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RESEARCH ARTICLE

TOXICITY EFFECT OF HEAVY METAL COPPER ON TOTAL LIPID ALTERATION IN THE FISH *TILAPIA MOSSAMBICUS*

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ABSTRACT

Impact of heavy metal copper is common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. Freshwater fish, *Tilapia mossambicus* is an important carp species in Tamil Nadu region having good nutritional values. Fishes living in close association with may accumulate heavy metals. In the present study, the toxic effects of heavy metal copper LC_{50} 1.8 mg/L on alterations in the total lipid content of freshwater fish, *Tilapia mossambicus* in the different tissues of gill, kidney, liver and muscle were estimated. There is decreased in all tissues on comparison with control. The results indicated the toxic nature of the pesticide dimethoate.

INTRODUCTION

Heavy metals are economic poisons used to control a wide range of animal and plant pests. The fresh water environment is becoming increasingly polluted throughout the biosphere with various heavy metals and as heavy metals are non-biodegradable, their concentration in the environment increases. These environmental pollutants bring about damage to different organs or disturb the physiological and biochemical processes within the organism. Various chemicals entering the aquatic ecosystem through human activities, either accidentantly or by design may cause adverse effects on the aquatic biota, including deleterious changes which disrupt metabolic activity at the biochemical levels (Hirth, 1964). Environmental poisoning by heavy metals has increased in recent years due to extensive use of heavy metals in agriculture, and chemical and industrial processes, posing a serious threat to living organisms. The discharges of heavy metals by industries pose a serious water problem due to the toxic properties of these metals and their adverse effects on aquatic life. According to the survey conducted by Central Inland Fisheries Research Institute (CIFRI, 1981), these heavy metals are well known pollutants which are often encountered in many rivers of India, and there is every possibility of deterioration of water quality and hence including man and various organisms are presenting a potential threat for survival. Copper is very toxic to fish. Its toxicity to fish varies with the species and the physical and chemical characteristics of the water. Even at recommended rates of application, this material may be poisonous to trout and other fish, especially in soft or acid waters.

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Its toxicity to fish generally decreases as water hardness increases copper sulfate is toxic to aquatic invertebrates. The high concentration of copper sulfate is toxic to aquatic organisms and may cause a significant decrease in population of aquatic animals (Toxine, 1986). Heavy metal constitutes serious types of pollution in fresh water and being stable compounds; they are not readily removed by oxidation and affect the animal. Heavy metals have a unique property of accumulation over a period of time, along a food chain and a very high level can be accumulated in an organism from very low level concentration in water and sediments (Bose *et al.,* 1994). Intoxication of copper reduces growth, survival and rate of reproduction in the aquatic invertebrates. Heavy metals are important for proper functioning of biological systems but their deficiency (or) excess could lead to a number of disorders (Ward, 1995). Copper has been widely used in the past as an algaecide in fish-bearing water, at concentrations which would be toxic if the metal was present in the toxic ionized form. However most, if not all of this inactive copper will ultimately enter sediment sinks where it may have limited bioavailability for organisms living there (Figuero *et al*., 2006). Among various heavy metals, copper, chromium and iron are the most important pollutants originating from industrial effluents and agricultural wastes in aquatic environment, causing significant damage to aquatic organisms, resulting in imbalance of the ecosystem. Aquatic organisms are characterized by the uptake and retention of heavy metals and the rate of accumulation are affected by chemical form of metal (Aanand *et al*., 2010; Boyd, 2010).

MATERIALS AND METHODS

Fish, *Tilapia mossambica* were collected from Chidambaram area and were brought to the laboratory in large plastic troughs and acclimatized for one week. Healthy, fish having equal size (length 10 to 12 cm) and weight (20 to 25 g) were used for experimentation. Stock solution of copper was prepared by dissolving appropriate amount of salt in distilled water. Physico-chemical characteristic of test water have analyzed regularly during the test periods following the standard method describe by APHA (APHA, 1998). Batches of 10 healthy fishes were exposed to different concentrations of heavy metal copper to calculate the medium lethal concentration LC_{50} value (1.8 mg/L) using probit analysis Finney method (Finney, 1971). Fishes (Four groups) were exposed to the two sublethal concentrations ($1/10^{th}$ and $1/30^{th}$ mg/L) of copper for 5, 10 and 15 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 lipid concentration was estimated by the method of Folch (1957).

RESULTS

Median lethal concentration (LC_{50}): Heavy metal copper caused 50% mortality of fish *Tilapia mossambicus* at 96 hours was 1.8 mg/L. The LC_{50} values of copper heavy metal for 24, 48, 72 and 96 hours were 2.4, 2.2, 2.0 and 1.8 mg/L respectively. The changes in the total lipid in different tissues such as liver, kidney, gill and muscle of *Tilapia mossambicus* exposed (10% & 30%) sublethal concentration of copper for 5, 10 and 15 days exposure period (Table 1). In the fish *Tilapia mossambicus* kept as control lipid content was highest in liver 3.23 followed by muscle 2.85 and kidney 2.30 mg/g, while low lipid level were observed in gills 0.78 mg/g for 15 days.

Liver the lipid: Fish *Tilapia mossambicus* treated with sublethal concentration of copper on (10% & 30%) showed a decreasing trend in the total liver lipid compared to control (Table 1 and Fig. 1). The 10% (copper) sublethal concentration of liver lipid content values were recorded from 2.89, 2.82, 1.6 mg/g and the 30% (copper) sublethal concentration of liver lipid values were recorded from 2.64, 2.18 and 1.24 mg/g followed by the control the lipid content were recorded from 3.23, 3.19 and 3.14 mg/g respectively. Maximum decrease of liver lipid content was observed in the tissues of fish exposed to 30% sublethal concentration of copper reared for 15 days.

Kidney lipid: Freshwater fish *Tilapia mossambicus* treated with sublethal concentration of copper on (10% & 30%) showed a decreasing trend in the total kidney lipid compared to control (Table 1 and Fig. 2). The 10% (copper) sublethal concentration of kidney lipid content were recorded from 1.88, 1.39, 1.12 and the 30% sublethal concentration of kidney lipid values were recorded from 1.29, 1.24 and 0.93 mg/g respectively. Followed by the control the kidney lipid values were recorded from 2.12, 2.21 and 2.30 mg/g respectively.

Gill lipid: Fish *Tilapia mossambicus* treated with sublethal concentration of copper on 10% & 30% showed a decreasing trend in the gill lipid when compared to control (Table 1 and Fig. 3). The 10% (copper) sublethal concentration of gill the lipid values were recorded from 1.21, 1.05, 0.98 mg/g and the 30% sublethal concentration of gill lipid value were recorded from 1.16, 1.03 and 0.78 followed by the control the gill lipid values were recorded from 1.79, 1.55 and 1.81 mg/g respectively.

Muscle lipid: *Tilapia mossambicus* treated with sublethal concentration of copper on 10% & 30% showed a decreasing trend in the muscle lipid when compared to control (Table 1 and Fig. 4). The 10% (copper) sublethal concentration of muscle lipid values were recorded from 2.67, 2.36, 2.11 and the 30% sublethal concentration of muscle lipid values were recorded from 2.49, 2.17 and 1.95 respectively followed by the control the lipid values were recorded from 2.81, 2.77 and 2.85 mg/g respectively. Decrease in lipid levels was noted in all the tissues of fish *Tilapia mossambicus* exposed to the copper (Table 1 & Fig. 1 - 4). The maximum decrease of lipid content was observed in the tissue of fish exposed to 30% sublethal concentration of copper reared for 15 days. Present study, heavy metal copper caused 50% mortality of fish *Tilapia mossambicus* at 96 hours was 1.8 mg/L. The LC_{50} values of copper heavy metal for 24, 48, 72 and 96 hours were 2.4, 2.2, 2.0 and 1.8 mg/L respectively. It was evident from the results that copper can be rated as highly toxic to fish. Similar trend was reported by Emad Abou El-Naga *et al*. (2005)

In the present study the liver lipid level was observed from freshwater fish *Tilapia mossambicus*. Fish *Tilapia mossambicus* treated sublethal concentrations of copper (10% & 30%) for 5, 10 and 15 days showed a decreasing trend in the lipid when compared to control. Maximum decrease of lipid content was observed in the tissues of fish exposed to 30% sublethal concentration of copper reared for 15 days. Similar result was reported by Maruthanayagam and Sharmila (2004). 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 were studied by Shivaprasad Rao and Raman Rao (1979). Amutha *et al.* (2002) observed the effect of dairy effluent on *O. mossambicus* and reported that lipid content was decreased. The concentrations of the total lipid decreased in all the tissues significantly with the progress of exposure period irrespective of exposure concentrations. The order of percent decreased within the tissues was hepatopangreas, gill and muscles. The considerable decreased in the total lipid in the hepatopangreas and muscles. The evidence of relatively higher lipid deposition in the hepatic tissues has been reported in the sequence of utilization of these reserves and the relative importance of the HP and MU tissue as storage organ during adverse conditions, such as stress and detoxification that are well documented (Armitige *et al.,* 1972; Vijayakumaran 1990). Reduced lipid and protein levels were observed in the pesticide exposed fish liver (Mustafa and Zofair, 1985). The lipids stored in the vital organs were oxidized by lipases to release energy to meet demand under stress, lipid level were declined in tissues (Vijayavel *et al*., 2006). Emad Abou El-Naga *et al*., (2005) reported that the total lipid of copper was decreased to after 7 days exposure to 0.5 ppm respectively. Generally, total lipid in muscle recorded high values for different groups exposed to different concentrations of copper after 2, 4 and 7 days. The total lipid was decreased in comparison to control group. Decrease in the hepatic lipid was higher in the hepatopangreas than in the tissues of gill and muscles (Maharajan *et al*., (2012).

Table 1. Total Lipid in different tissues of *Tilapia mossambicus* at different sublethal concentrations of heavy metal copper

Days	Exposure	Liver	Kidney	Gill	Muscles
5 days	Control	3.23 ± 0.57	2.12 ± 0.54	1.79 ± 0.54	2.81 ± 0.56
	10% SLC Copper	2.89 ± 0.39	1.88 ± 0.04	1.21 ± 0.06	2.67 ± 0.62
	30% SLC Copper	2.64 ± 0.60	1.29 ± 0.55	1.16 ± 0.30	2.49 ± 0.07
10 days	Control	3.19 ± 0.56	2.21 ± 0.57	1.75 ± 0.58	2.77 ± 0.54
	10% SLC Copper	2.82 ± 0.61	1.39 ± 0.55	1.05 ± 0.63	2.36 ± 0.62
	30% SLC Copper	2.18 ± 0.53	1.24 ± 0.50	1.03 ± 0.35	2.17 ± 0.49
15 days	Control	3.14 ± 0.76	2.30 ± 0.57	1.81 ± 0.65	2.85 ± 0.54
	10% SLC Copper	1.60 ± 0.54	1.12 ± 0.53	0.98 ± 0.25	2.11 ± 0.64
	30% SLC Copper	1.24 ± 0.50	0.93 ± 0.53	0.78 ± 0.29	1.95 ± 0.53

Values are mean ± SD three observations

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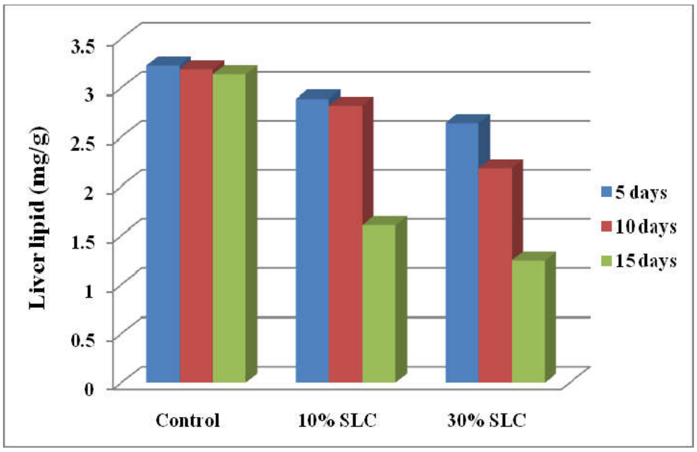

Fig. 1. Total lipid of liver tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper.

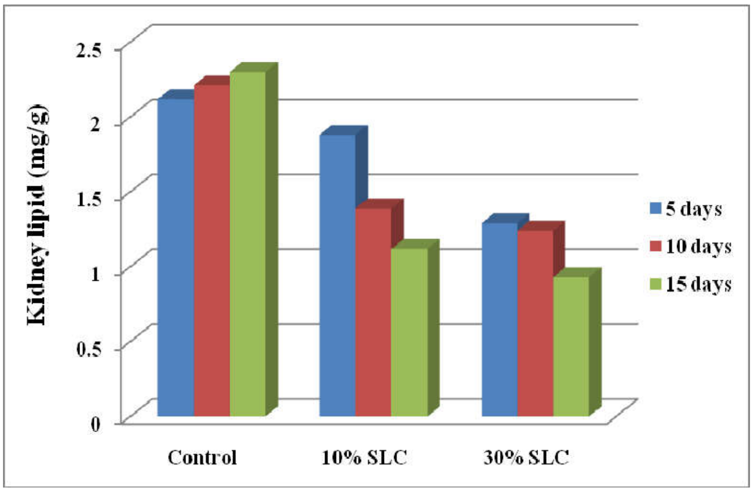

Fig. 2. Total lipid of Kidney tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

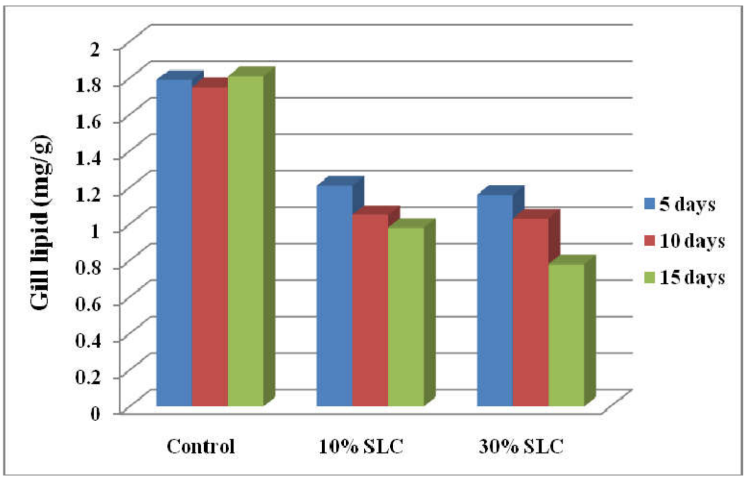

Fig. 3. Total lipid of gill tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

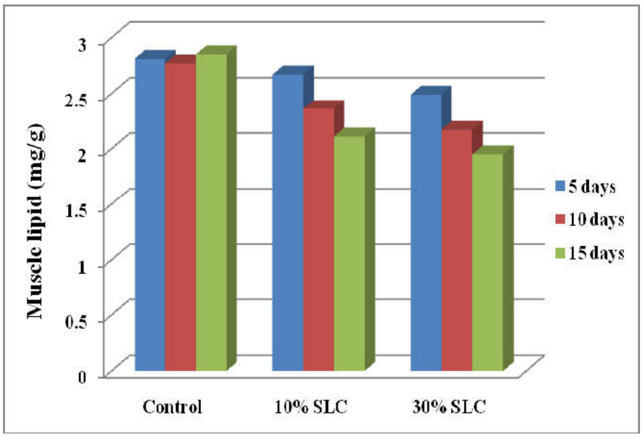

Fig. 4. Total lipid of muscle tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

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). The level of cholesterol was found to be higher in Liver > Gill > Muscle. However, after 96 hrs of exposure, the cholesterol content of exposed fishes were decreased compared to control (Suganthi *et al*., 2015).

Conclusion

The study suggested that the biochemical (total lipid) indices of *Tilapia mossambicus* for low and high sublethal concentrations of copper. This data verifies that the vicissitudes in biochemical (total lipid) indices may be used as sensitive biomarkers for animal health evaluation, especially in regions that are naturally affected by heavy metals, causing stress in fish on exposure to elevated levels in the water. Exposure of *Tilapia mossambicus* and other allied fish species to higher concentrations of copper demonstrated a toxic poisoning. The consumption of fish as a diet from such metal polluted areas is directly toxic threat to human blood characteristics. Thus sincere attentions should be devoted to minimize the risk of copper pollution in the ambient environment to save living organism including human population from adverse effects of these pollutants.

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