremely toxic to non target organisms like fish and affects fish health through impairment of metabolism, sometimes leading to mortality [11]. Cypermethrin is a synthetic pyrethroid insecticide used to control many pests, such as moth pests attacking cotton, fruit and vegetable crops, including structural pest control, or landscape maintenance. Cypermethrin is highly potent and broad-spectrum pyrethroid, used extensively for pest control [8]. Fish are particularly highly sensitive to very low concentration of cypermethrin [6] and [21].

The physiological and biochemical alterations observed in an animal under any physiological stress can be correlated with the structural and functional changes of cellular proteins. Nucleic acids play a major role in growth and development. The amount of DNA, the carrier of genetic information, is Quasi-constant in somatic cell numbers [17]. The amount of RNA in the cell is directly proportional to the amount of RNA in the synthesis occurring. The relationship between RNA and DNA is an index of the cell's metabolic intensity and has been used to measure recent growth in fishes [7]. So the aim of this study is to examine the toxicity of cypermethrin to the freshwater fish, *Channa punctatus* and to evaluate the alterations in biochemical profiles.

EXPERIMENTAL SECTION

The fish (*Channa punctatus*) were collected from kolathur lake, Chennai and transported to the laboratory in an oxygenated polythene bag. The healthy adult specimens of *Channa punctatus* ranging in length from 13 to 15 cm and weighing about 18 to 20 gm were selected and acclimatized for the experimental purpose. Water was replaced

regularly and the fishes were fed daily. The physio-chemical characteristics of water were analysed as per the methods given in APHA (2005).

Determination of LC_{50}

The pesticide Cypermethrin (10% E.C.) was obtained and the stock solution was prepared by dissolving 10 mg of cypermethrin in 10 ml of analytical grade acetone. A required quantity of cypermethrin was drawn from this stock solution for further experiment. Preliminary tests were carried out to find out the median tolerance limit (LC_{50}) of the fish to cypermethrin for 96 hours by probit analysis method [9]. The concentration of cypermethrin at which 50% mortality occurred was taken as the median lethal concentration (LC_{50}) for 96hrs, which was found to be 0.4 mg/L. One fifth of the LC_{50} value (0.08mg/L) was selected for sub lethal concentration studies.

Estimation of nucleic acids and total protein

The vital tissues like gill, liver and kidney of the fish Channa *punctatus* were taken for the estimation of total proteins and nucleic acids. The total protein content was estimated by the modified method of Lowry *et al.,* (1957). The nucleic acids, Deoxyribo nucleic acid (DNA) and Ribo nucleic acid (RNA) were estimated by the method of Schneider, (1957). The results were tabulated and subjected to statistical analysis, One-way Analysis of Variance (ANOVA) using the software package, SPSS (16.0 version) for the test of significance level ($p<0.05$).

RESULTS

In the present study, the freshwater fish *Channa punctatus* exposed to sub lethal concentration (0.08mg/L) of cypermethrin showed a significant decreased ($P<0.05$) level of protein in all the tissues (gill, liver and kidney) when compared to control with increasing the days of exposure (Table.1). In nucleic acids, the DNA content in the gill and liver tissues of the experimental fish was found to increase significantly ($p<0.05$), but, it got decreased significantly ($p<0.05$), in kidney tissue, when compared to control throughout the experimental period (Table.1). Whereas, the RNA content got decreased significantly ($p<0.05$) in all the tissues (gill, liver and kidney) when compared to control (Table.1).

Table.1 Changes in nucleic acids and total protein levels in different tissues of *Channa punctatus* on exposure to a sublethal concentration (0.08 mg/L) of Cypermethrin

S. No.	Parameters		Tissues	Control	Experimental periods		
					15 days	30 days	45 days
1	Nucleic acids	DNA	Gill	1.52 ± 0.07	1.68 ± 0.03*	1.87 ± 0.01*	1.92 ± 0.64*
			Liver	2.03 ± 0.01	3.33 ± 0.03*	4.97 ± 0.13*	5.24 ± 0.21*
			Kidney	2.27 ± 0.03	1.93 ± 0.06*	1.90 ± 0.38*	1.81 ± 0.10*
		RNA	Gill	4.22 ± 0.90	3.25 ± 0.64*	2.25 ± 0.12*	1.97 ± 0.01*
			Liver	14.75 ± 0.30	11.25 ± 0.14*	10.73 ± 0.19*	8.87 ± 0.01*
			Kidney	8.25 ± 0.26	7.52 ± 0.39*	6.83 ± 0.34*	5.54 ± 0.28*
3	Total Protein		Gill	16.32 ± 0.20	14.31± 0.29*	11.64 ± 0.19*	10.92 ± 0.14*
			Liver	44.92 ± 0.94	38.84 ± 0.11*	35.82 ± 0.15*	31.43 ± 0.15*
			Kidney	28.96± 0.12	24.94 ± 0.11*	23.4 2± 0.09*	21.26 ± 0.13*

*Values are expressed in mg/L (Mean ±SD); n=5; *=Significant (P<0.05)*

DISCUSSION

The Depletion of protein fraction in various tissues of the experimental fish may have been due to their degradation and possible utilization of degraded products for metabolic purposes. Mommensen and Walsh, (1992) reported that the proteins are mainly involved in the architecture of the cell, which is the chief source of nitrogenous metabolism and during chronic period of stress they are also a source of energy. Decreased total protein level was observed in the muscle and liver tissues of the fresh water teleost fish *Channa fasciatus* exposed to sub-lethal does of malathion and carbaryl pesticides [24].

The decrease in protein content was more when the fish was exposed to the toxicant due to break down rather than retarded synthesis which is supported by the findings of Radhaiah (1988). Begum, (2005) who reported that the reduction in protein content of liver is in response to sublethal concentration of cypermethrin (0.07 ppm). Present findings are supported by the report of Susan *et al*., (1999), who showed the reduction in DNA and protein content of different tissues of *Channa punctatus* after exposure of alphamethrin. Schmidt and Nielson (1975) stated that the decreased tendency of total protein may be due to the metabolic utilization of the Keto acids to gluconeogenesis of proteins from the synthesis of glucose or may be due to directing the synthesis of proteins from free amino acids.

In the present study, the maximum level of DNA was found in liver which is supported by earlier findings of Holbrooks (1980) that, the thymine incorporation into hepatic DNA has markedly increased after 1 to 3 of days of

administration of the various toxicants. The increase of DNA contents in gill region, in the present study was due to the hypertrophic nature of chloride cell, secreting cell leading to less transcription and the enlargement of nuclei in *Channa striatus* exposed to metasystox, *Oreochromis mossambicus* to quinolphos and *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* to chlorpyrifos [23] and [16]. The DNA contents in kidney has decreased which may be due to reduction or absence of the essential factors controlling DNA synthesis which are the substrates (4-Deoxyribonucleoside triphosphates), enzymes (polymerase), template activity of deoxyribonucleic-protein and activators like Mg^{2+} and other divalent ions [1] and [25].

The synthesis of RNA plays an important role in protein synthesis. The inhibition of RNA synthesis in transcription level, thus may affect the protein level. In this study, a significant decline in the RNA level in exposed freshwater fish was observed. The decrease in the RNA concentration may also have been a cause of protein depletion [20]. The decreasing level of RNA suggests a decrease in protein synthesis and further damage to the liver, which is the major metabolic organ of drug detoxification [15]. The gradual decrease in the protein content of the treated fish suggests the disruption of carbohydrate metabolism, destruction of protein and inhibition of ATP synthesis [5]. Significant decrease in RNA and DNA content in the fish, *Claria batrachus* exposed to endosulfan was recorded by [3].

CONCLUSION

In the present study, the significant decrease in both protein and nucleic acids levels would suggest that pollutant impair the process of protein synthesis in the tissues of fishes exposed to cypermethrin. It may be suggested that cypermethrin tends to change the levels of micromolecular constituents in the tissues of the fish and inturn might be deposited by means of contaminated water bodies and it leads to harmful consequences in human beings on continuous consumption.

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