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Toxicity of Copper sulphate ($CuSO_4$, $5H_2O$) to *Oreochromis mossambicus* (Tilapia)

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ABSTRACT

Acute toxicity of Copper sulphate (CuSO4, $5H_2O$) to *Oreochromis mossambicus* (Tilapia) was investigated. The present study was conducted to evaluate the toxic effect of water born Copper sulphate to Oreochromis mossambicus (Tilapia). Fish species displayed different mortality responses to the varying concentrations of copper sulphate studied (45, 46, 47, 48 and 49mg/L) 96-hour LC50 value for was found to be 47mg/L-1. The data obtained were statistically evaluated using finney`s probit analysis method. While asserting the fact that copper sulphate is an important constituent in municipal wastes discharged into fresh water and marine, there is clear indication from our results of the necessity to control the use of this metal. Further toxicity testing approaches on fish will be very useful in assessing possible ecological risk of heavy metals.

Key words: LC50, Toxicity, Copper sulphate and *Oreochromis mossambicus* (Tilapia)

INTRODUCTION

Numerous chemicals called "contaminants" are introduced deliberately or accidentally into the aquatic ecosystem and impair water quality, making it unfavorable for aquatic life. Pollution is the negative feedback of the environment that affects living organisms. With increasing industrialization and discharge of effluents, heavy metals are becoming important pollutants in aquatic ecosystems (Joshi et al. 2002).

These chemicals can produce an adverse response in a biologic system by seriously damaging its structure or function or causing death (Sorensen, 1991). Contaminants have a potential impact on ecosystems and organisms at relatively low (sublethal) concentrations.

Heavy metals may affect organisms directly by accumulating in their bodies or indirectly by transferring to the next trophic level of the food chain (Shah and Altindag 2005). Heavy metals accumulate in the tissues of aquatic animals and may become toxic when accumulation reaches a substantially high level (Kalay and Canli, 2000).

The toxicity of copper sulphate depends on the copper content. Copper levels in natural unpolluted waters is as low as 0.5 to 1 µg L^{-1} (Moore and Ramamoorthy, 1984). However, industrial development has contributed to a continuous increase of copper in the aquatic environment. The toxic effect of copper on fish varies from one species to another and is strongly influenced by hardness, alkalinity, pH, temperature and dissolved oxygen in the water. Although copper limits for the protection of

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aquatic life (20 µg CuL^{-1}) recommended by the U.S. EPA (1984)

MATERIALS AND METHODS

Oreochromis mossambicus (Tilapia) were collected from local pond and transported to the laboratory in polythene bags. The fish were acclimatized for 15 days to the laboratory conditions in pre-cleaned fish tank which was filled with tap water. The fish were fed with commercial pelleted food twice a day. The experiment water used in the investigation was aerated for 48 hours to remove chlorine. Acclimatized fish were not fed for one day prior to the experiment and during experiment also. Five equal size tubs were taken filled with 10 liters normal tap water in each tub. Physicochemical parameters of test water analyzed by below given methods. Water quality of the experimental tubs were determined according to standared procedures dissolved oxygen (mg/L) (Wrinkler's chambers method), Temperature (^{0}C) (Field method), P^H were recorded individually in each test container at exposure times of 24, 48, 72 and 96h. Physicochemical parameters of test water before starting the experiment. Total hardness (mg/L) (EDTA titration method); Magnesium (mg/L) (Persulphate method); Ammonia (mg/L) (Phenate-Method),

Nitrate (NO_3-N) (mg/L), (U.V.Spectrophotometric method), concentrations were determined at the beginning of the test. (APHA-1998). A group of 6 fishes were exposed to different concentrations of penta-hydrated copper sulphate ($CuSo_4.5H_2O$). The exposed time of fish to $CuSo_4.5H_2O$ was 96 hours. Without adding any food. The average weight of fish used in experiment was 13.20 (±0.2) grams. To estimate the LC_{50} of $CuSo_4$ five different concentrations of $CuSo_4$ (45, 46, 47, 48 and 49 mg/L) were used. The concentration range of copper sulphate in this study was determined from 45 to 49 mg/L. Total experiment was conducted at 28±1^{o}C. Mortalities of fish were noted at 24, 48, 72 and 96 hours of exposure and the dead fish were removed regularly from the test solution.LC50 values were calculated from the data obtained in acute toxicity bioassay, by Probit analysis method and data was analyzed with SPSS Statistical software.

RESULTS

The physicochemical properties of the test water was shown in Table-1. The acute toxicity of copper sulphate ($CuSo_4.5H_2O$) to the fresh water fish, *Oreochromis* mossambicus was evaluated by static bioassays in water. Table-2 shows the 96 hours acute toxicity of copper sulphate to *Oreochromis mosambicus*, and Figure -1 displaying the probity line graph of the $CuSo_4$ toxicity data probit kill.

Table-1. Physical and chemical composition of the test water

S. No.	Parameter	Values of test water
1	P^H	7.3
2	Dissolved Oxygen (mg/L) (Iodometric method)	8.1
3	Temperature (^{0} C) (field methods)	28
4	Magnesium (mg/L) (persulphate method)	5.2
5	Nitrate (No_3-N, mg/L) (U.V.Spectrophotometric screening method)	0.5
6	Ammonia (Phenate method)	0.3
7	Total hardness $CaCo_3$ (mg/L) (EDTA titration method)	220

The LC50 value for Copper sulphate, calculated by probit analysis method and SPSS Statistical Software at 96 hours of exposure was shown in table-2.

Figure-2 shown the median LC_{50} value of Copper sulphate for *Oreochromis mossambicus* which was found to be 47 mg/L by probit analysis method. According to figure-3, LC_{50} value was estimated to be 47 mg/L with SPSS Statistical Software.

DISCUSSION

Toxicity testing has been widely used as a tool to identify suitable organisms as a bio-indicator and to derive water quality standards for chemicals. Toxicity testing is an essential tool for assessing the effect and fate of toxicants in aquatic ecosystem (callow, 1993; Rand et al, 1995). The 96-hr. LC_{50} tests were conducted to measure the susceptibility and survival potential of animals to particular toxic substance such as cupper. If the concentration of copper sulphate increased, fish mortality also increased, which indicates a direct proportional relationship between mortality and the concentration of copper sulphate. The major cause of mortality might be due to respiratory epithelium damage by oxygen culmination during the formation of a mucus film over the gills of fish (Das and sahu, 2005).Because Cu toxicity in water is influenced by water pH, dissolved oxygen (mg/L), temperature (^{0}C) and total hardness of $CaCO_3$, magnesium, nitrate and ammonia, fish toxicity are carried out at a wide range of different experimental conditions, caution should be taken when comparing LC_{50} data from the literature. In general, water hardness is beneficial by reducing metal toxicity to fish. Rathore and changaret (2003)

Table-2. LC_{50} value of *Oreochromis mossambicus* (Tilapia) exposed to different concentrations of $CuSo_4$ for 96 hours

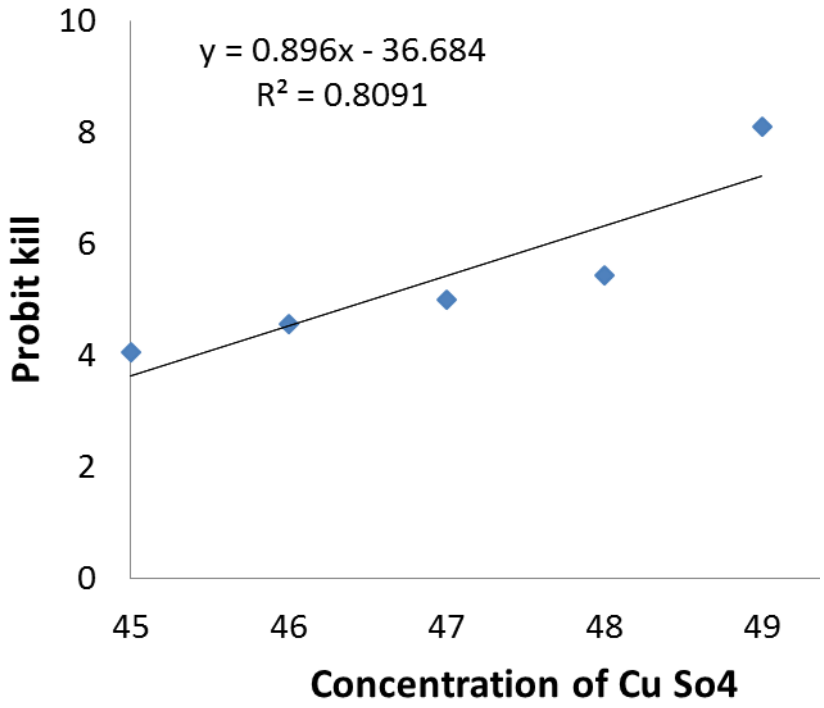
	No of Fish					
S.No.	Concentration of Cu So4	Log Concentration	Exposed or tested	Died	Percent kill	probit kill
1	45	1.6532	6	1	16.67	4.05
2	46	1.6628	6	2	33.33	4.56
3	47	1.6721	6	3	50.00	5
4	48	1.6812	6	4	66.67	5.44
5	49	1.6902	6	6	100.00	8.09

found that the toxicity of mercuric chloride decreased with increasing water hardnees. The 96 h LC_{50} value for copper sulphate was higher in the present study than values available in the literature; the reason might be due to high water hardness (120 mg/L). In shuhaimi–othman study (2010), the water hardness was low, and the water was categorized as soft water (75 mg/L as $CaCO_3$). Gundogdu (2008), used test water with P^H =7.4 and a total hardness of 249.56 mg/L as $CaCO_3$.

In the present study, water hardness was 120 mg/L as $CaCO_3$ and the pH of the test water was less than seven. The characteristics of the test water (hardness and pH) were high and less pH in the present study than values available in the literature. Khangarot et.al. (1985) reported that the acute toxicity to the common carp fry (cyprinus carpio) decreased with increasing pH 5.5- 8.5. It was found that at low pH (pH < 7) mercury was more toxic compared to higher pH (pH > 5), which might be due to acid toxicity itself causing bicarbonate loss in the body fluid (Das and Sahu, 2005). At low pH, metals are usually in their most bioavailable form as monovalent or divalent cations. In this way ameliorating effect of low pH was attributed to H^+ competition with metal ions at gill surfaces(Pyle et.al;2002). It seems that two factors, water hardness and pH levels, could affect the acute toxicity of copper sulphate on the fish Oreochromis *mossambicus*.

Mortality was also related to the retention time of CuSo4 in water, i.e. the more the retention time of

Figure-1 Graph of Concentration of CuSo4 Vs Probit kill



the CuSO4 in the water, the more the mortality rate of the fish. At the first 24 h, more of the CuSo4 in water was taken up by the fish and its concentration decreased. In other words, the mortality rate of the fish decreased as the time of toxicity exposition increases (Ebrahimpour et.al.2010). LC_{50} obtained in the present study compare with corresponding values that have been published in the literature for other species of fish, show different LC_{50} of copper sulphate in different species.

Figure-2. The median LC_{50} value of CuSO4

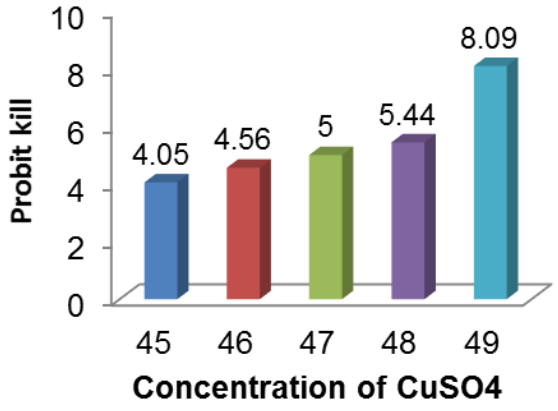
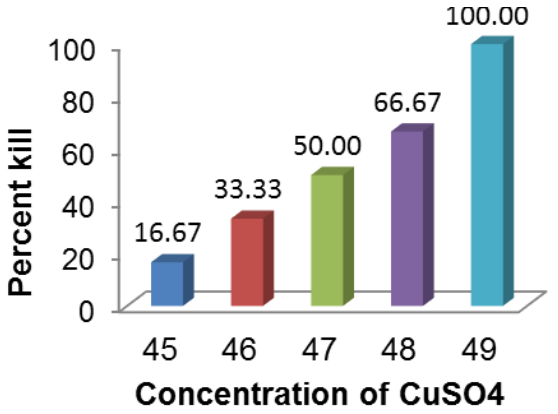


Figure-3. Concentration of CuSO4 Vs Percent kill



According to the results of this experiment, the LC_{50} values decreased with time, and about 50% of all mortalities occurred at the first 24 hours. It was found that there was a positive relationship between the mortality and concentration levels; when the concentration level increased, the mortality rate increased as well. However, there was a negative relationship between the mortality time and concentration level; when the concentration level increased, the mortality time decreased. We employed probit analysis method of data evaluation for acute toxicity bioassay. The environmental contamination with this metal can represent a great threat for the fish populations and a serious problem for the aquaculture.

Conflict of Interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

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