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RESEARCH ARTICLE

EFFECT OF COPPER IN THE LIPID CONTENT OF FRESHWATER FISH *TILAPIA MOSSAMBICUS*

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ABSTRACT

Heavy metal copper is common pollutants of freshwater ecosystems where they induce adverse effects on the aquatic biota. 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 observation, the toxic effects of the heavy metal copper LC_{50} 1.8 mg/L on the total lipid of different tissues (liver, kidney, gill and muscle) in the fish, *Tilapia mossambicus* were estimated. There is decreased in all tissues on comparison with control. The results indicated the toxic nature of the heavy metal copper.

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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). 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. 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). Aquatic pollution undoubtedly has direct effects on fish health and survival. Copper and its compounds have been used by man since prehistoric times. Copper is a trace element that is essential in small amounts, but can be toxic in large quantities. There are several sources of copper emission into the atmosphere. Copper reaches the aquatic environment through wet or dry deposition, mining activities, land runoff and industrial, domestic and agricultural waste disposals (Bertine and Goldberg, 1997). Heavy metal can accumulate in the tissues of aquatic animals and as such as tissue concentration of heavy metal case of public health concern to animals (Kalay *et al.,* 1999). 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). In the present investigation was carried out to determine of median lethal concentration (LC_{50}) and degree of toxicity, oxygen consumption and biochemical (Lipid) of copper on the freshwater fish *Tilapia mossambicus.*

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Table 1. Levels of total Lipid in different tissues of *Tilapia mossambicus* at different sublethal concentrations of copper

Days	Exposure	Liver	Kidney	Gill	Muscles
	Control	3.23 ± 0.57	2.12 ± 0.54	1.79 ± 0.54	2.81 ± 0.56
5 days	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
	Control	3.19 ± 0.56	2.21 ± 0.57	1.75 ± 0.58	2.77 ± 0.54
10 days	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
	Control	3.14 ± 0.76	2.30 ± 0.57	1.81 ± 0.65	2.85 ± 0.54
15 days	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 – or + indicate present decrease or increase over control.

MATERIALS AND METHODS

Fish, *Tilapia mossambicus* was collected from Ariyalur area and were brought to the laboratory in large plastic troughs and acclimatized for one week. Healthy, fish having equal size (length 7 to 10 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. 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 heavy metal copper to calculate the medium lethal concentration LC_{50} value (1.8 ml/g) 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 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 liver, kidney, gill 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 lipids. Total lipid concentration was estimated by the Folch method (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. 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. The maximum decrease of liver lipid content was observed in the tissues of fish exposed to 30% sublethal concentration of copper reared for 15 days. 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. 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. *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. Decreased in the total lipid levels was noted in all the tissues of fish *Tilapia mossambicus* exposed to the copper (Table 1 & Fig. 1 to 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.

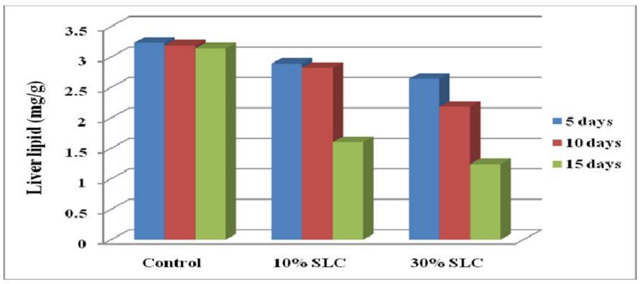

Fig. 1. Total lipid of liver tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

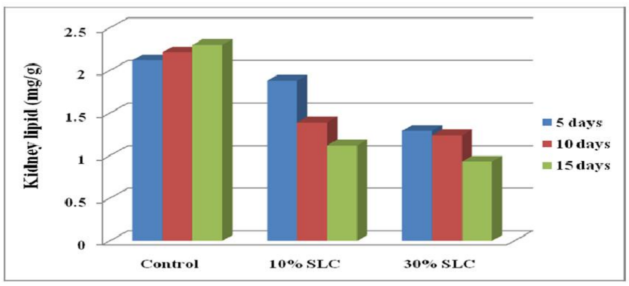

Fig. 2. Total lipid of Kidney tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

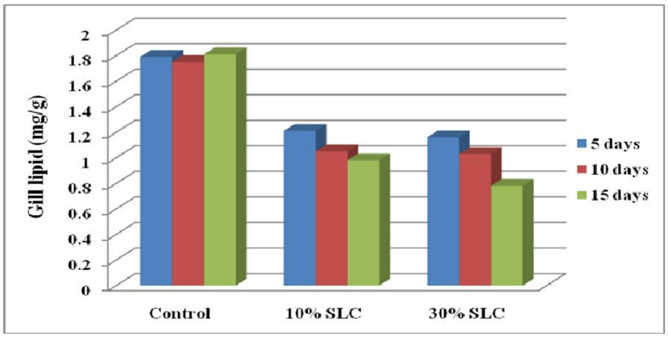

Fig. 3. Total lipid of gill tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

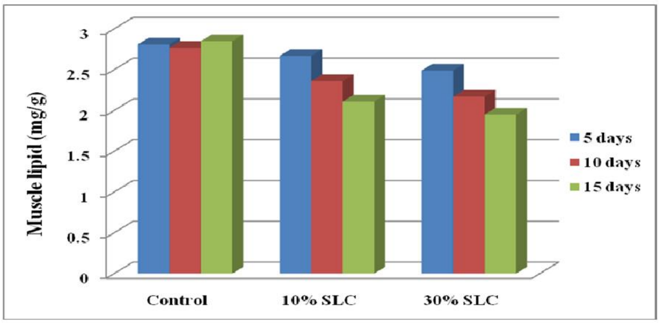

Fig. 4. Total lipid of muscle tissues in the fish *Tilapia mossambicus* under sublethal concentrations of copper

DISCUSSION

In the present observation, 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. 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. Fish *Tilapia mossambicus* kept as control lipid content was the highest in liver and followed by muscle, kidney and low lipid content seen in gills for different exposure periods. The decrease in lipid content was noted in all the tissues of exposed to the copper. The 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. 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). The decrement in the total lipid levels may be due to the increased activity of lipase, the enzyme responsible for the breakdown of lipids into free fatty acids and glycerol. Lipids constitute the rich alternate energy reserves whose calorific value is twice as that of an equivalent weight of carbohydrates and proteins and the mobilisation of lipid reserves may be due to the imposition of high energy demands to counter the toxic stress (Reddy and Rao, 1989). 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). In *P. homarus homarus* the effect of copper toxicity results in the reduction of total lipids as reported in crab *Thalamita crenata* (Villalan *et al*., 1988). Reduced lipid and protein levels were observed in the pesticide exposed fish liver (Mustafa and Zofair, 1985). The total lipids in the muscles, hepatopancreas and gill of *P. homarus homarus* showed decreasing trend as the duration of exposure in each concentration of copper increased. Significant decreases in muscle and hepatopancreas weight may be due to its utilization for energy during detoxification mechanism. In the spiny lobster *P. ornatus*, the hepatopancreas is the most sensitive indicator of physiological stress than the muscle tissue (Trendal and Prescott, 1989). 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. Effect of chlorpyrifos on the lipid content was reported by earlier investigations (Levesque *et al.,* 2002; Pande *et al.,* 1963). 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. Levels of the total lipid in different tissues of the test lobsters and controls during the exposure period are depicted. In general, the total lipid concentrations in all the studied tissues of lobsters exposed to sublethal doses of copper were significantly lower than those in controls. The decrease in the hepatic lipid was higher in the hepatopangreas than in the tissues of gill and muscles (Maharajan *et al*., (2012). Lipid is an important constituent of animal tissue, which plays a prime role in energy metabolism. 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. 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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