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RESEARCH ARTICLE

IMPACT OF DIMETHOATE TOXICITY ON BIOCHEMICAL ALTERATIONS IN A FRESHWATER FISH, *LABEO ROHITA*

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ABSTRACT

Impact of pesticides is common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. Freshwater carp fish, *Labeo rohita* is an important carp species in Tamil Nadu region having good nutritional values. Fishes living in close association with may accumulate pesticides. In the present study, the toxic effects of the dimethoate LC_{50} 1.5 mg/L on some biochemical characteristics (total protein in gill, kidney, liver and muscle) of the freshwater carp fish, *Labeo rohita* were estimated. There is decreased in all tissues on comparison with control. The results indicated the toxic nature of the pesticide dimethoate.

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INTRODUCTION

Application of pesticides has contributed greatly in enhancing agricultural yields and also for the control of insect borne diseases. Excessive use of broad-spectrum or nonselective pesticides damages the ecosystem, sometimes irreversibly, contaminates soil surface and ground water as well as food chains and thus compromises the health and well being of the inhabitants of aquatic and terrestrial environment. Organophosphate compounds comprise insecticides currently used worldwide for agricultural and household applications. These insecticides produce toxicity by inhibition of the enzyme acetylcholinesterase which accumulates in the synapses of the central and peripheral nervous system. This in turn results into overactivation of postsynaptic cholinergic receptors and signs of cholinergic neurotoxicity. Among various groups of pesticides, organophoshates are more frequently used, due to their high insecticidal property, low mammalian toxicity, less persistence and rapid biodegradability in the environment. Dimethoate is an organophosphate (trade name Rogor) possessing contact and systemic properties (Scott, 1967; Jackson, 1968). Dimethoate is one of the organophosphorous insecticide widely used against vegetables and fruit sucking aphids, mites, saw flies and boring insects on cereals, cotton, chili, tobacco and oil seeds.

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During rainy season along with running water, dimethoate insecticide enters the freshwater resources and results into aquatic pollution. Pesticides are also well known for causing more toxic effects in teleost (Scott, 1967; Jackson, 1968). Dimethoate is an organophosphorous insecticide widely used against vegetable and fruit sucking aphids, mites and saw flies. Exposure to chemical pollutants may cause many molecular, biochemical changes in the fish which precede cellular and systemic dysfunctions. So that, if appropriate parameters are monitored, early warning signs of distress may be detected (Palmes, 1976).

The pollution of rivers and streams with chemical contaminants has become one of the most critical environmental problems. Residual amount of pesticide and their metabolites have been found in drinking water and foods increasing concern for the possible threats to human health posed by exposure to these chemical. Different species of fish show active uptake and accumulation of many toxicants such as herbicides, pesticides, heavy metals and polychlorinated biphenyls from water bodies. Among all these agrochemicals, pesticides found to be extremely toxic to organisms and also to the food chain of aquatic ecosystems. The accumulation of pesticides produces some physiological, biochemical and as well as morphological responses in the freshwater fauna by influencing several activities of metabolites and enzymes reported by Ramamurthy *et al*. (2000).

The alteration in biochemical contents in different tissues of fish due to toxic effects of different heavy metals and pesticides have been reported by number of workers (Khan *et al*., 1992; James and Sampath, 1995; Das *et al*., 1999).

MATERIALS AND METHODS

The freshwater carp fish, *Labeo rohita* were collected from Ariyalur area and were brought to the laboratory in large plastic troughs and acclimatized for one week. Healthy, carp fish having equal size (length 10 to 12 cm) and weight (20 to 25 g) were used for experimentation. Stock solution of dimethoate was prepared by dissolving appropriate amount of salt in distilled water. The physico-chemical characteristic of test water have analyzed regularly during the test periods following the standard method describe by APHA (1998). Batches of 10 healthy fishes were exposed to different concentrations of insecticide dimethoate to calculate the medium lethal concentration LC_{50} value (1.5 mg/L) using probit analysis Finney method (Finney, 1971). The fishes (Four groups) were exposed to the two sub lethal concentrations (1/10th and 1/30 th mg/L) of dimethoate for 10, 20 and 30 days respectively. Another group was maintained as control. At the end of each exposure period, fishes were sacrificed and tissues such as gill, kidney, liver and muscle were dissected and removed. The tissues (10 mg) were homogenized in 80% methanol, centrifuged at 3500 rpm for 15 minutes and the clear supernatant was used for the analysis of total proteins. Total protein concentration was estimated by the method of Lowry (1951).

RESULTS

The changes in biochemical composition of gills, kidney, liver, and muscles of freshwater carp fish, *Labeo rohita* exposed to acute concentrations of dimethoate were studied along with control fish. The data was supported by various statistical analyses and the standard deviation of the mean was calculated. The changes in the total protein in different tissues such as gills, kidney, liver, and muscles of *Labeo rohita* exposed to two sublethal concentrations of dimethoate for 10, 20 and 30 days (Table 1 and Fig. 1 to 4). Freshwater fish *Labeo rohita* kept as control protein content was highest in muscle 8.63 mg/g followed by liver 8.09 and kidney 6.46 mg/g, while low protein levels were seen in gills 3.52 mg/g for 30 days.

Gill Protein

Indian major carp *Labeo rohita* treated with sublethal concentrations of dimethoate on 10% & 30% showed a decreasing trend in the gill protein when compared to control (Table 1 and Fig. 1). The control protein values were recorded from 4.93, 4.86 and 4.88 mg/g. The 10% sublethal concentration of gill protein values were recorded from 4.76, 4.22 and 3.69 mg/g, and the 30% sublethal concentration of gill protein values were recorded from 4.27, 3.99 and 3.52 mg/g after exposure of 10, 20 and 30 days respectively.

Kidney Protein

Fish *Labeo rohita* treated with sublethal concentrations of dimethoate on 10% & 30 % showed a decreasing trend in the kidney protein when compared to control (Table 1 and Fig. 2). The 10% sublethal concentration of kidney protein values were recorded from 6.27, 5.67 and 5.04 mg/g, and 30% sublethal concentration of dimethoate exposed to tissues of kidney protein values were recorded from 6.09, 5.51 and 4.46 mg/g respectively. The control protein values were recorded from 6.36, 6.41 and 6.46 mg/g after exposure of 10, 20 and 30 days respectively.

Liver Protein

Freshwater fish *Labeo rohita* treated with sublethal concentrations of dimethoate on (10% & 30%) showed a decreasing trend in the total liver protein compared to control (Table 1 and Fig. 3). The 10% sublethal concentration of liver protein values were recorded from 7.15, 6.14 and 5.19 mg/g and the 30% sublethal concentration of liver protein values were recorded from 6.36, 5.39 and 4.87 mg/g respectively. The control protein of liver tissues was recorded from 7.78, 8.09 and 8.05 mg/g after exposure of 10, 20 and 30 days respectively.

Muscle Protein

Fish *Labeo rohita* treated with sublethal concentrations of dimethoate on 10% and 30% showed a decreasing trend in the muscle protein when compared to control (Table 1 and Fig. 4). The control protein values were recorded from 8.49, 8.58 and 8.63 mg/g. The 10% sublethal concentration of muscle protein values were recorded from 7.66, 7.11 and 6.57 and the 30% dimethoate sublethal concentration of muscle protein values were recorded from 7.36, 6.96 and 6.38 mg/g after exposure of 10, 20 and 30 days respectively.

Table 1. Total protein content (mg/g) in wet weight tissues of freshwater fish, *Labeo rohita* exposed to two sublethal concentrations (10% and 30%) of dimethoate

Days	Exposure	Gill	Kidney	Liver	Muscle
10 days	Control	4.93 ± 0.78	6.36 ± 0.51	7.78 ± 0.54	8.49 ± 0.12
	Dimethoate 10 % SLC	4.76 ± 0.34	6.27 ± 0.61	7.15 ± 0.44	7.66 ± 0.22
	Dimethoate 30 % SLC	4.27 ± 0.43	6.09 ± 0.54	6.36 ± 0.19	7.36 ± 0.7
20 days	Control	4.86 ± 0.31	6.41 ± 0.2	8.09 ± 0.5	8.58 ± 0.4
	Dimethoate 10 % SLC	4.22 ± 0.6	5.67 ± 0.42	6.14 ± 0.58	7.11 ± 0.43
	Dimethoate 30 % SLC	3.99 ± 0.36	5.51 ± 0.79	5.39 ± 0.82	6.96 ± 0.36
30 days	Control	4.88 ± 0.5	6.46 ± 0.44	8.05 ± 0.45	8.63 ± 0.57
	Dimethoate 10 % SLC	3.69 ± 0.27	5.04 ± 0.53	5.19 ± 0.41	6.57 ± 0.23
	Dimethoate 30 % SLC	3.52 ± 0.47	4.46 ± 0.43	4.87 ± 0.51	6.38 ± 0.39

Means ± SD (N=4)
SLC – Sublethal concentration

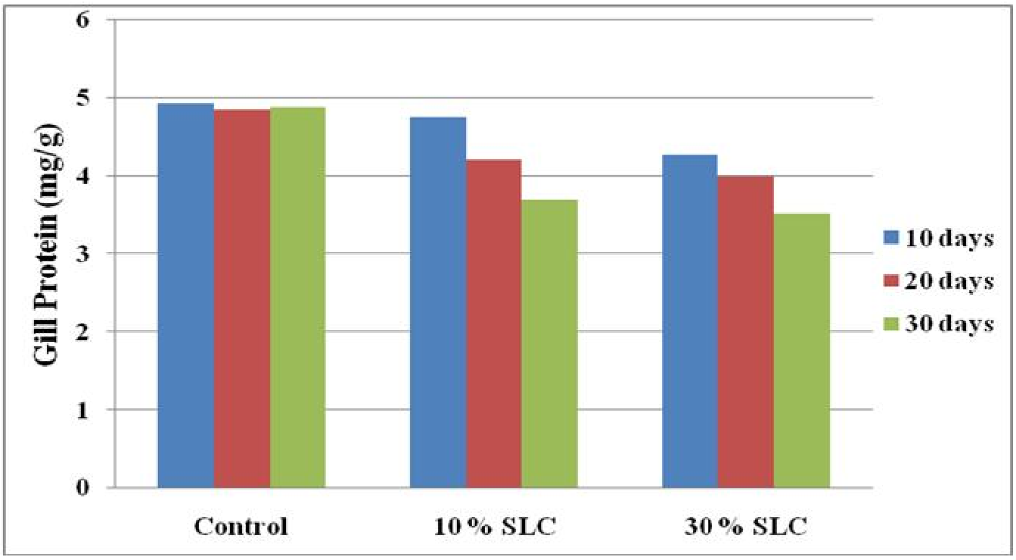

Fig. 1. Total protein content in gill tissues of *Labeo rohita* exposed to sub lethal concentrations of dimethoate pesticide

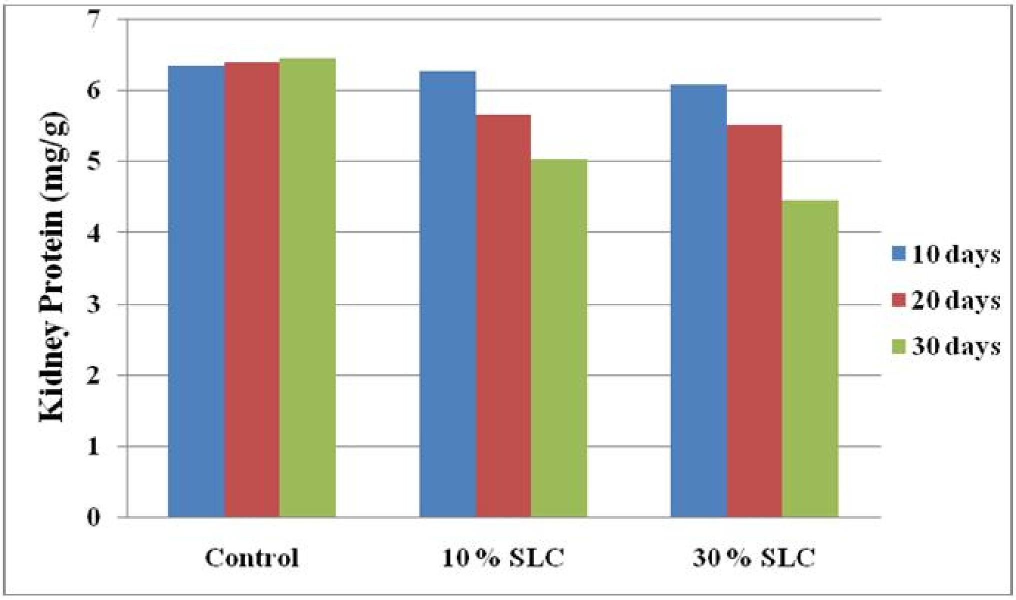

Fig. 2. Total protein content in kidney tissues of *Labeo rohita* exposed to sub lethal concentrations of dimethoate pesticide

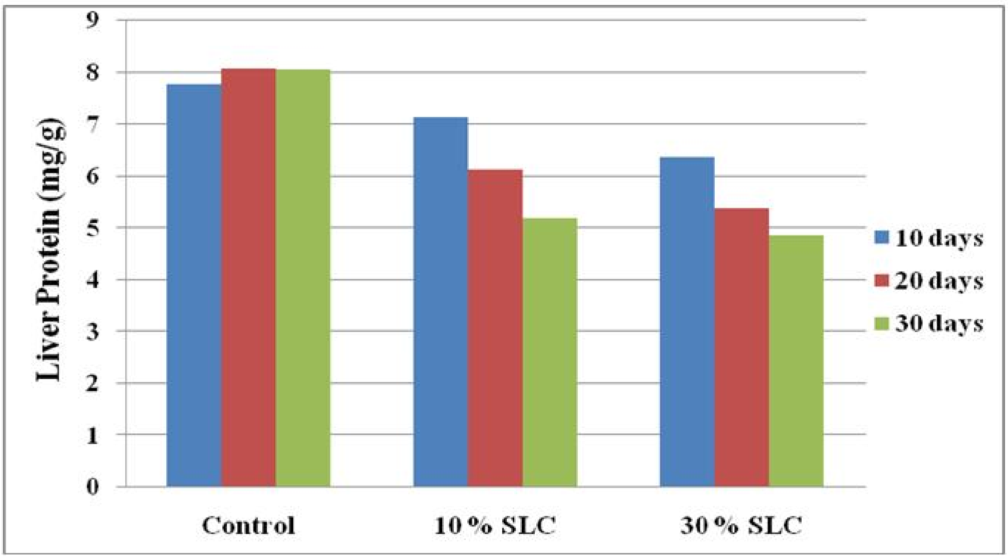

Fig. 3. Total protein content in liver tissues of *Labeo rohita* exposed to sub lethal concentrations of dimethoate pesticide

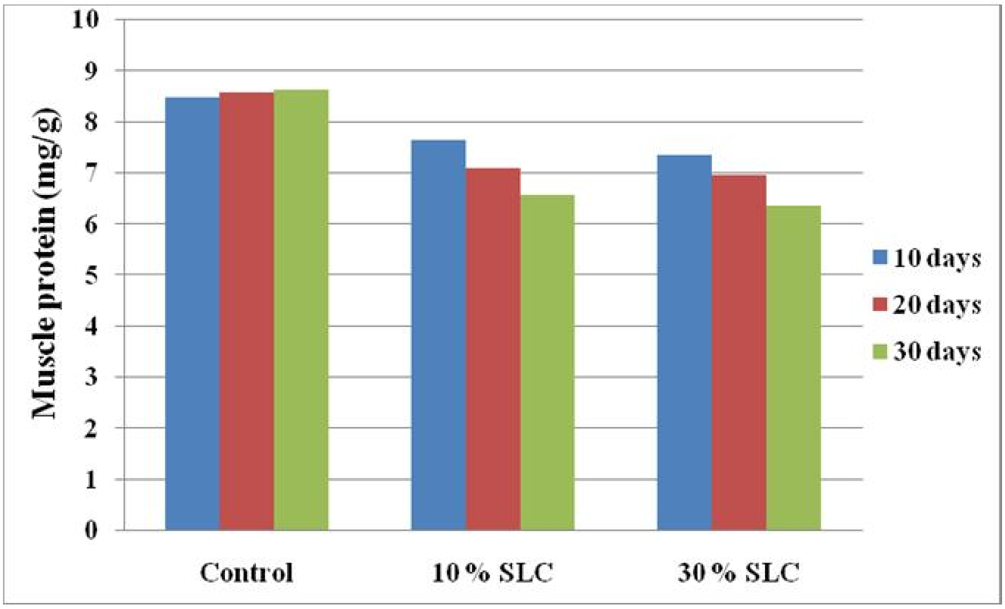

Fig. 4. Total protein content in muscle tissues of *Labeo rohita* exposed to sub lethal concentrations of dimethoate pesticide

DISCUSSION

In the present study LC_{50} values of dimethoate of fish *Labeo rohita* at 96 hours LC_{50} were 1.5 mg/L. and Sub lethal concentrations namely 10% and 30% values were selected, studying their effects on biochemical aspects. During the acute toxicity tests, the fish were seen to exhibit several behavioural responses, such as fast jerking, frequently jumping, erratic swimming, spiraling, convulsions and tendency to escape from the aquaria. Following this state of hyper excitability, the fish became inactive and loss of orientation. There was loss of equilibrium and paralysis which ultimately resolved in death of the fish. These altered behavioral abnormalities were observed only at high concentration ranges (values higher than 96 hr LC_{50}). The decreased trend of protein content in various tissues of *L. rohita* may be due to metabolic utilization of keto acids in the synthesis of glucose or for the osmatic and ionic regulation as mentioned (Schmidt, 1975; Vutukuru, 2005; Venktramana *et al*., 2006).

Decrease in protein may be due to the impairment of protein synthesis or increase in the rate of its degradation to amino acids, which may be fed to tricarboxylic acid (TCA) cycle through aminotransferases probably to cope up with high energy demands in order to meet the stress condition. The decrease in protein content suggests an increase in proteolytic activity and possible utilization of its products for metabolic purpose. The fall in protein level during exposure may be due to increased catabolism and decreased anabolism of proteins. Decrease in protein content under toxicity stress has already being reported (James *et al*., 1979; Natarajan, 1983; Khare and Singh, 2002).

Saxena *et al*. (1989) attributed the decrease in protein content due to decreased protein synthesizing capacity of liver of *Channa punctatus* exposed to carbaryl and malathion. Decrease in the protein content was observed throughout the exposure period. The two sublethal exposure results show the decrease in protein content and it depend upon the concentration. The toxicity of dimethoate also showed a direct correlation with the concentration and time exposure. Similarly, this was also observed by Singh and Bhati (1994) and Khare and Singh (2002). Borah and Yadav (1995) have reported gradual decrease in protein and glycogen of gill in *Heteropneustes fossilis* under dimethoate toxicity. James and Sampath (1995) observed sublethal effects of mixtures of copper and ammonia on biochemical parameters in *H. fossilis* and showed concentration dependent significant reduction of protein and glycogen content in gill, liver and muscle. Jones Nelson and Kumar (1996) also observed decline in protein content in liver of *Etrophis maculates* under Ekalux stress.

Das *et al*. (1999) studied the effect of cypermethrin 25% EC on biochemical composition and observed marked decrease in glycogen content in the gills of *Channa punctatus*. Rao and Ramaneshwari (2000) observed decrease in protein content in the gill of *Labeo rohita, Mystus vittatus* and *C. punctata* under endosulfan and monocrotophos toxicity. Khare and Singh (2002) have reported the gradual decrease in protein content in the gills of *C. batrachus* under malathion toxicity.

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