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Impact of Some Heavy Metals on Oxygen Consumption in an Air Breathing Fish, *Channa gachua*

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Abstract

Heavy metal toxicity is a global problem. Impact of heavy metals namely copper sulfate, cadium carbonate, cobalt carbonate, zinc sulfate and lead nitrate on the oxygen consumption of an air breathing fish, *Channa gachua* was undertaken in the present study. The rate of oxygen consumption of the fish was studied at concentrations of 1, 2, 3, 4 and 5 ppm in all metals. The oxygen consumption of treated fish at all doses of chemical was found to be decreased compared to control one. Of all the metals, the maximum decrease of oxygen consumption of fish was recorded under lead nitrate toxicity. The relative magnitude of toxicity of metals to the fish, *Channa gachua* appears to be in the order of lead nitrate > Zinc sulfate > Cadmium carbonate > Cobalt carbonate > Copper sulfate. The present study suggests that the reasons for the differences in the rate of oxygen consumption was due to the toxic action of heavy metals in gills and blood. The degree of interaction of the toxicants are further needed to identify the general characteristics of certain combined pollutants.

Key words : Heavy metals, Oxygen consumption, *Channa gachua.*

Heavy metals have long been recognized as serious pollutants of the aquatic environment as they cause serious impairment in metabolic, physiological and structural system when present in non-permissible concentrations. These may affect organisms directly or indirectly by accumulating in their body or indirectly by transferring into next trophic level of the food chain. Trace metals are introduced into the environment by a wide spectrum of natural and anthropogenic sources. Metals are non-biodegradable and once they enter in the environment, bioconcentration may occur in fish tissue by means of metabolic and bio-absorption process. From the surrounding water, fish may absorb dissolved heavy metals that may accumulate in various tissues and organs and even can be bio-magnified in the food chain through different routes. On global scale metal ions such as copper, zinc, nickel, chromium toxic to living organisms (1). Copper and zinc are essential to sustain life activities but if in excess are potential toxicants affecting the icthyofauna (2, 3).Lead contamination is world wide neurological and hematological problems in young animals including man (4). Cadmium and cobalt are also reported to induce change in oxygen consumption and tissue respiration (5—8). Reports available in the recent years suggest that contamination of fresh water bodies by heavy metals coming though industrial water lead to biological magnification resulting to severe alteration in physiological and biological parameters in fish (9—11). Discharge of effluents into fresh water depletes the dissolved oxygen content and cause heavy fish mortality by interference with respiratory metabolism (12, 13). This paper reports a comparative account of the impact of five heavy metals on oxygen consumption of the fish, *Channa gachua.*

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Methods

Live fish *Channa gachua* were procured from the local fish market at Hazaribag (latitude 25° 59′ N and Longitude 85° 22′ E) and maintained in glass aquaria of size (90 × 60 × 60 cm). The fish were fed on chopped goat liver daily and acclimatized for 15 days in laboratory. Routine oxygen consumption from air and still water was measured in a closed glass

Table 1. Effects of heavy metals on oxygen consumption in *Channa gachua.* Values are mean of ± SD of five individual observations. *Values are significant at 5% level. Degree of Freedom at 4t =2.132.

	Oxygen consumption (ml/kg/h) Concentrations (ppm)									
Doses	1		2		3		4		5	
Name of metal	Control	Treated	Control	Treated	Control	Treated	Control	Treated	Control	Treated
Copper sulfate	1.62 ± 0.17	1.06 ± 0.22 4.076*	1.40 ± 0.06	0.94 ± 0.21 4.282*	1.36 ± 0.19	0.74 ± 0.19 4.755*	1.04 ± 0.30	0.62 ± 0.25 2.654*	1.30 ± 0.90	0.64 ± 0.10 9.838*
Cadmium carbonate	1.34 ± 0.10	0.16 ± 0.14 8.541*	1.24 ± 0.20	0.56 ± 0.10 9.610*	1.16 ± 0.10	0.56 ± 0.14 7.171*	1.12 ± 0.25	0.42 ± 0.25 8.488*	1.14 ± 0.10	0.38 ± 0.12 9.810*
Cobalt carbonate	1.64 ± 0.10	0.76 ± 0.14 10.517*	1.38 ± 0.12	0.68 ± 0.09 9.437*	1.34 ± 0.18	0.66 ± 0.08 10.744*	1.24 ± 0.030	0.66 ± 0.10 9.447*	1.26 ± 0.10	0.44 ± 0.16 8.637*
Zinc sulfate	1.44 ± 0.12	0.70 ± 0.14 8.063*	1.56 ± 0.10	0.56 ± 0.13 12.442*	1.58 ± 0.07	0.58 ± 0.12 13.481*	1.62 ± 0.12	0.54 ± 0.10 13.941*	1.52 ± 0.12	0.52 ± 0.32 10.533*
Lead nitrate	1.44 ± 0.10	0.76 ± 0.14 8.127*	1.62 ± 0.12	0.66 ± 0.10 12.392*	1.54 ± 0.10	0.48 ± 0.12 13.683*	1.72 ± 0.12	0.48 ± 0.10 16.327*	1.70 ± 0.11	0.44 ± 0.10 17.807*

respirometer contained 3 liters of water (initial O_2 content, 6.5 mg O_2/liter, pH, 7.2) and 0.51 ml of air. The fish weight 14—17 g and length 7—10 cm were exposed to different concentrations i.e. 1, 2, 3, 4, and 5 ppm of five chemical compounds namely copper sulfate, cadmium carbonate, cobalt carbonate, zinc sulfate and lead nitrate, which are known to be present in one or other type of industrial effluents. The selection of concentration was based on trial and error basis as this study formed a preliminary ones. Changes in the rate of oxygen consumption of the fish exposed to five concentrations of each chemical were evaluated once a week for four weeks and a control set was maintained regularly. The control and experimental media were renewed for every 24 hours. The rate of oxygen consumption was estimated by employing Winkler's method (14). Results were expressed in ml/kg per/h.

Results and Discussion

The results showed conspicuous changes in the rate of oxygen consumption of the fish *Channa gachua* exposed to different concentrations of copper sulfate, cadium carbonate, cobalt carbonate, zinc sulfate and lead nitrate (Table 1). The rate of oxygen consumption was found to be maximum under 1 ppm whereas it was minimum under 5 ppm of cadmium carbonate, cobalt carbonate, zinc sulfate and lead nitrate. The rate of oxygen consumption was decreased at all the concentrations compared to control. The *t* analysis showed highly significant changes between controls and treated ones.

The oxygen consumption under the treatment of all five chemicals showed marked changes and results indicated that the fish was under toxic stress during the exposure. Respiration is a vital phenomenon of the life and the rate of oxygen consumption in turn controls the metabolic activities. Changes in respiratory rates have been used as the indicator of stress in pollutant exposed organism (15—18). The decrease in oxygen consumption at a higher concentration after increase at intermediate levels of concentration also suggests that there is a temporary stimulation followed by damage in the respiratory epthlelium of gills, alteration in diffusing capacity and decrease or inhibition of enzyme system (19). The fluctuated response in respiration may be attributed to reduction in gill permeability causing a drop in oxygen consumption for which the fish compensates by increasing the ventilation volume. Decrease in oxygen consumption of *Channa gachua* was observed when exposed to copper salt. Metal induced changes in respiration of fish depend on the type of metal, its concentration, experimental conditions, duration of exposure. Metallic mixture was capable of

producing severe damage in gills leading to the death of the fish (20—25). The oxygen consumption is sensitive physiological process and the changes in respiratory activity has been used as a indicator of stress in animals exposed to toxicants. Many workers suggested reason for the reduction of oxygen consumption when fish were exposed to pollutants (26, 27). They have suggested reason for the reduction of oxygen consumption as the coagulation of mucus in the gills which interfere with respiratory metabolism due to abnormality in gills and tissues and due to injury caused to the red blood corpuscles, reduction in RBC count and haemoglobin content.

The reduction in the oxygen consumption of the fish may be due to interference of metals with respiration of *Channa gachua* by coagulation of gill mucus, asphyxiation and inhibition of enzyme system at mitochondrial level and resulted in decrease of oxygen consumption. The increased gulping activity and opercular movement by the fish, *Channa gachua* may be the reflection of an attempt by the fish to extract more oxygen to meet the increased demand to withstand cadmium toxicity. It may also be correlated to the formation of hypoxic condition due to the interference in gaseous exchange caused by the accumulation of mucus on gill epithelium. Cadmium causes gill necrosis in fishes which may also because of decreased in oxygen consumption and increase in ventillation frequency.

The present findings suggests that cadmium produces respiratory distress in fishes and opercular beats per minute can be considered as good biomarker to access the health status of these valuable and air breathing fish and worsening status of aquatic bodies in relation to metallic contaminants particularly heavy metals. A perusal of literature suggests that heavy metals induced alteration in the respiratory function of *Channa gachua* differs not only from metal to metal but also the site of action. Reduced oxygen consumption at higher concentration of heavy metals could also arise as a result of respiratory inhabiting factors that come into play. Our findings are also at par with the previous reports (28, 29).

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