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Full Length Research Article

TOXICITY EFFECT OF DIMETHOATE ON CARBOHYDRATE AND LIPID ALTERATIONS IN THE FRESHWATER FISH, *CIRRHINUS MRIGALA*

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Impact of pesticides is common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. Freshwater fish, *Cirrhinus mrigala* 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 investigation, the toxic effects of the dimethoate LC_{50} 1.6 mg/L on some biochemical characteristics (total carbohydrate and lipid in the tissues of gill, liver and muscle) of the freshwater carp fish, *Cirrhinus mrigala* were estimated. There is decreased in all tissues on comparison with control. The results indicated the toxic nature of the pesticide dimethoate.

Key words: Freshwater fish, Cirrhinus mrigala, dimethoate, carbohydrate, lipid

INTRODUCTION

Dimethoate is an organophosphate available in the market by the trade name of Rogor. It is a systemic insecticide used for control of a wide variety of insect pests of fruits, also vegetables and crop plants. Dimethoate is highly selective as insecticide because relative rate of degradation of toxicant by enzymes (esterases and amidases) are very low in insects as compared with those of mammals (Rose and Hodgson, 2004). The earlier authors found out that different kinds of insecticides can cause serious impairment to physiological and health status of fishes (Begum, 2004; Monteiro *et al*., 2006). These pesticides are carried into aquatic ecosystem trade name by surface runoff from sites of application, where they enter the organisms through food webs and through contact in water. Therefore, the health of aquatic ecosystem is being adversely affected because they serve as ultimate sink for these pesticides. These pesticides are found to be highly toxic not only to fish but also to other organisms which constitute food of the fishes. A number of pesticides currently in use are biocides that have high mammalian toxicity and necessitate considerable precaution in their application (Saeed *et al*., 2005). The insecticide dimethoate was selected for study because it is a widely used organophosphate insecticide to kill mites and aphids among other insects and is applied on citrus, cotton, fruit, olives, potatoes, tea, tobacco and vegetables. It is also used on flies in home gardens and on livestock. Dimethoate is highly soluble in water and can leach into nearby water sources and affect aquatic organisms (Tuduri *et al*., 2006). Fishes are particularly sensitive to the environmental contamination of water. Hence, pollutants such as insecticides may significantly damage certain physiological and biochemical processes when they enter into the organs of fishes (John, 2007; Banaee *et al*., 2011).

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MATERIALS AND METHODS

The freshwater carp fish, *Cirrhinus mrigala* were collected from Thanjavur 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 (50 to 100 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 (1971). The fishes (Four groups) were exposed to the two sub lethal concentrations ($1/10^{th}$ 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 carbohydrate concentration was estimated by the method described by Hedge and Horfreiter (1962) and carbohydrate concentration was estimated by the method of Folch *et al.* (1957).

RESULTS

The changes in biochemical composition (carbohydrate and lipid) of gills, liver, and muscles of freshwater carp fish, *Cirrhinus mrigala* 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 carbohydrate and lipid content in different tissues such as

gills, liver and muscles of *Cirrhinus mrigala* exposed to two sublethal concentrations of dimethoate for 5, 10 and 15 days (Table 1 & 2 and Fig. 1 to 6). *Cirrhinus mrigala* treated with sublethal concentrations of dimethoate on 10% & 30% showed a decreasing trend in the gill carbohydrate when compared to control (Table 1 and Fig. 1).

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

Days	Exposure	Gill	Liver	Muscle
5 days	Control	5.29 ± 0.91	7.92 ± 0.61	7.41 ± 0.38
	Dimethoate 10 % SLC	5.29 ± 0.31	7.33 ± 0.68	6.32 ± 0.53
	Dimethoate 30 % SLC	5.17 ± 0.26	7.28 ± 0.27	6.09 ± 0.23
10 days	Control	5.21 ± 0.37	7.98 ± 0.36	7.54 ± 0.43
	Dimethoate 10 % SLC	4.34 ± 0.81	7.09 ± 0.76	5.62 ± 0.65
	Dimethoate 30 % SLC	3.98 ± 0.73	6.84 ± 0.63	5.38 ± 0.40
15 days	Control	5.63 ± 1.09	7.85 ± 0.37	7.44 ± 0.27
	Dimethoate 10 % SLC	4.13 ± 0.03	6.78 ± 0.05	4.61 ± 0.54
	Dimethoate 30 % SLC	3.76 ± 0.36	5.98 ± 0.22	4.53 ± 0.46

Means ± SD (N=3); SLC – Sublethal concentration

Table 2. Total lipid content (mg/g) in wet weight tissues of freshwater fish, *Cirrhinus mrigala* exposed to two sublethal concentrations (10% and 30%) of dimethoate

Days	Exposure	Gill	Liver	Muscle
5 days	Control	3.35 ± 0.54	4.45 ± 0.29	3.68 ± 0.50
	Dimethoate 10 % SLC	2.10 ± 0.48	4.16 ± 0.05	3.52 ± 0.65
	Dimethoate 30 % SLC	2.03 ± 0.35	3.93 ± 0.48	3.43 ± 0.43
10 days	Control	3.27 ± 0.58	4.37 ± 0.34	3.58 ± 0.46
	Dimethoate 10 % SLC	2.03 ± 0.58	3.98 ± 0.38	3.27 ± 0.55
	Dimethoate 30 % SLC	2.13 ± 0.17	3.68 ± 0.49	3.16 ± 0.44
15 days	Control	3.33 ± 0.36	4.34 ± 0.18	3.61 ± 0.54
	Dimethoate 10 % SLC	1.49 ± 0.21	2.51 ± 0.46	2.19 ± 0.58
	Dimethoate 30 % SLC	1.19 ± 0.21	2.24 ± 0.43	1.98± 0.58

Means ± SD (N=3);

The control carbohydrate values were recorded from 5.29, 5.21 and 5.63 mg/g. The 10% sublethal concentration of gill carbohydrate values were noted from 5.29, 4.34, 4.13 and the 30% sublethal concentration values were recorded from 5.17, 3.98 and 3.76 mg/g respectively. Fish *Cirrhinus mrigala* when treated with sublethal concentration of dimethoate on 10% & 30% showed a decreasing trend in the liver carbohydrate when compared to control (Table 1 and Fig. 2). Carbohydrate values of control fish were estimated from 7.92, 7.98 and 7.85 mg/g. The 10% sublethal concentrations of liver carbohydrate content were noted from 7.33, 7.09, and 6.78 followed by the 30% sublethal concentration values 7.28, 6.84 and 5.98 mg/g respectively. *Cirrhinus mrigala* treated with sublethal concentration of dimethoate on 10% & 30% showed a decreasing trend in the muscle the carbohydrate when compared to control (Table 1 and Fig. 3).

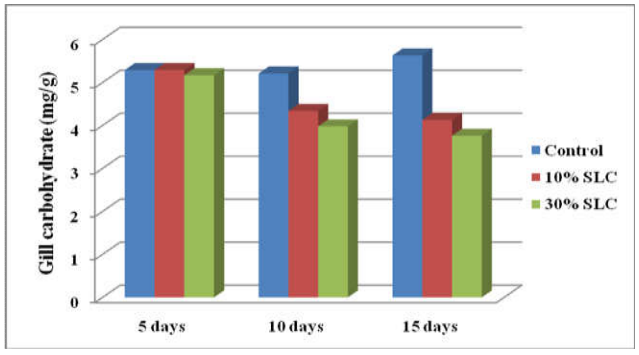

Fig. 1. Total carbohydrate content in gill tissues of *Cirrhinus mrigala* exposed to sublethal concentrations of dimethoate pesticide

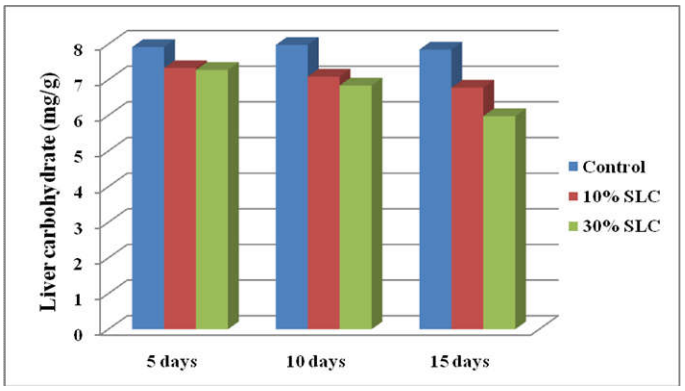

Fig. 2. Total carbohydrate content in liver tissues of *Cirrhinus mrigala* exposed to sub lethal concentrations of dimethoate pesticide

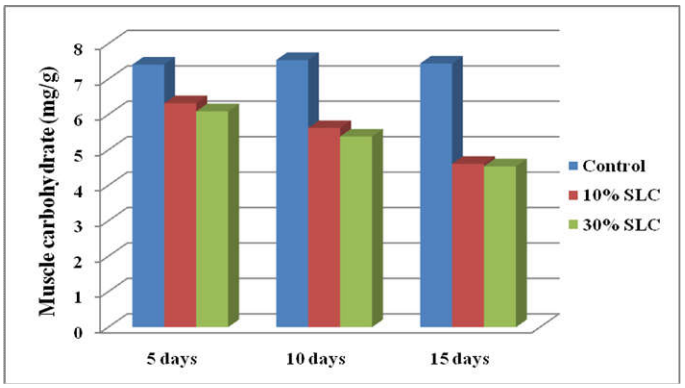

Fig. 3. Total carbohydrate content in muscle tissues of *Cirrhinus mrigala* exposed to sublethal concentrations of dimethoate pesticide

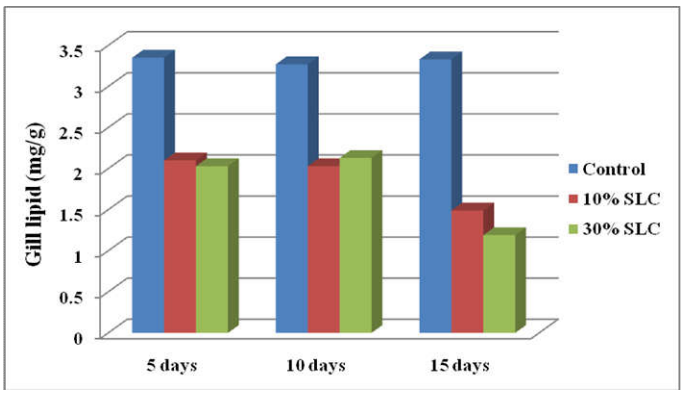

Fig. 4. Total lipid content in gill tissues of *Cirrhinus mrigala* exposed to sublethal concentrations of dimethoate pesticide

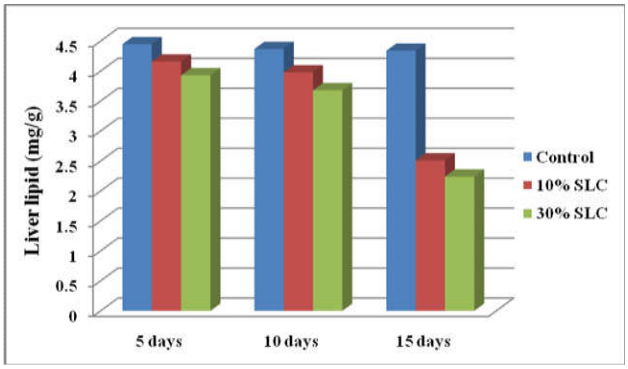

Fig. 5. Total lipid content in liver tissues of *Cirrhinus mrigala* exposed to sub lethal concentrations of dimethoate pesticide

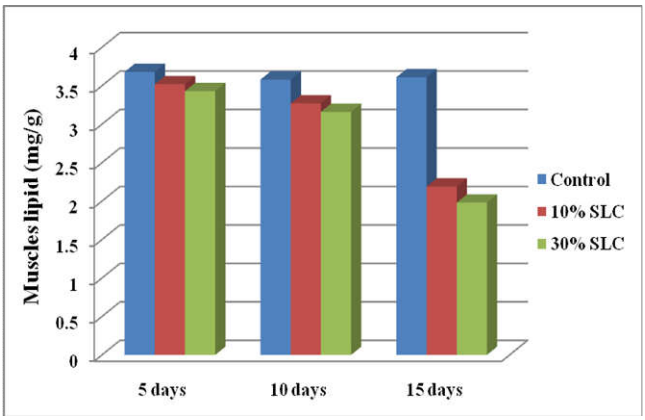

Fig. 6. Total lipid content in muscle tissues of *Cirrhinus mrigala* exposed to sublethal concentrations of dimethoate pesticide

Muscle carbohydrate values of control fish were estimated from 7.41, 7.54 and 7.44 mg/g. In the 10% sublethal concentration of muscle the carbohydrate values were recorded from 6.32, 5.62 and 4.61 followed by the 30% sublethal concentration of muscle the carbohydrate values from 6.09, 5.38 and 4.53 mg/g respectively. Decreases in gill, liver and muscles carbohydrate level as observed in different sublethal concentrations when compared to control. The maximum decrease of carbohydrate content were observed in the tissue of gill, liver and muscles of fish *Cirrhinus mrigala* exposed to 30% sublethal concentration of dimethoate reared for 15 days. The changes in the total lipid content in different tissues such as gill, liverl and muscle of fish *Cirrhinus mrigala* exposed (10% & 30%) sublethal concentrations of dimethoate for 5, 10 and 15 days are shown in Table 2. In the fish *Cirrhinus mrigala* kept as control carbohydrate content was highest in liver 4.45 mg.g, while low lipid level were observed in gills 1.19 mg/g for 15 days. Freshwater fish *Cirrhinus mrigala* when treated with sublethal concentrations of dimethoate on 10% & 30% showed a decreasing trend in the gill lipid when compared to control (Table 2 and Fig. 4).

The 10% sublethal concentration of gill lipid values were recorded from 2.10, 2.03 and 1.49 mg/g and the 30% sublethal concentration of gill lipid value were analysed from 2.03, 2.13 and 1.19 mg/g followed by the control fish gill lipid values were recorded from 3.35, 3.27 and 3.33 mg/g respectively. *Cirrhinus mrigala* treated with sublethal concentrations of dimethoate on (10% & 30%) showed a decreasing trend in the total liver lipid compared to control (Table 2 and Fig. 5). The 10% sublethal concentration of liver lipid content values were noted from 4.16, 3.98, 2.51 mg/g and the 30% sublethal concentration of liver lipid values were estimated from 3.93, 3.68 and 2.24 mg/g followed by the control lipid content were noted from 4.45, 4.37 and 4.34 mg/g respectively. The maximum decrease of liver lipid content was observed in the tissues of fish exposed to 30% sublethal concentration of dimethoate reared for 15 days. Freshwater fish *Cirrhinus mrigala* treated with sublethal concentration of dimethoate on 10% & 30% showed a decreasing trend in the muscle lipid when compared to control (Table 2 and Fig. 6). The 10% sublethal concentration of muscle lipid values were recorded from 3.52, 3.27 and 2.19 mg/g and the 30% sublethal concentration of muscle lipid values were analysed from 3.43, 3.16 and 1.98 mg/g respectively followed by the control lipid values were recorded from 3.68, 3.58 and 3.61 mg/g respectively.

The maximum decrease of lipid content were observed in the tissues gill, liver and muscles of fish exposed to 30% sublethal concentration of dimethoate reared for 15 days.

DISCUSSION

In the present study LC_{50} values of dimethoate of fish *Cirrhinus mrigala* at 96 hours LC_{50} were 1.5 mg/L. and sublethal concentrations namely 10% and 30% values were selected, studying their effects on biochemical aspects. Decreases in gill, liver and muscles carbohydrate level as observed in different sublethal concentrations when compared to control. The maximum decrease of carbohydrate content were observed in the tissue of gill, liver and muscles of fish *Cirrhinus mrigala* exposed to 30% sublethal concentration of dimethoate reared for 15 days. 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 carbohydrate content in the gill of *Labeo rohita, Mystus vittatus* and *C. punctata* under endosulfan and monocrotophos toxicity. The highest amount of carbohydrate was found in non-treated *C.striatus* fishes. The 2, 4-D treated fish group exhibited much lesser carbohydrate content of fish *Channa striatus* was noted (Anusuya and Hemalatha, 2014). In the present investigation, the maximum decrease of lipid content were observed in the tissues gill, liver and muscles of fish exposed to 30% sublethal concentration of dimethoate reared for 15 days.

Sweilum and Mohamed, (2006) reported that the effects of sublethal doses of Dimethoate and Malathion on growth parameters in *Oreochromis niloticus*, glycogen and lipid in fish muscle gradually decreased with increased pesticidal concentrations, the effects of sublethal doses of Dimethoate and Malathion in *Oreochromis niloticus* bioaccumulated in the liver was higher than in gill or muscle. Amutha *et al.* (2002) observed the effect of dairy effluent on *O. mossambicus* and reported that lipid content was decreased. Reduction of lipid content of *Catla catla* in this study may have been due to the utilization of lipids for energy demand under stress condition (Harpert *et al.,* 1977). 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 decreased in lipid content in various tissues of *L. rohita* after chronic treatments of monochrotophos of various periods of exposure were studied by Muthukumaravel *et al.* (2013). 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. Lipids are also the storage from of energy like glycogen. The lipid levels also decreased in the tissues of the fish exposed to the sublethal concentration of chlorpyrifos. The lowest level of 12.8% of lipid content was recorded in 2,4-D treated fish groups and the highest amount of 49.6% in non-treated group of fish *Channa striatus* was observed ((Anusuya and Hemalatha, 2014).

Conclusion

The present study indicates that presence of low concentration of dimethoate in the water is toxic to fishes and alters the

carbohydrate and lipid of the fish tissues. The results indicate that the usage of the dimethoate in the agriculture fields may be a threat to aquatic fauna and flora as well as humans. Therefore, the information obtained may be useful for management and monitoring of agricultural insecticide contamination in aquatic ecosystem.

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