Research Article

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EVALUATION OF CHROMIUM INDUCED MORTALITY IN AQUATIC ANIMALS AND IMPACT ON POPULATION

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ABSTRACT

Industries discharges the most notorious toxic chemicals in to water, soil and air which predominantly affect the people's health through food chain from the nature and environment. Once toxic metals or chemicals enter into the biochemical processes, they produce dangerous and unknown diseases on living conditions. Man has brought dramatic modifications with the disastrous consequences like natural calamities in the natural environment both intentionally and accidentally. Due to human occupational activities Geochemical and biochemical process are also involved in metal pollution together in technological fields as well, which results aquatic contamination. The present study was targeted to examine the chromium toxicity levels in aquatic animals of Chao Phraya River Bangkok Thailand. Exposure of fishes at different dose levels of hexavalent chromium concentrations in the present study, the rate of mortality was observed with the exposed dose concentrations of the test chemical. Toxicity tests were conducted for 12 hours, the results were calculated. Lethal and near lethal concentrations of chromium they became highly irritable and hyper excitable jumping movements were observed with profuse mucous secretion and loss of equilibrium. Shedding of scale, patches on the surface of skin were observed in the fish exposed to lethal concentrations. In the present study high mortality rates was observed with the levels of increased concentrations of chromium.

KEY WORDS: Mortality, Probit Study, Hexavalent Chromium, Cyprinus carpio and metal pollution.

INTRODUCTION

Man and industrial originated wastage discharges, domestic and untreated waste water intruding in to the klongs, canal, rivers, and certainly it enhances the chance of heavy and chemical toxicity in the water bodies and aquatic animals[1]. Freshwater bodies are always prone to contagious because they are the direct discharge sources for various pollutants. Heavy metals are the one of the major group of aquatic pollutants, which increasing gradually from the recent past decades due to manmade activities[2]. In spite of that environmental waste enhancement and metal-toxicity have an immense health troubles to the aqua because metals are unlikely non-biodegradables[3] but they may be modified from high toxicants to less toxic compounds.

Despite, most of the metals are toxic and carcinogenic which can be influences the toxic effects on mammalians and other living organisms with the help of reactive oxygen species to cause oxidative damage[4, 1]. Fish are more prone to expose and concentrate metal toxicants from polluted aquatic environments. The increasing concentrations of heavy metals in fish is depends on daily feeding habits, tropical status, food, metalo-thionine, biomagnification and the concentration detoxifying proteins in the body[5]

Modifications of the toxic compositions are differed in differen tropical conditions, physicochemical properties of water, transportation of metals in cells with in the body. Metabolic rate of the individual animal body also influences the concentration and the levels of metal. In recent studies reported the chromium is one of the most harmful heavy metal pollutant for the aquatic life which occurs in nature and water in the form of $Cr^{3+}$and Cr^{6+}. However, Cr^{6+} ions are more than the trivalent forms of chromium[6].

The present study is carried by taking a definite size group of fish, Cyprinus carpio weight 6g+1g, length 7 cm and determined the LC of Chromium at 72 hours of exposure to analyze the impact of exposure period if any, on the levels of toxicity of this metal.

MATERIALS AND METHODS

Toxicity Evaluation in Fish

The static bioassay procedure was followed as given by Dowdoroff to elucidate chromium LC_{50} levels in fish. Holden a constant ratio of biomass volume of water was maintained during these studies. For toxicity evaluation probit method[7] was followed. Toxicity tests were conducted using chromium as test metal. Before experimentation, these fishes in batches of six each were acclimatized to tap water in plastic troughs. After acclimatization of fishes was administered to chromium. Test chemical was administered at different doses to fingerlings of fishes were exposed. A constant pH and dissolved oxygen were maintained. One seventh dose levels of the LC_{50} was selected as sub lethal concentration and fishes were exposed chromium continuously 72hr. The exposed medium was also changed alternate days using fresh tap water and mixed with required amount of test chemical. This was done to ensure to discard the facets and left over food so as to minimize toxicity by these sources. The water was also changed every alternate day for the reason cited above. Every precautionary step was undertaken to ensure and maintain the physiochemical parameters constant. Estimations of the physiochemical parameters were done in accordance with ambient medium.

Ten concentrations ranging from 15ppm to 70ppm are selected for chromium each concentration ranges were selected and taken on basis of the trial and error basis. Mortality rate was observed in each concentration of hexagonal chromium. The experiments were reported twice for accuracy. It was identified the mortality of fingerlings at every different dose levels in mean of three, was converted as percent mortality value, from this, the probit mortality value was obtained[7]. Appropriate distribution of test chemical in number of fishes, in relation to water volume and chromium concentration were maintain to prevent hypoxia due to crowding. Evaluation of the toxic damages at each concentration was taken to determine at 72hours time with LC_{50} through probit-method by plotting probit mortality versus log concentration of Chromium[8]

Exposure time and sub lethal concentration selection

The knowledge on a toxicant concentration which kills 50 % of the fingerlings from the total animals of the test animals with respect to time and period of the study, however may not be insufficient to determine various responses of the animals to that toxicant. Further studies needed to carry out on lethality of a heavy metal could have serious limitations like the possibility of ignoring the occurrence of adaptation of the test animal to the exposed toxicity. Viewed in the need for the levels of lethal and sub-lethal research studies because distinct changes involving sequence of events in the response of the experimental fish could occur in the concentrations of sub lethal test dose.

There are good numbers of report on adversity of pesticide sub-lethal concentrations on aquatic animals, but in nature the concentrations present in water bodies are mostly sub lethal. So, keeping in view on lethality of water pollutants with reference to chromium on fishes become consistent with in 72 hours of exposure[7, 8], about the one seventh concertation of LC_{50} / 72hr dosage of test chemical was taken as the sub lethal concentrations for further studies.

LC_{50} value was determined for the chromium and 1/7th concentration was aimed selected to observe lethal impact of hexavalent chromium on fingerlings of fishes. Healthy finger lings of fish - Cyprinus carpio segregated in to two groups having ten fishes in each tub. The second group (30days) of fishes named as experimental fish where the first group considered as controls with their respective experimental animals.

Experimental Design

Fish were segregated into two groups, with the first group serving as control and second group as experimental group each with three replicates located at glass aquaria (volume 100 L on average). Fingerlings of the experimental aquaria were administered to a sub lethal Cr at a concentration levels of 1/7th of LC_{50}, which was prepared as stock solution and added depending on the volume of each aquarium to obtain the required levels of concentrations, over a period of 30 days studied at St. Theresa International College, Thailand. The all animal procedures were approved by the Institutional Ethics Committee (Proceeding No. PHC01/Cr, 2015) at St. Theresa International College.

The control and exposed aquatic fish after the stipulated period (i.e. on 30th day) were sacrificed and the tissues were isolated; cleaned in physiological saline and processed immediately for microscopic analysis. The tissues were also quickly isolated under ice cold conditions and stored in deep freezer at- 80 ^{0}c for biochemical analysis.

RESULTS AND DISCUSSION

Exposure of fishes at different dose levels of hexavalent chromium concentrations in the present study, the rate of mortality was observed with the exposed dose concentrations of the test chemical. Toxicity tests were conducted for 12 hours, the results were calculated by the method, probit analysis described by[7]. The lethality of regressive equations was obtained for chromium, the results after toxicity evaluation in the fingerlings. LC50 of chromium are summarized in the Table 1. 30% mortality at 25ppm, 50% mortality at 35ppt, 70 % mortality at 55pprn, 5 % mortality at 70 ppm (Table 1). The levels of mortality percentage of fish fingerlings were observed at different concentrations as shown in a typical sigmoid curve in the figure (Figure 1.1). When probit mortalities of the chromium metal plotted against their log concentrations, the relationship was observed as in the form of straight line (Figure 1.2). The graphical evaluation,[7] of LC50 value for heavy metal like chromium hexavalent is 35ppm with the experimental value. Thus the results obtained from the present study revealed that the fingerlings of Cyprinus carpio is more susceptible to hexavalent chromium.

As we all know heavy metals are toxic than any other water pollutants to aquatic animals. They are the non-target organisms which is prone to expose to a multilevel of heavy metals and untreated manmade waste materials. According to Warren study results that the there is a large difference in the scattering phenomena in exposure and absorption of chemicals species of plants and animals.

In the present study high mortality rates was observed with the levels of increased concentrations of chromium. During the experimental period behavioral manifestations of acute toxicity like copious secretion of mucous, rapid movements and surfacing, loss of scale was observed in cyprinus carpio and similar to animal exposed to chromium and other heavy metals[2]

Despite, many chromium toxicity studies were also done by several workers. The LC50 value of Chromium was found to be rotifers and crustaceans range between 0.4 and 67 mg/liter[1], heavy metals are reported to disrupt enzyme system[2].

The exact causes on mortality rates multiples in exposed animals due to heavy metal poisoning and depends mainly on time of exposure, heavy metal levels of concentration and combinations of multiple heavy metals. However, here is no clear cut explanation regarding the mode of action of different metals how they are causing the mortality of exposed aquatic animals.

Heavy are reported to disrupt enzyme system and cause tissue and organ damage resulting in the abnormal functioning of the systems in fishes. Metals also inhibit the respiratory activity which reduces oxygen consumption. The effect of heavy metals on aquatic life also been studied extensively on the fresh water prawn, Macro brachium on Carbicula regularis. The relative toxicity of some other metals on different fishes was also done by several workers. The LC50 value of chlorpyriphos on the Cyprinus carpio 0.07pprn, Chromiun on the Labeorohitha 111.45 mgllite,r Mercuric chloride on the

Ctenophitryngodonidella, Rogar on Channa Puncicttii,c 34.0 ppm, monochrtophos on the channa punctatus 3.285 ppm,[9,1,2].

In the present study the fish maintained in fresh water without toxicant behaved very normally i.e., they were very active and movements were well coordinated and they were altered and at any slight disturbances they swam faster. Their natural color is maintained as olive green. But in lethal and near lethal concentrations of chromium they became highly irritable and hyper excitable jumping movements were observed with profuse mucous secretion and loss of equilibrium. Shedding of scale, patches on the surface of skin were observed in the fish exposed to lethal concentrations. More over examination of gills revealed significant change in their color from dark red to brownish black. A high mucous film over surface of gills was also observed. Under lethal concentrations the fish slowly became sluggish with short jerky movements and erratic opercula activity, finally turned upside down and died.

Some behavioral changes were also reported in fishes exposed to metals[10]. The, behavioral changes like hyper excitable movements appear thin mucous film and surfacing and engulfing of air and formation of a thin mucous film over the gill region was observed in the fish exposed to sub lethal concentrations. On the whole, with the knowledge of toxicity studies and behavioral observations it is possible to establish limits of tolerance and susceptibility of the fish to the toxicity of chromium metals[10, 11] and later it will enter in to cow milk through food chain as well[12].

SUMMURY AND CONCLUSION

The analysis of data from the present investigation evidenced that hexavalent chromium is toxic and had profound impact on behavior and respiration in *C. Carpio.* Due to this toxic impact of chromium has led to the altered fish respiratory physiology. Thus, variations in the oxygen consumption in chromium treated fish is probably due to impaired oxidative metabolism and chromium induced respiratory stress. Based on this results author would like to continue his further research on the impact of heavy metals in aquatic animals of Chao Phraya River with special reference to fish.

Table 1.1: effect of hexavalent chromium on cyprinus carpio for a period of 72 hours

S. No	Concentration ppm	Log concentration	No. of Fishes		% Kill	Probit Kill
			Exposed	Dead		
1	15	1.176	10	--	--	--
2	20	1.301	10	1	10	3.72
3	25	1.397	10	3	30	4.48
4	30	1.477	10	4	40	4.75
5	35	1.544	10	5	50	5.00
6	40	1.602	10	6	60	5.25
7	50	1.698	10	7	70	5.52
8	60	1.788	10	8	80	5.84
9	65	1.812	10	9	90	6.28
10	70	1.845	10	10	100	8.09
11	75	1.875	10	10	100	8.09

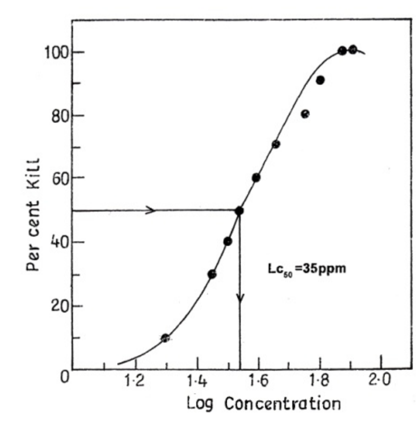

Figure 1.1: sigmoid curve showing mortality of cyprinus carpio against log concentration of hexavalent chromium.

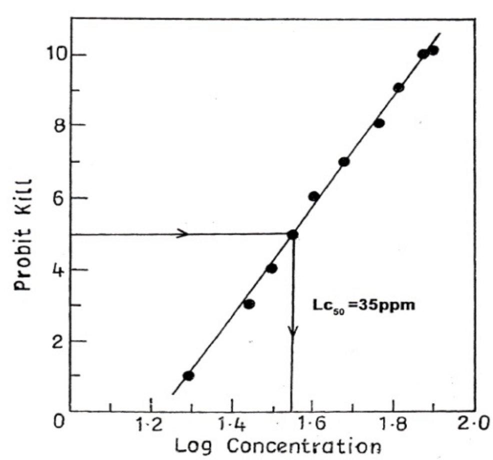

Figure 1.2: probit regression line showing mortality of cyprinus carpio against log concentration of hexavalent chromium.

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