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TOXICITY OF ARSENIC ON SUCCINIC DEHYDROGENASE ACTIVITY IN *LABEO ROHITA* (HAMILTON)

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ABSTRACT

The freshwater fish, *Labeo rohita*, treated with two different sublethal concentrations (1/10 and 1/3 of the 96 hr LC_{50}) of arsenic, have revealed a significant decrease in the succinic dehydrogenase (SDH) activity in liver and muscle tissues throughout the period of 28 days of exposure. With the decline of SDH activity, the metabolic pathway has turned anaerobic to meet the increased energy demands during arsenic stress.

INTRODUCTION

Study of toxicology pertaining to aquatic animals has become an important field with respect to water pollution. Nowadays, indiscriminate discharge of heavy metals through industrial effluents and other sources into aquatic waters affects fishes and prawns, which are of importance to man (Joshi et al. 2002). There are many heavy metals, which are harmful to human beings. Among these, arsenic compounds are known to be toxic to human beings as well as fishes. The toxicological studies point out that the enzymes are the common target of the toxicants. Enzymes are the functional units of metabolism (Lehninger 1984). Sakthivel et al. (1991) have stated that the oxidative enzymes play a vital role in respiratory metabolism. Succinic dehydrogenase is one of the important oxidative enzymes in the tricarboxylic (TCA) cycle.

Karuppasamy (1999) has studied the inhibitory effect of phenyl mercuric acetate (PMA) in SDH activity in liver, muscle, kidney and gill tissues the of fish, *Channa punctatus* under short term and long term exposures. Sivaprasada Rao & Ramana Rao (1979) have reported the inhibition of SDH activity level in the liver, muscle and gill in fish after exposure to methyl parathion. However, there is no clear picture about the effect of arsenic on the enzyme system of fish. Therefore, the present investigation was carried out in the fish, *Labeo rohita*, to ascertain the enzymatic changes in the tissues when exposed to lower and higher sublethal concentrations of arsenic.

MATERIALS AND METHODS

Freshwater fish, *Labeo rohita*, ranging from 10-12 cm in length and weighing between 9 and 14 g, were collected from a fish farm located in Puthur, and acclimatised under laboratory conditions (29 ±1° C). The fish were fed daily with oilless groundnut cake. The unused food was removed after 2 hours and water was changed daily. Prior to experimentation, the fish were acclimatized to experimental tanks for at least one week. The LC_{50} values were determined by the method of Finney (1971). Sublethal studies are helpful to assess the response of the test organism under augmented stress caused by metals. As per Konar (1979) and Sprague (1971), one-tenth (0.27 ppm) and one-third (0.91 ppm) of the 96 hr LC_{50} values of arsenic trioxide were selected for the present investigation as sublethal concentrations. The fish were exposed to these concentrations for a period

of 7, 14, 21 and 28 days. The toxicant water and normal water were renewed everyday. The fishes were scarified after each exposure period and SDH activity levels of liver and muscle were estimated. Succinate dehydrogenase activity level was estimated by the method of Nachales et al. (1960).

RESULTS

The SDH level in the different tissues of control and arsenic treated fish, *Labeo rohita*, are presented in Table 1.

Liver: A consistent reduction in the SDH activity has been observed in liver of the fish exposed to arsenic. The decrease in SDH activity is evident on fish after lower and higher sublethal concentration exposure. The percent decrease over the control after 7, 14, 21 and 28 days of arsenic exposure was 10.86, 14.05, 27.17 and 45.40 at lower sublethal concentration whereas it was 22.82, 31.35, 46.20 and 61.62 at higher sublethal concentration.

Muscle: In the fish exposed to arsenic, the level of SDH activity in the muscle has also decreased at all exposure periods. The magnitude of reduction over control was 10.00, 13.58, 21.25 and 28.39 percent at lower concentration and 23.75, 35.80, 41.25 and 50.62 percent at higher sublethal concentration after 7, 14, 21 and 28 days of exposure periods respectively. The inhibitions were statistically significant in both the tissues at the two sublethal concentrations at all the exposure periods.

DISCUSSION

In the present investigation, a significant decrease in SDH activity has been observed in the liver and muscle of *Labeo rohita* exposed to lower and higher sublethal concentrations of arsenic after the period of 7 , 14 , 21 and 28 days. Similar inhibition of SDH activity has been reported for *Cyprinus*

Table 1: Effects of lower and higher sublethal concentrations of arsenic on SDH enzyme activity levels in liver and muscle tissues of *Labeo rohita* at different periods.

Tissues	Group	Exposure period in days				F value
		7	14	21	28	
Liver	C	0.184 ± 0.0026	0.185±0.0008	0.184 ± 0.0003	0.185 ± 0.0022	0.101 NS
	LC	0.164 ± 0.0017 (-10.86)	0.159 ± 0.0030 (-14.05)	0.134 ± 0.0213 (-27.17)	0.101 ± 0.002 (-45.40)	152.10 *
	HC	0.142 ± 0.0017 (-22.82)	0.127 ± 0.0013 (-31.35)	0.099 ± 0.002 (-46.20)	0.071 ± 0.0014 (-61.62)	86.90 *
Muscle	C	0.080 ± 0.0015	0.081 ± 0.003	0.080 ± 0.0.0012	0.181 ± 0.0017	0.240 NS
	LC	0.072 ± 0.0015 (-10.00)	0.070 ± 0.0021 (-13.58)	0.063 ± 0.007 (-21.25)	0.581 ± 0.0008 (-28.39)	31.12 *
	HC	0.061 ± 0.022 (-23.75)	0.052 ± 0.003 (-35.80)	0.047 ± 0.0062 (-41.25)	0.040 ± 0.0004 (-50.62)	57.07 *

C - Control; LC - Lower sublethal concentration
HC - Higher sublethal concentration
Mean ± S.E. indicates the mean of six individual observations.
(+/-) indicates the percent increase/decrease over the control.
Values are expressed in mmole formazan formed/mg protein/hr
NS - Non significant
* indicates significant at 5% level of F test.

carpio due to industrial effluent (Sakthivel et al. 1991), *Etroplus suratenis* exposed to mercury (Magendran 1990) and *Anabas testudineus* exposed to lethal concentration of disyston and furadon (Bakthavathsalam 1980).

James et al. (1995) have observed the inhibitory effect of mercury on SDH activity in gill, liver and muscle tissues of fish *Heteropneustes fossilis*. The marginal inhibition of SDH activity has been observed in liver and muscle of *H. fossilis* exposed to cadmium throughout the exposure period of two months (Sastry & Subhadra 1982). Decline of SDH activity in liver and muscle has been reported in *Tilapia mossambica* exposed to sevin and sumithion in *Saccobronchus fossilis* (Koundinya & Ramamurthi 1978, Verma et al. 1980). A significant reduction in the levels of SDH activity was reported in liver, muscle and gills of *Hypothalmithys molitrix* when exposed to mercury (Jagadeesan & Jabanesan 1998).

Shobha Rani et al. (2000) have stated that there is a decrease in SDH activity in the liver, muscle and gill of *Tilapia mossambica* when exposed to arsenite. Inhibition of SDH activity has been studied in the muscle of *Anabas testudineus* exposed to lethal concentration of disyston and furadon (Bakthavathsalam 1980), *Channa striatus* exposed to metasystox (Natarajan 1981), *Channa punctatus* exposed to benzene hexachloride (BHC) (Priscilla 1985), and in liver and muscle of *Oreochromis mossambicus* exposed to ethofenprox (Muniyan 1999).

Decreased SDH activity in liver of *Mystus vittatus* after exposure to median lethal concentration of copper may be accounted for as the fish depends more on anaerobic metabolic pathway for its energy needs under heavy metal toxic stress (Rajamanickam 1992). The suppression of SDH activity in *Oreochromis mossambicus* indicates impairment of oxidative metabolic cycle and hence relies on anaerobic glycolysis to meet its energy demands (James et al. 1992). In the present study, during exposure to lower and higher sublethal levels of arsenic, the activity of SDH enzymes in liver and muscle tissues of the fish has got inhibited. These results indicate that there is a shift in the metabolism towards anaerobiosis at the tissue level during arsenic exposure. Further, results of the present study are in agreement with those of Karuppasamy (1999) in *Channa punctatus*, Muniyan (1999) in *Oreochromis mossambicus* and Indra et al. (1999) in *Polypedates maculatus*.

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