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Effect of chromium on protein metabolism of fresh water mussel, *Lamellidens marginalis*

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Abstract: *Effect of sub-lethal concentration of chromium was studied on the protein metabolism in adductor muscle, gill and mantle tissues of fresh water mussel, Lamellidens marginalis. Total proteins and RNA showed a decrease while free amino acids and protease activity showed an increase. Alanine and Aspartate aminotransferase activities showed an increase, while GDH activity showed a decrease. It may be suggested that the proteins are degraded and the amino acids are incorporated into TCA cycle to augment the energy needs of the organism due to chromium toxicity.*

Key words: *Chromium toxicity*, *L. marginalis, Protein metabolism, Amino transferases, GDH.*

Introduction

Indiscriminate disposal of industrial effluents into water bodies leads to the contamination of aquatic environment with heavy metals as they can not be removed or non-biodegradable. They pose a severe threat to aquatic organisms, which form important members of food chain of man. Chromium is an essential element in trace amounts, however, it is toxic above permissible limits (Sreenath *et al.,* 2003). It is widely used in metallurgic, refractory, chemical and tannery industries. Tanneries are the major industries that use chromium for the treatment of leather and nearly 40% of the chromium used is released into the environment as sludge which contaminates surface water as well as ground water (Kamaludeen *et al.,* 2003).

Much of the information available on chromium relates to survey of water resources (Rajendrababu and Nandakumar, 1982) and metabolic studies on fishes (Arillo *et al.,* 1982; Pamila *et al*., 1991). There is paucity of information on the effect of hexavalent chromium on the metabolism of bivalves. The present study deals with the effect of chromium on certain aspects of protein metabolism of *L. marginalis*.

Materials and Methods

Fresh water mussels *Lamellidens marginalis*, were obtained from local ponds and maintained in the laboratory. They were allowed to acclimatize to the laboratory conditions for 10 days before experimentation. In order to determine the LC_{50}, the mussels were exposed to eight different concentrations of potassium chromate for 72 hr. LC_{50} value calculated according to the method of Finney, (1964), was 11.74 mg/l and one third of the LC_{50} was taken as sublethal as suggested by Konar (1969). After the exposure to sub-lethal concentration for 72 hr, mussels were sacrificed and the tissues namely adductor muscle, gill and mantle were isolated and used for biochemical estimation. Proteins were estimated by the method of Lowry *et al.* (1951), free amino acids by the method of Moore and Stein (1954), RNA by the method of Dische (1955), protease activity as suggested by Krishnamoorthy (1971), ALAT (Alanine aminotransferase) and AAT (Aspartate aminotransferae) activities were estimated according to the method of Reitman and Frankel (1957) and GDH (Glutamate Dehydrogenase) activity by Lee and Lardy (1965). Results were subjected to statistical analysis by using student's 't' test for significance.

Results and Discussion

The levels of total protein, free amino acids and RNA are shown in Table 1. Total protein content decreased on exposure to chromium in all the three tissues studied. The decrease is more pronounced in gill followed by adductor muscle and mantle. Decreases in protein content of fish after exposure to nickel (Desai *et al.*, 2002) and copper (Indra and Ramalingam, 1996) were reported. The free amino acid levels of the mussel increased in all the tissues studied. The increase is more in mantle followed by adductor muscle and gill. Similar trend in amino acid levels were reported in snail exposed to nickel (David *et al.*, 2003). RNA levels on the other hand showed a decrease in the tissues exposed to chromium. The decrease in protein along with an increase in the levels of free amino acids and decrease in the levels of RNA might indicate an increased catabolism of protein and decreased synthesis. Protease activity, alanine aminotransferase and aspartate aminotransferase and glutamate dehydrogenase activities are shown in the Table 2. Protease activity increased in the tissues of mussel after exposure to chromium. Increase in protease activity is reflected in the decrease in protein content and increase in the levels of amino acids in the present study.

Aminotransferases are important as they convert amino acids into ketoacids and incorporate them in to TCA cycle. Both ALAT and AAT levels increased in tissues of *L. marginalis* suggesting the conversion of aminoacids released by the proteolysis into ketoacids for energy production. Glutamate

Table – 1: Levels of total protein, free aminoacids and RNA in selected tissues of *L. marginalis* exposed to sublethal concentration of chromium.

Tissue	Total protein		Free amino acids		RNA	
	Control	Exposed	Control	Exposed	Control	Exposed
Adductor muscle	162.1 ± 14.0	123.1± 10.0 (-24.05)*	14.96 ± 1.1	17.46±5.0 (+16.71)	6.24 ± 0.6	4.67± 0.4 (-25.1) *
Gill	11.4 ± 6.7	80.90 ± 14.0(-27.3)*	10.60 ± 0.2	11.28± 0.4 (+ 7.02)*	75.4 ± 3.0	47.6 ± 0.6 (-36)*
Mantle	89.5 ± 6.1	70.2 ± 6.10(-21.6)*	6.56 ± 6.3	83.2± 10.0 (+ 26)*	42.9 ± 0.3	31.6± 0.4 (-26)*

Values expressed as mg/g wet weight of the tissue. Each value is mean ± S.D of six individual observations. '+' and '-' indicate percent increase or decrease over control .
*Statistically significant at 5% level.

Table – 2: Levels of protease, ALAT, AAT and GDH activities in selected tissues of *L.marginalis* exposed to sublethal concentration of chromium.

Tissue	Protease (μ moles of tyorosine / g/hr)		ALAT (μ moles of pyruvate / g/hr)		AAT (μ moles of pyruvate/ g/hr)		G.D.H (μ moles of formazan/ g/hr)	
	Control	Exposed	Control	Exposed	Control	Exposed	Control	Exposed
Adductor muscle	20.45 ± 0.34	23.10 ± 0.40 (+ 13.00)*	78.08 ± 9.1	97.30 ± 8.5 (+24.6)*	73.08 ± 9.2	104.72 ± 8.2 (+ 43.2)*	25.3 + 2.5	22.5 ± 3.2 (-11.6)*
Gill	1.117 ± 0.25	1.33 ± 0.4 (+ 19.5)*	45.45 ± 6.8	61.68 ± 11.8 (+ 35.7)	31.63 ± 2.0	48.48 ± 5.32 (+ 53.2)*	17.7 ± 4.6	11.4 ± 3.0 (-35.6)*
Mantle	1.45 ± 0.29	1.90 ± 0.5 (+ 31.8)*	43.47 ± 8.8	64.82 ± 10.7 (+ 49.1)*	36.12 ± 4.5	49.25 ± 5.6 (+ 36.5)	34.0 ± 4.0	12.0 ± 1.1 (-64.7)*

Values are mean ± SD of 6 observations. '+' or '–' indicate percent decrease or increase over control.
* Significant at 5% level.

dehydrogenase activity decreased in all the three tissues of mussel exposed to chromium. Decrease in GDH activity suggests a decrease in the incorporation of glutamate into TCA cycle. GDH is involved in oxidative deamination of glutamate liberating ammonia. Since ammonia is toxic to organism, the mussel might have adapted to less toxic state as reflected by a decrease in GDH activity.

Increase in protease activity, decrease in protein level and increase in amino acid levels suggest degradation of proteins. Increased levels of ALAT and AAT activities indicate the conversion of liberated amino acids into keto acids for energy production. Decrease in GDH activity suggests the organism's adaptation to avoid ammonia toxicity.

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