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Effects of heavy metals on the ventilation and opercular movement in C.gachua and C.reba.

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ABSTRACT

Several heavy metals which are present as pollutants in the water bodies have been established a toxic substances to fishes. The present study has been aimed to regulate their entry in the various water bodies so that it can be ensured that they may not be adversely affected in any way. It has been found that the effects of heavy metals in fish can be variable to a greater extent. apart from causing death either directly or due to starvation by destruction of food organism many heavy metals have shown to affect the survival behavior, growth, reproduction, physiology biochemistry and pathology of fish with evidence of tissue damage.

The present study death with the opercular frequencies and respiratory deals with. It was found that there frequencies and distress were increased 2-4 times more than the control fishes. The opercular frequency/minute were observed in two different habit fishes at different concentration to two heavy metals i.e. C_uSo_4 and $K_2Cr_2O_7$ pollutants in relation to exposure periods. At the initial stage of exposure, both fishes i.e C.gachua and C.reba exhibited similar result and no significant affect were noticed. However in case of C.gachua, the opercular frequency was found in increasing there from 40mg/l to 265.4 mg/l level but suddenly and abruptly declined at 517.9mg/l level up to 72 hour of exposure in both pollutants Another test fish C.reba exhibited some different affects i.e increasing trend from 24 hour exposure and started decreasing at 9b hr. of exposure which was not abrupt like C.gachua rather in or systematic manner except in case of C_uSo_4 pollutants of 88mg/l level of concentration where it exhibited 46±2.

The initial increase in the opercular movement followed by a gradual decrease which becomes rapid just prior to death. These development depended mainly on the concentration limit and exposure period and normally this is concentration dependent Further the movement of C.gachua and C. reba towards water volume increased in almost all concentration to meet their O_2 requirement but it did not materialize in lethal concentration.

Key words : Heavy metals, C.gachua, C.reba, ventilation, opercular movement, C_uSo_4, $K_2CR_2O_7$

INTRODUCTION

Aquatic pollution has become a global problem in recent years. Extensive industrialization has influenced the quality of water all over the world. Heavy metals are recognized as one of the most hazardous pollutants and toxic to many organisms. The natural aquatic systems many extensively contaminate with heavy metals released from domestic, industrial and other man made activities (vutukuru, 2003 Monazaki et. al. 2015).

Fishes are widely used to evaluate the health of aquatic ecosystem. They respond sensitivity to an increased concentration of contaminants in water. Heavy metals at high concentrations can cause hazardous effects to metabolic, physiological and biochemical system of fishes (Heath. 1987).

Among the heavy metals, cadmium, lead, mercury, copper, zine, chromium and nickel are comparatively notorious toxicants and most of their compounds are water soluble and non-degradable zine and copper which are used in agriculture works and are knows as essential element in animals and plants metabolism are also reported toxic to fishes (singh and singh 1979).

The initial increase in the opercular movement followed by a gradual decrease which becomes rapid just prior to death. These development depended mainly on the concentration limit and exposure period and normally this is concentration dependent further the movement of C.reba and C.gachua towards water volume increased in almost all concentration to meet their oxygen requirement but it did not materialize in lethal concentration.

The present study deals with the opercular frequencies and respiratory distress in the presence of undesirable concentration of C_uSO_4 and $K_2Cr_2O_7$. It is an attempt towards the aim of reducing the level of pollution to those which can at least be tolerated and beneficial to the fishes and other aquatic biota and also for maintaining healthy stock of fish.

MATERIALS AND METHODS.

Mature specimen of healthy and alive Channa gachua commonly known as “Changa” of 36.5±2.5 gm, weight groups and Cirrhinus reba commonly known as “Reba” of both sexes collected from the aquatic resources situated in the vicinity of Motihari town and brought to the laboratory, where they washed for few minutes in 0.1% aquous potassium permagnate solution followed by several changes of fresh water to remove any dermal infection present.

During acclimation and experimental periods, fishes were provided with “Fish tone” (an artificial food), tubifex and chopped goat’s liver and alternate day respectively two to three hours prior to the change of water and chronic exposure except bio-assay test, during which fishes were not provided food twenty four hours prior to start the experiment to the end of the experiment (i.e. up to 96 hours).

Bioassay test : - Static bioassay tests for determining the acute toxicity or median lethal concentrations (Lc_{50}) value at 24, 48, 72 and 96 hr of exposures to the selected metallic salts (C_uSO_4 and K_2Cr_2 O_7) individually were patterned following the method described by doudoroff et at. (1951) and APHA. (1995).

The opercular frequencies or ventilation rates of five fish of each concentration and the controls at selected periods of exposures (i.e. 24,48,72 and 96 hr of exposure) were counted by visual observation/using magnifying glass for 5-10 minutes and average value per minutes/fish were calculated and recorded.

RESULTS AND DISCUSSION

During the experimental period no death was recorded in the test level and at tlowest concentration of heavy metals. Both fish exhibited Characteristics but identical behavioruable changes depending upon the concentrations and exposure period. Their increased opercular movement initially reflected the restlessness evidence of difficulty in respiration of the fishes was apparent because they surfacing. The poison symptomolgy usually started before three to four hrs. of death as observed by loss of equilibrium, convulsion and erratic Jerky body action. The fishes gradually became lethargic followed by paralysis and finally they settled down at the bottom of the container. The respiratory distress along with opercular frequency was seen to be increased by 2-4 times more than the control fish.

The opercular frequency per minute were observed in both fishes at different concentration levels to both metal pollutants in relation to exposure periods. The frequency were studied at 24, 48, 72 and 96 hrs.

In case of C.gachua when exposed to 24, 48, 72 and 96 hr. at different concentration level to $CuSO_4$ the opercular frequency was found 38 ±2 at starting point and was found to be increased from 40mg/l concentration to 265.4 mg/l level but suddenly and abruptly declined at 517.9mg/l level. The opercular movement of C.gachua when exposed to $K_2Cr_2O_7$ at different level at selected hr. of exposures revealed more abruptly declining trend at 265.4 and 517.9mg/l concentration level. At 48 hr. of exposure almost similar trend was noticed when exposed to both pollutants but decreasing level was starting at 38 ± 3 and 39 ± 2 after increasing level to some concentration level, abruptly decreased to 29 ± 2 and 24 ± 2 and 20 ± 3 and 18 ± 2 respectively to both C_uSO_4 and $K_2Cr_2O_7$. At 72 hr. of exposure to both pollutants, the opercular frequency was observed to be in the increasing, decreasing and increasing trends abrupt decreased to 19 ± 3 and 18 ± 3 respectively at 265.4mg/l. level concentration and no movement was seen at 517.9 mg/l concentration to both pollutants (Table-1).

The opercular movement of C-gachua to both pollutants at 96 hrs of exposure at different concentration level exhibited decreasing trend except in case of C_uSO_4 exposure at 88 and 258.1mg/l level concentration. These frequency was finally came to half at 265.4mg/l concentration level.

The opercular frequency per minute in relation to exposure periods and concentration of both heavy metals with percent change in case of C.gachua has been shown in Table-1.

In case of C.reba the opercular frequency were too observed. It exhibited increasing, decreasing and increasing trend and showing nothing extra action.

At 24 hrs. of exposure to C_uSO_4 pollutants exhibited increasing decreasing and increasing trend and finally the opercular movement was found to be 47 ± 3 at 517.9 mg/l level of concentration . Similar trend was noticed to $K_2Cr_2\ O_7$ pollutants except that it abrupts decreased 28 ± 3 at 517.9 level.

At 48 hr. of exposure to C_uSO_4 the opercular frequency was observed to be in the similar fashion as per the result at 24 hr. of exposure above but at $K_2Cr_2O_7$ pollutants the increasing and decreasing level of opercular frequency does not show any significant variation rather it moves in between 36 ± 3 to 39 ± 3 except at 285.1mg/l level of concentration where it exhibited 40 ± 2.

At 72 and 96 hr. of exposure to both pollutants at selected level of concentration the decling trend right from starting point was observed which was not abrupt rather in a systematic manner except in case of C_uSO_4 pollutants at 88mg/level of concentration where it exhibited 46 ± 2

The opercular frequency per minute in relation to exposure hr. and different concentration of both pollutant i.e. C_uSO_4 and $K_2Cr_2O_7$ with percent change in case of C.reba has been enumerated in Table-2

In the present study, both fishes when exposed to both heavy metals at different concentration and exposure hour, it was observed that both fishes become sluggish and later on they started erratic swimming losing their equilibrium, loss of balance and sinking to bottom or floating on the surface just prior to death. Almost similar symptoms have been reported by several workers while working on different fishes when treated with different pollutants. Grant and Mehrle (1970) in C.auratus, Munsigeri and David (2003) in C.mrigala, Prasad et al. (2002) in C.marulius, Prasad et. al. (2003) in C.gachua, S.Thangamalathi et. al (2020) in C.punctatus and Oreochromis niloticus, Roy et. al (2020) in C.reba, Hameed et al. (2005), Gurusamy.K (2020), sellers (1975) etc.

It can be safely concluded that the toxicant from the environment mainly enter fish by means of their respiratory system. A mechanism of toxicant uptake through gills probably occurs through pores by simple diffusion and is then absorbed through cell membranes. From the result it is clearly evident that decrease in oxygen consumption by the whole animal may be due to the respiratory distress which affect the opercular movement.

Table - 1

Opercular frequency per minute in relation to exposure period and concentrations of the heavy metal during acute exposure in Channa gachua.

Heavy Metal	Concentration (ppm)	Starting point	Hour of exposure			
			24	48	72	96
Test	00	38±4	36±3	38±3	35±3	38±3
C_uSO_4	40	38±4	43±3	41±3	36±3	27±3
	60	38±4	41±3	42±2	32±2	27±3
	88	38±4	38±3	41±2	35±2	29±2
	127.4	38±4	49±2	41±1	33±2	29±2
	182.2	38±4	51±1	45±4	36±1	28±1
	285.1	38±4	50±4	37±3	28±4	20±2
	265.1	38±4	50±3	29±2	19±3	-
	517.1	38±4	35±2	24±2	-	-
	0	38±4	35±2	39±2	38±2	39±2
$K_2Cr_2O_7$	40	38±4	36±2	41±2	38±2	34±2
	60	38±4	51±4	45±4	35±4	31±4
	88	38±4	41±5	42±5	41±5	28±5
	127.4	38±4	40±2	39±2	74±2	24±2
	182.2	38±4	52±4	45±2	33±4	18±4
	258.1	38±4	51±2	32±2	19±2	11±2
	265.4	38±4	28±3	20±3	18±3	-
	517.9	38±4	21±2	18±2	-	-

±is standard error of 4 observation

Table - 2

Opercular frequency per minute in relation to exposure period and concentrations of the heavy metal during acute exposure in C.reba.

Heavy Metal	Concentration (ppm)	Starting point	Hour of exposure			
			24	48	72	96
Test	00	38±2	38±3	39±3	37±3	37±3
C_uSO_4	40	38±4	44±3	45±3	38±3	39±3
	60	38±4	42±2	44±2	46±2	36±2
	88	38±4	41±2	39±2	38±2	31±2
	127.4	38±4	48±2	42±2	35±2	29±2
	182.2	38±4	52±3	46±3	34±3	28±3
	285.1	38±4	42±2	41±2	31±2	27±2
$K_2Cr_2O_7$	265.4	38±4	45±2	40±2	29±2	26±2
	517.9	38±4	47±3	42±3	29±3	25±2
	0	38±4	41±2	37±2	38±2	39±2
	40	38±4	39±3	39±3	37±3	37±3
	60	38±4	38±3	37±3	39±3	37±3
	88	38±4	39±3	36±3	38±3	35±3
	127.4	38±4	39±2	38±2	36±2	34±2
	182.2	38±4	40±3	38±3	39±3	34±3
	258.1	38±4	41±2	40±2	37±2	33±2
	265.4	38±4	43±3	39±3	36±3	30±3
	517.9	38±4	28±3	37±3	35±3	29±3

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