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RESEARCH ARTICLE

NITRITE TOXICITY ON POTASSIUM TO FRESHWATER FISH "*CIRRHINUS MRIGALA*"

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ABSTRACT

The aim of the study was to determine the toxicity of nitrite in exposure of electrolytes (potassium) to freshwater fish Cirrhinus mrigala. Changes in the electrolyte content of fish Cyprinus carpio exposed to sublethal concentration of nitrite for 35 days were presented in Table 1. During subsequent exposure period the potassium level was increased showing a maximum percent increase of 18.61 at the end of 35th day. There were significant ($P< 0.05$) variation among the treatments ($F1, 40= 3322.20$; $P< 0.05$), period ($F 4, 40= 249.37$; $P< 0.05$) and their interactions ($F 4, 40= 84.72$; $P< 0.05$).

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INTRODUCTION

All aquatic organisms maintain an internal environment which is different from their external environment and they regulate the passage of water and solutes between their interior and exterior. The total amount of water retained in a body maintained at constant level, the principal factors controlling the location and the amount of fluid in various compartments are the osmotic forces which are maintained by electrolytes. Nitrite is considered as a disrupter of multiple physiological functions, respiratory, cardiovascular, and excretory processes, including inorganic ion regulation. Nitrite exposure also induces ionoregulatory disturbances in freshwater fish. Furthermore, accumulation of No_2 disturbs K^+ homeostasis. K^+ is the major cation. Potassium (K^+) and Sodium (Na^+) are essential for the regulation of water, electrolyte balance, and acid base balance and to sustain biological life. Potassium is involved in several physiological functions, viz., nerve and muscle function, and osmotic pressure. Potassium (K^+) is considered as macro elements and they are essential to sustain biological life. High intracellular concentration of K^+, regulate the body metabolism, the excitability of nerve and muscle cells, for the substance of osmotic balance and constancy of cell volume. Variations in plasma potassium concentration would have widespread effects on the general body metabolism, altering and resting potential of most cells regulating their metabolism, glycolytic processes and regulating reduction of minerallocorticoids. Any imbalance in the levels of these ions in animals will lead to impairment of various physiological activities (Logasamy *et al*., 2007). Elevated plasma potassium level in fish exposed to heavy metals like chromium and lead in *Salmo gairdneri* and copper in *Prochilus scrofa* has been reported (Cerquiera and fernandes, 2002). Similar, increase in blood K^+ was observed in *Rainbow trout, Oncorhynchus mykiss* exposed to aluminium, in nitrite exposed fish *Cyprinus carpio* (Jensen *et al*., 1987), *Rainbow trout* (Aggregard and Jensen, 2001), *Flounder* (Grosell and Jensen, 2000), *Matriza* (Avilez *et al*., 2004). A decrease in plasma K^+ level was also reported by Cerquiera and Fernandes (2002) in tropical fish *Prochilodus scorfa* and Schjolden *et al*. (2007) and in *Crucian carp*, Folmar *et al*. (1993) in *Lagodon rhomboids* treated with CCL4 and in *Crucian carp*. High intracellular concentration of K^+, regulate the body metabolism, the excitability of nerve and muscle cells, for the substances of osmotic balance and constancy of cell volume. Organic toxicants can increase or decrease plasma Na^+, Cl^- and osmolarity (Ramesh *et al*., 2008). Potassium is lost from skeletal muscles from the red blood cells, leading to extracellular hyperkalemia and K^+ to the environment. The review of literature clearly indicates that nitrite disturbed the ionoregulation in fish and many authors have reported such ionoregulatory failure in fresh water fish. However to our knowledge the impact of nitrite on ionoregulation of Indian major carps are scanty. Hence the objectives of this study was to determine the effect of sublethal nitrite toxicity on

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electrolyte balance of an Indian major carp *Cirrhinus mrigala*. This study also aimed to use these ionic concentrations in blood plasma as potential biomarkers of chemical exposures and effects.

MATERIALS AND METHODS

Estimation of potassium was done by the method Marunan (1958).

RESULTS

Changes in plasma potassium level of fish *Cirrhinus mrigala* treated with sublethal concentration of nitrite for 35 days was given in table 1. Plasma potassium level was found to be increased as the exposure period extended. On day 7 the plasma potassium level was 9.43%. During subsequent exposure period the potassium level was increased showing a maximum percent increase of 18.61 at the end of 35th day. There were significant ($P< 0.05$) variation among the treatments ($F1, 40= 3322.20$; $P< 0.05$), period ($F 4, 40= 249.37$; $P< 0.05$) and their interactions ($F 4, 40= 84.72$; $P< 0.05$).

Table 1. Changes in the Plasma Potassium level of *Cirrhinus mrigala* exposed to sublethal concentration of nitrite for 35 days

S.No	Exposure Period	Control	Experiment	Change %
1	7	7.22±0.043d	7.90±0.020d	+9.43
2	14	7.28±0.024c	8.04±0.005c	+10.41
3	21	7.40±0.020b	8.07±0.004c	+8.99
4	28	7.49±0.002a	8.31±0.005b	+10.85
5	35	7.53±0.037a	8.94±0.026	+18.61

DISCUSSION

Pollution impact on ecosystem and human health is an urgent and international issue since there is an ever increasing number of environmental disturbances likely to effect the biota and human both natural and anthropogenic stress. The assessment of environmental status has become an important issue in the striving for a sustainable society and use of natural resources. The fertilizer, salts and pesticides used extensively in agriculture, are most directly concerned with human health problems as they find their way to aquatic environment through flushing by rains, and disturb the hydro biological characters of the water, inflicting injuries to the aquatic organisms in general and fishes in particular. Freshwater fish can be used as selective bio indicators of trace metals in freshwater reservoirs. Since they not only accumulate metals in their bodies but also react to water contamination with alterations of various vital functions. Growth rate of fish is highly variable, and very sensitive to environmental factors.

Thus, measurements of growth can be used to provide information on fish performance. The growth of fish is associated with changes in morphometric traits, body shape, and in chemical and biochemical body composition. Fish growth depends on water physio-chemical characteristics, and in polluted waters usually decreases (Rowe *et al*, 2003). Potassium content of plasma is most sensitive to changes in plasma cation concentration. But according to Lutz (1972) plasma K^+ is unrelated to all other ions and that it is possibly playing an independent role.

In the present study, acute and sublethal exposure to nitrite showed a marked increase in plasma potassium. The loss of water from the circulation could be in part account for the rise in the plasma electrolytes in *Pseudopleuronectes americanus* during stress. A similar rise in plasma electrolyte level was observed in *Aphaniu dispar* exposed to sublethal mercury level. This may be due to disruption of liver metabolism or damaged intestinal mucosa causing free exchange of ion between gut contents and sub mucosal capillary bed as suggested by Hilmy *et al,*. (1982). The elevation in plasma potassium level in the present study during acute and sublethal period may be due to the loss of water from the circulation or disruption of liver metabolism, as suggested by the above authors.Alternations in the ionic regulation of environmental organisms can be due to stressor affects on the ion regulating organs (Gilles and Raquex 1993). Concentration of plasma potassium level is depressed in *flounder Platichthys flesus* exposed to cadmium has been found to be associated with kidney damage (Larsson *et al*., 1981). Euryhaline teleost *Fundulus heteroclitus* exposed to cadmium suffered from pathological alternations in renal tubules (Gardner and Yevich, 1970). A defective renal function induced by Cr (VI) in rainbow trout *Salmo garidneri* resulted in an impaired reabsorption of potassium and sodium ions in the renal tubules, (Larsson *et al*., (1981) reported a pronounced decrease in potassium level during long term exposure of *Flounders* to acute cadmium stress. In the present study decrease in plasma potassium level indicates the inhibition of the Na^+, K^+, Cl^- due to chromium in *Cyprinus carpio*.

Many authors have observed elevated plasma potassium level in fish exposed to various toxicants in various fish species. However a significant decrease in potassium level was reported by Folmer *et al*. (1993) in *Logodon rhomboids* treated with carbon tetrachloride. The conspicuous increase in the level of K^+ ions in kidney could be attributed to the failure of renal tubular reabsortion of K^+ ions as opined by Gardner and Yevich (1970). The higher K^+ content in tissue might be indicative of active protein synthesis (Satosker, 1993). An elevation in K^+ and Mg^{2+} ions was found by Malte (1996) in *Rainbow trout*, *Salmo gairdneri*. Wood *et al*. (1990) in *trout Salvelinus fontinalis* when treated with aluminum. One of the reasons for hyperkalemia also occurs in shock conditions such as endosulfan stress. Potassium content of plasma is most sensitive to changes in plasma anion concentration. Nitrite exposure has been reported to alter ionic homeostasis in fish (Jensen, 2003). In terms of K^+ ion concentration, exposure to nitrite has been demonstrated to cause extracellular hyperkalemia, Matrinza (Avilez *et al*., 2004).

But according to Lutz (1972), plasma K^+ is unrelated to all other ions which would possibly indicate that it is playing an independent role and significant effects of hypokalemia are cardiac failure, muscle weakness and paralysis. In present study the observed increase in plasma potassium ion during acute and sublethal treatment indicate K^+ efflux from skeletal muscle tissue, leading to extracellular hyperkalemia, which has been described as a common symptom of nitrite toxicity episodes in several fish species (Grosell and Jensen, 2000; Jensen, 2003). The potassium contents are especially involved in various segments of protein and carbohydrate metabolism and also in maintaining the integrity of cells. Potassium content of plasma is most sensitive to changes in plasma anion concentration.

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