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Toxic effects of aluminium salts to fish *Cyprinus carpio*

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Abstract

The common carp (*Cyprinus carpio*) was exposed to three different Aluminium salts, $AlCl_3$, $Al_2(SO_4)_3$ and $Al(OH)_3$ to determine the lethal concentration (LC_{50}) values at different times and effects of sub-lethal concentrations on blood glucose and serum calcium levels were estimated. The LC_{50} values at varying times 24hr, 48hr, 72hr and 96 hr were recorded for three Aluminum salts. The LC_{50} value of 96 hr for $AlCl_3$, $Al_2(SO_4)_3$ and $Al(OH)_3$ was found as 3.580 ppm, 5.902ppm and 4.786ppm respectively. Fishes exposed to sub-lethal concentrations of the three Aluminium salts ($1/4^{th}$ of the LC_{50} for 96 hrs) for 30 days revealed that biochemical parameter like glucose increased significantly ($p < 0.001$) from the control value whereas the serum calcium level decreased significantly ($p < 0.001$) from the control.

Keywords: Aluminium, fish, glucose, and calcium

1. Introduction

Aluminium is the most abundant metal and comprising 8% of earth's crust and it is widely distributed. Aluminium is a very reactive element and is not found in free form in nature. Toxic discharge to the environment from industrial processes, mining, and agricultural developments may have detrimental effects on aquatic animals [1, 2]. Fish form an important part of human food as the richest source of proteins [3]. Aluminium occurs widely in nature with silicates, such as mica and feldspar, as the hydroxide (bauxite), and as cryolite [4]. The rapid increase in human population has escalated the demand for quality food, like fish in the world. To fulfill the food requirements, fish assume greater importance. Fish also serves as an indicator to metal pollution. Environment pollution symbolizes a major problem in developed and undeveloped countries [5]. The toxic pollutant affects water quality, feeding and swimming behaviour of fish and also delays the hatching, the maturation period of fish larvae [6]. Hence an attempt was made to study the median lethal concentration of $AlCl_3$, $Al_2(SO_4)_3$ and $Al(OH)_3$ in *Cyprinus carpio* and blood glucose and serum calcium levels are estimated for 24hr, 48hr, 5 days, 10 days, 15and, 30 days. These values are compared with control to determine the effect of the three Aluminium salts on the behavioural, physiological and biochemical level in the *Cyprinus carpio*

2. Materials and Methods

Specimens of common carp *Cyprinus carpio* were procured from a local fish farm located at Balabhadrapuram, East Godavari, and India ($16^{\circ} 57' 30'' N$, $82^{\circ} 0' 20'' E$). The length and weight ranged from 06 ± 0.5 cm and 15-20 gms, respectively. Fish were divided into three groups were and kept in batches in 20L glass containers to estimate toxic effects of three Aluminum salts. They were acclimatized to laboratory condition in glass aquaria ($1.5 \times 1.0 \times 0.6$ m) for a period of fifteen days to recover from the stress which might have occurred during catching and transportation. During the period of acclimation, the fish were fed with fish pellet containing (36%) protein twice a day. Three experiments were performed for each group of fish to determine the LC_{50} values by adopting probit analysis [7] (Finney, D. J., 1952). The water conditions like temperature, pH, dissolved oxygen and hardness analyzed weekly were 27 ± 1.5 °C, 7.2 ± 0.5 , 4.8 ± 0.6 mg/l and 238 ± 3.8 mg/l as calcium carbonate ($CaCO_3$), respectively. After determining the LC_{50} value, three experimental group were selected with sub lethal concentration as $1/4^{th}$ of LC_{50} for 96 hrs exposure for $AlCl_3$, $Al_2(SO_4)_3$ and $Al(OH)_3$ respectively along with the control group. The exposure period was for 30 days. During the experimental period fishes were fed regularly with continuous aeration.

At the end of 24hr, 48hr, 5 days, 10 days, 15and, 30 days live fish from control and experimental tubs were taken and sacrificed for biochemical studies on 31st day. A minimum of 20 fish per treatment, 5 replicates per treatment and 20 fish per replicate were used for sub lethal studies. Care was taken to avoid stress during sampling. Blood was drawn by puncturing the caudal blood vessels. Heparin sodium salt was used for stabilization of the fish blood. Blood glucose levels were determined following the methods of Yemn & Willis [8]. Sera were separated by centrifugation and analyzed for calcium following the methods of Trinder (1969) [9] and Fiske and Subbarow (1925) [10] respectively. Data were analyzed by ANOVA.

3. Results and Discussion

Blood parameters of fish are suitable tool for evaluating the effects of various metal pollutants [11]. Some investigators have also identified changes in several haematological parameters as indicators of metal exposure [12] (Roche and Boge, 1996) (Cyriac *et al.*, 1989). A comparative analysis of the toxicity curve for the three Aluminium salts to the fish, *Cyprinus carpio* is shown in fig.1. Results on the effect of AlCl₃, Al₂(SO₄)₃ and Al (OH)₃ on blood glucose and serum calcium levels for sub lethal toxicity of AlCl₃, Al₂(SO₄)₃ and Al (OH)₃ for *Cyprinus carpio* were estimated after 24 hrs, 48 hrs, 5 days, 10 days, 15 days and 30 days of exposure. It is clearly evident from fig.2 and fig.3 that, the LC 50 for 96hr of AlCl₃ is least followed by Al(OH)₃ and Al₂(SO₄)₃ respectively.

The above analysis reveals that glucose level was significantly affected during sub lethal stress of the three Aluminium salts. A significant rise ($p < 0.001$) in the plasma glucose level was observed in the treated fish than that of the control fish throughout the experimental period and it was directly proportional to the duration of exposure. The increase in glucose concentration after Aluminium salts exposure might be a probable reason for the increased blood glucose level in the present study which indicates stressful condition of fish to require more energy. Blood cortisol level increases when fishes were under Aluminium stress [13]. There was a significant decrease ($p < 0.001$) in the serum calcium levels when compared to that of control fish and the decrease was more for in AlCl₃ followed by Al₂(SO₄)₃ and Al (OH)₃. The decrease in serum calcium levels indicates that Aluminium salts in various forms also alter in calcium metabolism disturbing ionic imbalance. The present findings also show the fish common carp *Cyprinus carpio* is very sensitive to the toxicity as evident from the behavioural responses. Such as erratic swimming, attempt to jump out of water, fall in opercular activity, copious secretion of mucous all over the body and increased gulping of air to meet out the respiratory distress of fish. There is paucity in literature regarding the effects of Aluminium on *Cyprinus carpio*. Thus an attempt was made to determine toxicity and effect of AlCl₃, Al₂(SO₄)₃ and Al (OH)₃ on biochemical, physiological and behavioural activities.

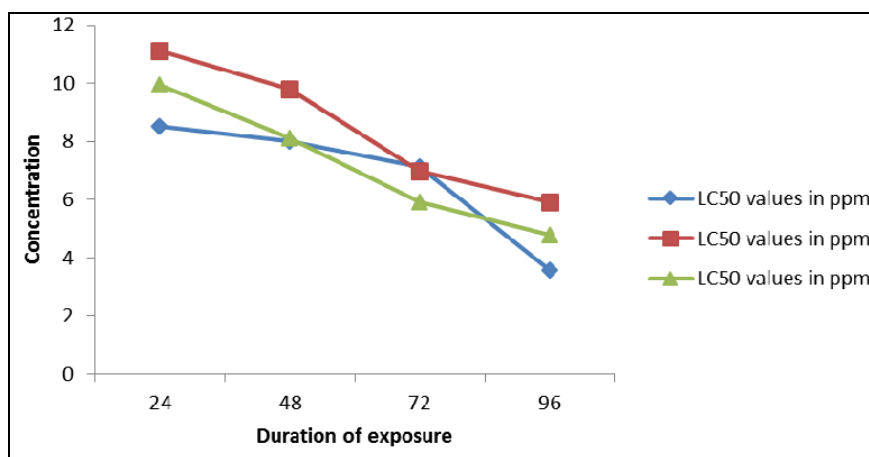


Fig 1: Comparative analysis of Toxicity of AlCl₃, Al₂(SO₄)₃&Al (OH)₃ for *Cyprinus carpio*

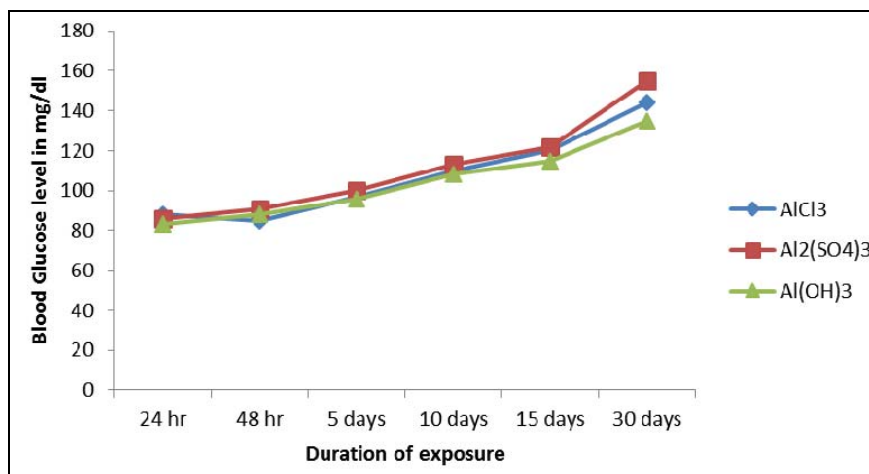


Fig 2: *Cyprinus carpio* Result of blood glucose levels after sublethal exposure to AlCl₃, Al₂(SO₄)₃&Al (OH)₃

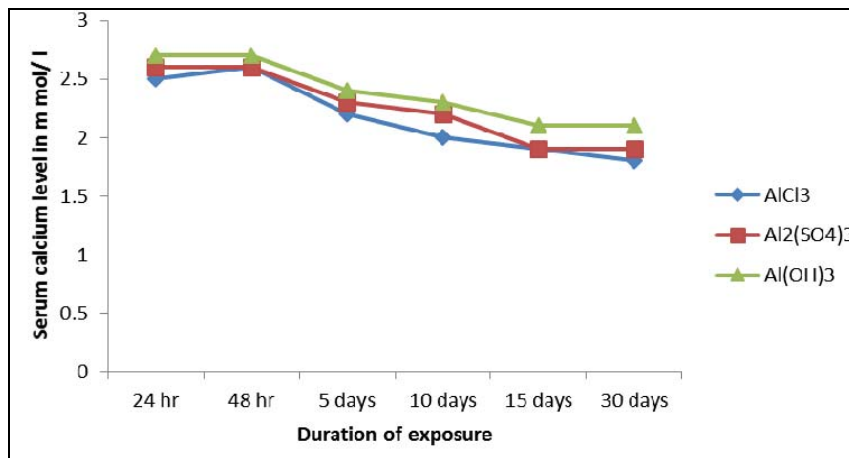


Fig 3: *Cyprinus carpio* Result of serum levels after sublethal exposure to AlCl₃, Al₂(SO₄)₃ & Al(OH)₃

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