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Toxicity of Aluminum Salts on Lc 50 Of Indian Major Carp, *Catla Catla* (Hamilton)

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Abstract

The effect of three forms of Aluminium salts, $AlCl_3$, $Al_2(SO4)_3$ and $Al(OH)_3$ on the LC 50 of Catla catla were determined and found toxic. The LC50 values were found to be 9.93, 7.74, 5.97 and 4.66 ppm for 24 hrs, 48 hrs, 72 hrs and 96hr respectively for $AlCl_3$. Similarly the LC 50 values observed for $Al_2(SO4)_3$ were 11.65, 9.58, 7.26 and 6.53 ppm for 24 hrs, 48 hrs, 72 hrs and 96 hrs respectively and for $Al(OH)_3$ the LC 50 values determined were 10.1, 8.04, 6.92 and 5.08 ppm for 24 hrs, 48 hrs, 72 hrs and 96 hrs respectively . The fish showed abnormal behavior when exposed to higher concentration of Aluminium salts, vigorous movements of the fish with increased opercular movement with wounds and black patch were found.

Keywords: Aluminium, Toxicity, Catla, LC 50, operculum.

Introduction

Aluminium is a natural contaminant of many soils, minerals and generally present in ground and surface water in very low concentration. Rain and water run offs are mainly responsible for increasing concentration of Aluminium salts in soil and aquatic bodies, concentration of Aluminium also increases due to mineral weathering (Schofield and Trojnar, 1980; Driscoll et al., 1980; Dickson 1975; Wright & Gjessing, 1976; Johnson, 1979; Hutchinson et al., 1943). Even though, Aluminium is not a heavy metal, it is proved toxic to human and other fauna, but detailed information is needed about the toxicity of Aluminium salts. It has been determined that fish tend to be more sensitive to Aluminium toxicity than aquatic invertebrates (Sparling et al. 1997). Aluminium salts enter the food chain through different routes; Aluminum chloride and Aluminium sulphate are natural ingredients of food substances including soft drinks, baking powder, self-rising flour etc; drugs, such as antacids, analgesics, and anti-diarrheals contain additives such as Aluminium hydroxide. Aluminium is toxic to fish in acidic, un-buffered waters starting at a concentration of 0.1 mg/l . Basing on the fact that scientific information available on toxicity of Aluminium on aquatic fauna is lacking and results are awaited, the following experiments are planned on the Indian major carp, *Catla catla* to evaluate the LC 50 after exposing the fish to three salts of Aluminium, $AlCl_3$, $Al_2(SO4)_3$ and $Al(OH)_3$; in animals affecting various physiological activities.

Materials and Methods

Juvenile fish of *Catla catla* were collected from the fish hatchery at Balabhadrapuram, EastGodavari Dist, AP, India and the fish were initially acclimatized to laboratory conditions in large glass aquaria for a period of two weeks. Thirty to forty

individuals from each group in the size range 6 ± 0.5cm with a bodyweight of 15 - 20 gm were used for the experiment. The three groups of fish were kept in batches in 20 lit glass tanks filled with de-chlorinated tap water under constant aeration. The fish were fed with fish pellet with 36% protein twice a day. The toxicity determination was carried out in a round bottom glass jar of one litre capacity. Healthy fish, which were of the same age group and same body weight of 15-20gms, were used in the experiment. For estimating the degree of toxicity of Aluminium chloride, Aluminium hydroxide and Aluminium sulphate, a batch of 10 test fish were released at a time into each container for each chemical. Experiments for each dose of the chemical were repeated ten times to get average mortality rate from a sample test of 100 specimens. A control experiment with 10 fish was set simultaneously without toxicant. The three test solutions were renewed every 24hr to maintain the dissolved oxygen concentration at optimum level. All the experiments were conducted at room temperature at 27°C using Probit Analysis (Finney, 1971) for determining the LC50 values. Three experiments were performed to determine the LC 50 values of 95% upper and lower confidence limits by adopting Trimmed Spearman- Kaber method LC 50 (1976). P^H was determined in digital P^H meter and dissolved oxygen was determined following modified Winkler's method.

Results: The experimental results on water quality parameters are shown in Table 1. It was evidenced that the dissolved oxygen values were reduced in the aquaria when $AlCl_3$ and $Al_2(SO4)_3$ were added to the medium, simultaneously the waters became acidic in these salts.

Table-1: Physico-chemical characteristics of the normal and water and water with dissolved Aluminium salts.

Parameters	Normal Water	Water dissolved with $AlCl_3$	Water dissolved with $Al_2(SO4)_3$	Water dissolved with $Al(OH)_3$
Odour	Odourless	Unpleasent	Unpleasent	sore
Temperature^{0}C	27	28	27.3	26.8
P^H	7.2	6.7	6.8	7.3
DO,mg/L	4.8	3.6	4.3	4.1
Total hardness, mg/L	238	234	240	244

The effects of Aluminium salts on % mortality are given in Table-2. When the fish were exposed to $AlCl_3$, mortality started at concentration 1 ppm after 96 hrs of exposure, in $Al_2(SO4)_3$ mortality started at a concentration of 3 ppm and in $Al(OH)_3$ mortality commenced at 2 ppm. 100% mortality was observed at 13 ppm for to $AlCl_3$, 15 ppm for $Al_2(SO4)_3$ and 14 ppm for $Al(OH)_3$.

Table.2 : ***Catla catla, %*** *m*ortality of exposed fish to different concentrations of Aluminium Chloride , Aluminium sulphate and Aluminium hydroxide.

Ccc concentration in ppm			No of test specimens	Mortality Percentage											
				24hr			48hr			72hr			96hr		
$AlCl_3$	$Al_2(So_4)_3$	$Al(OH)_3$	100	$AlCl_3$	$Al_2(So_4)_3$	$Al(OH)_3$	$AlCl_3$	$Al_2(So_4)_3$	$Al(OH)_3$	$AlCl_3$	$Al_2(So_4)_3$	$Al(OH)_3$	$AlCl_3$	$Al_2(So_4)_3$	$Al(OH)_3$
0.5	0.5	0.5	100	0	0	0	0	0	0	0	0	0	0	0	0
01	01	01	100	0	0	0	0	0	0	0	0	0	10	0	0
02	02	02	100	0	0	0	0	0	0	10	0	0	20	0	10
03	03	03	100	0	0	0	0	0	0	20	0	10	40	10	20
04	04	04	100	0	0	0	10	0	0	40	10	20	50	20	40
05	05	05	100	0	0	0	20	0	10	50	20	40	60	40	50
06	06	06	100	10	0	0	30	10	20	60	40	50	70	50	60
07	07	07	100	20	0	10	50	20	30	70	50	60	80	60	70
08	08	08	100	40	10	20	60	30	50	80	60	70	90	70	80
09	09	09	100	50	20	40	70	50	60	90	70	80	100	80	90
10	10	10	100	60	40	50	80	60	70	100	80	90	100	90	100
11	11	11	100	70	50	60	90	70	80	100	90	100	100	100	100
12	12	12	100	90	60	70	100	80	90	100	100	100	100	100	100
13	13	13	100	100	70	90	100	90	100	100	100	100	100	100	100
14	14	14	100	100	90	100	100	100	100	100	100	100	100	100	100
15	15	15	100	100	100	100	100	100	100	100	100	100	100	100	100

Results of LC 50 values with 95% upper and lower confidence limits are shown in Table-3. The concentration of $Al_2(SO4)_3$ required for LC 50 is more when compared to $AlCl_3$ and $Al(OH)_3$ during 96 hours of exposure.

Table.3 : *Catla catla* Result of LC_{50} values for Aluminium Chloride, Aluminium sulphate and Aluminium hydroxide with 95% confidence limit.

Test duration	Aluminium chloride			Aluminium sulphate			Aluminium hydroxide		
Hr	LC_{50} values mg/lit	95% lower confidence limit	95% upper confidence limit	LC_{50} values mg/lit	95% lower confidence limit	95% upper confidence limit	LC_{50} values mg/lit	95% lower confidence limit	95% upper confidence limit
24	9.39	8.41	11.37	11.65	10.08	13.02	10.1	9.68	10.52
48	5.97	6.91	8.57	9.58	8.12	11.04	8.04	7.12	8.96
72	7.74	4.49	6.45	7.26	6.50	8.42	6.92	6.50	7.34
96	4.46	3.58	5.74	6.53	5.11	7.95	5.08	4.17	6.99

Three different toxicity curves are plotted for $AlCl_3$, $Al_2(SO4)_3$ and $Al(OH)_3$ taking concentration of test chemicals in ppm on X-axis and duration of exposure in hours on Y-axis. There was a gradual decrease in the slope function corresponding to an increase in the exposure time from 24 to 96 hr. Slope decline was more with $AlCl_3$ and $Al_2(SO4)_3$ than $Al(OH)_3$ (Fig-1,2,3, 4) along with an increase in exposure time. The values for lethal concentration of the three Aluminium salts for 24 hr, 48 hr, 72 hr and 96 hr were calculated from the regression equation $Y = 1.596x + 10.93$, correlation co-efficient (r) = .997 for AlC_3, $Y = 1.741x = 13.08$, correlation co-efficient (r) = .981 for $Al_2(SO_4)_3$ and $Y = 1.618x + 11.58$, correlation co-efficient (r) = .993 for $Al(OH)_3$.

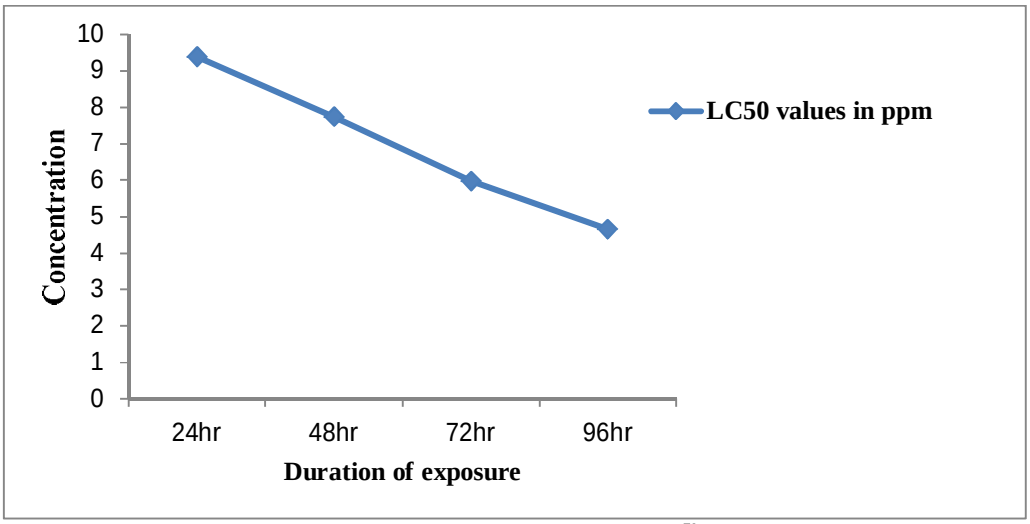

Fig1 -Toxicity curve of $AlCl_3$ for ***Catla catla***

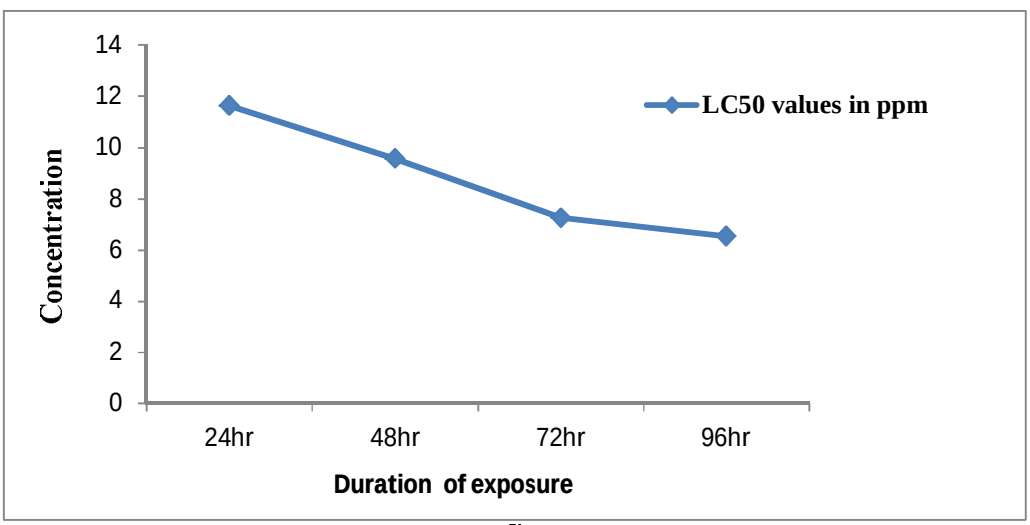

Fig2- Toxicity curve of $Al_2(SO4)_3$ for ***Catla catla***

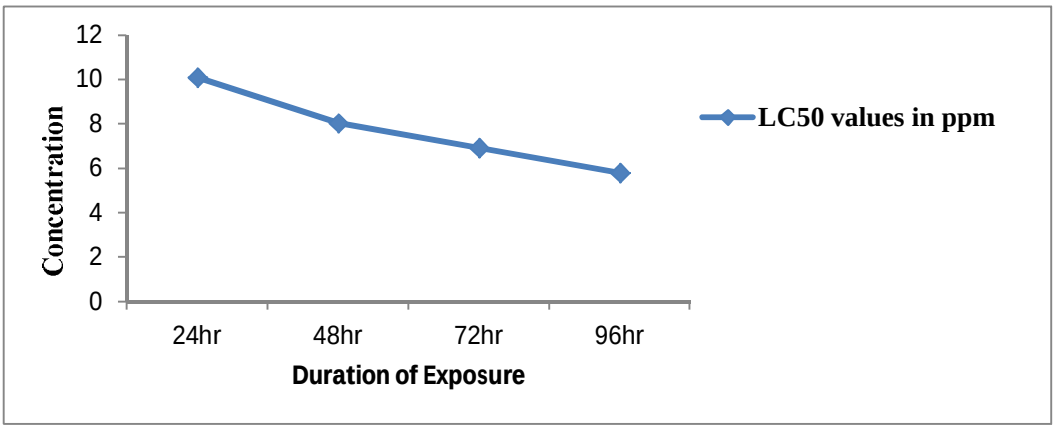

Fig3 -Toxicity curve of Al $(OH)_3$ for ***Catla catla***

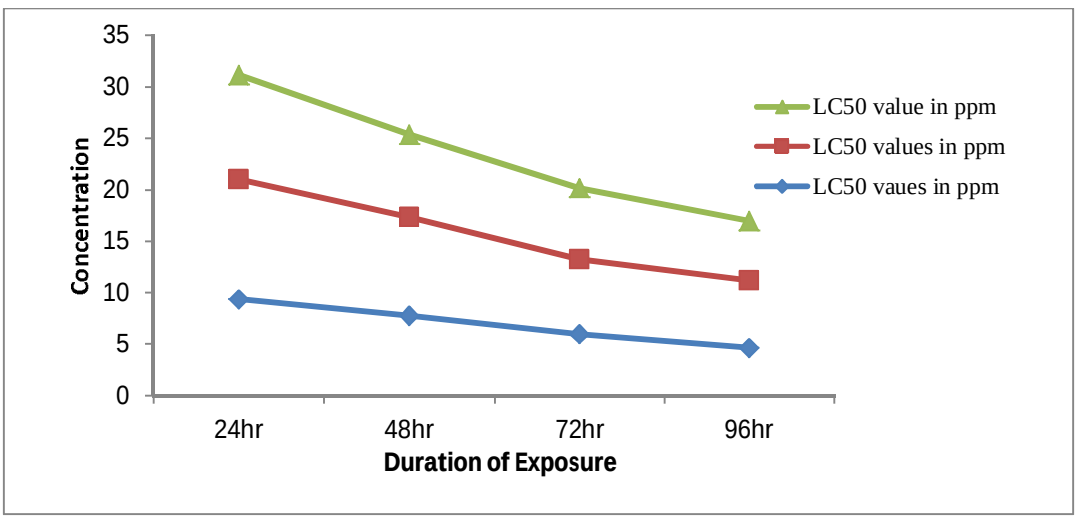

Fig4- Comparative analysis of Toxicity of $AlCl_3$, $Al_2(SO4)_3$ & Al $(OH)_3$ for *Catla catla*

Discussion

The results of acute toxicity tests conducted on the test specimen *Catla catla* with three different forms of aluminium salts, $AlCl_3$, $Al_2(SO4)_3$ & $Al(OH)_3$ have clearly indicated their toxic nature leading to alteration in the physio-chemical quality of water and causing mortality of test fish at varying rates. Mahajan and Parurukmani (2012) have reported as LC 50 for *Catla catla* as 53.1 PPM at a body size of 3.0 ± 0.5 cm, but in the present investigations, the LC 50 values observed were 9.93 ppm, the important point of consideration is about the size of the fish and brand of chemical used; in the present

experiments the size of the fish used were 6.0 ± 0.5 cm and the chemical used were E Merck ltd, Germany. LC 50 values for $Al_2(SO4)_3$ and $Al(OH)_3$ are provided for the first time on the fish *Catla catla.* The results have indicated that the toxicity of the three salts these have impacts on physiological functioning of the organism. .

The fish showed abnormal behavior when exposed to higher concentration of Aluminium salts, vigorous movements of the fish with increased opercular movement was of significant observation made, excess activity demands more energy accounting for enhanced blood glucose levels. Increase in the concentration of the salts further enhanced their movements. Another important point of discussion is about the development of wounds and black inundations on the skin at LC 50 concentration of $AlCl_3$, but the fish developed white patches on the skin when treated with $Al(OH)_3$, followed by mucous secretions indicating the role of the salts on epidermal glands. Feeding activity and opercular movement was reduced gradually before mortality of the fish after exposure to the salts; the effect was more in $AlCl_3$.

Acknowledgement

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