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Research Article

Exposure of Cadmium Chloride and Toxicity Stress on *Barytelphusa Gureini*

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Abstract: Toxicity of cadmium on some metabolic processes can lead to disturbances and imbalance of various physiological activities. The present study reflects the effect of cadmium chloride on carbohydrates in some vital organs of the fresh water crab *Barytelphusa gureini***.** The crabs were treated with different concentrations of cadmium chloride (2.0, 4.0, 6.0. 8.0, and 10.0 µg/mL) mortality rate was noted up to 96 h. After deducing the LC50 they were treated with sub lethal concentration of cadmium chloride (6.7µg/mL) for 24, 48, 72 and 96 h. The carbohydrates were estimated to study the stress caused by the cadmium chloride as a toxicant. The results showed a significant decline in the total carbohydrates in different organs and the order of the decline found to be hepatopancreas (66.2%) > muscle (62.0%) > hemolymph (powder form) (59.4%) > gill (52.2%) > gonad (48.4%) at sub lethal concentration of cadmium chloride. In contrast, there was an increase in the carbohydrate in various organs of control crabs viz gonad (0.036mg/100mg) < gills (0.070mg/100mg) < hemolymph (powder form) (0.074mg/100mg) < muscle (0.173mg/100mg) < hepatopancreas (0.211mg/100mg). The significant role of cadmium chloride in some vital organs of the experimental animal is discussed and the results correlated and corroborated with the findings of the earlier researchers.
Keywords: *Barytelphusa gureini*, Cadmium chloride, Carbohydrate, Toxicity

INTRODUCTION

Cadmium is a ubiquitous, non essential element which possesses high toxicity to both human and aquatic organisms. It is classified as the second most dangerous metal in our environment. It occurs naturally in the environment and in insignificant amount. In the recent past, its concentration in aquatic systems is steadily and considerably increasing due to anthropogenic activities [1]. Its deleterious effects on aquatic flora and fauna by adverse effect on various physiological, biochemical and cellular processes have been reported [2].

Cadmium toxicity has become the focus of intense research globally next to mercury as the most notorious of heavy metal pollutant. After absorption into the gastro-intestinal tract it is transferred to the liver, kidney and finally excreted via urine. It becomes toxic when it is not metabolized by the body and accumulates in soft tissues, liver, kidneys and mostly as metalloprotein [3]. Cadmium toxicity to aquatic ectotherms depends on complex biochemical interaction and a balance between rates of absorption, detoxification and excretion.

It has been found that cadmium could change glycogen reserves and serum glucose levels in aquatic animals by affecting the activities of liver enzymes that have pivotal role in the carbohydrate metabolism such as gluconeogenesis, glycogenesis and glycolysis. Thus, the several biochemical parameters of aquatic animals could be used as an indicator of heavy metal toxicity and health status of aquatic population.

The *B. gureini* is well known for its high nutritive value and is commonly cultured by the local farmers. Cadmium causes instantaneous physiological disorders and alteration in the pathways of carbohydrate metabolism in tissues and organs. Biochemical parameters are the best indicator of stress caused by heavy metals and thus toxicity testing becomes an essential tool for assessing the effect and fate of a toxicant. Therefore, the studies were conducted to estimate the toxicity and variations in carbohydrate levels, in *B. gurieni* exposed to cadmium.

MATERIALS AND METHODS

Experimental animals

Adult specimens of fresh water crab *Barytelphusa gureini* were collected from the outskirts of paddy fields of Pune district (Maharashtra), and were brought to the laboratory. They were acclimatized in the laboratory for seven days before they were used for experimentation. Only healthy crabs weighing

between 30-40 grams and almost equal in size were selected for experimentation. The animals were fed with small pieces of goat flesh and un cocked oats. The physico-chemical parameters of water were estimated and were as follows [4]: dissolved oxygen: 7.2 -7.4 ppm, pH 7.0 - 7.2, temperature: 29 ± 2.^{0}c, salinity: 0.4 - 0.5 µg/mL, and total hardness: 280 - 288 mg/L.

Toxicity bioassay

The acclimated crabs of equal size were divided into five experimental groups of ten crab each and treated with different concentrations of cadmium chloride (2.0, 4.0, 6.0, 8.0 and 10.0 µg/mL) respectively. The mortality rate was noted up to 96 hours, the test medium and dead crabs were removed after every 24 hours of an interval. The Lc 50 was calculated by using Probit analysis [5]. After finding Lc50, the crabs were treated with a sub lethal concentration of cadmium chloride (6.7µg/mL) for 24, 48, 72 and 96 hours respectively. The other group of crabs kept as control. Each group of crabs maintained in plastic trough of 30 liter capacity and was starved for 24 hours, prior and during the course of experiment for the estimation of carbohydrates. The water was changed at regular intervals along with waste feed and faecal material. The estimation of carbohydrate was carried out by Anthrone method. The concentration of carbohydrates was expressed in mg/100mg wet weight of organs and in percentage.

Statistical analysis

The two way analysis of variance (ANOVA) was used to test the differences between two groups. Significance of differences assessed at P< 0.05 level. Thus the results were found to be statistically not significant.

RESULTS

The biochemical response of cadmium chloride in fresh water crabs were studied by exposure to a sub lethal concentration 6.7 µg/mL for 24, 48, 72 and 96 h. The Table 1 reveals that there was a significant decline in the concentration of carbohydrates in various organs of the crab: hepatopancreas (66.2%) > muscle (62.0%) > hemolymph (powder form) (59.4%) > gills (52.2%) gonad > (48.4%). The table 2 check showed that there has been a significant increase in the carbohydrate (mg/100 mg) in various organs of controlled crabs in the following order: gonad (0.036mg/100mg) < gills (0.070mg/100mg) < hemolymph (powder form) (0.074mg/100mg)< muscle (0.173mg/100mg) < hepatopancreas (0.211mg/100mg).

Table 1: Carbohydrate content in the various organs of controlled *Barytelphusa gureini*

Concentration of carbohydrate (mg/100mg wet weight)					
Organs	**Control**	**24 hrs**	**48 hrs**	**72 hrs**	**96 hrs**
Hepato pancreas	0.675±0.08	0.610±0.04	0.542±0.08	0.374±0.11	0.211±0.20
Muscle	0.602±0.26	0.502±0.08	0.424±0.00	0.332±0.03	0.173±0.03
Hemolymph	0.324±0.02	0.280±0.04	0.202±0.03	0.180±0.02	0.074±0.00
Gill	0.280±0.05	0.212±0.04	0.126±0.03	0.090±0.02	0.070±0.11
Gonad	0.155±0.04	0.102±0.04	0.092±0.04	0.062±0.03	0.036±0.01

Table 2: Total carbohydrate content (%) in various organs of exposed *Barytelphusa gurieni*

Organ	Exposue time	Control mean ± S.D	Treated mean ± S.D	Paired t test values	P values	Decrease %
Hepatopancreas	0-96 hr	0.675±0.08	0.547±0.01	5.415	< 0.05	66.2
Muscle	0-96 hr	0.602±0.26	0.522±0.01	5.292	< 0.05	62.0
Hemolymph	0-96 hr	0.324±0.02	0.286±0.02	2.886	< 0.05	59.4
Gill	0-96 hr	0.280±0.05	0.235±0.03	2.390	< 0.05	52.2
Gonad	0-96 hr	0.155±0.04	0.128±0.00	1.268	< 0.05	48.4

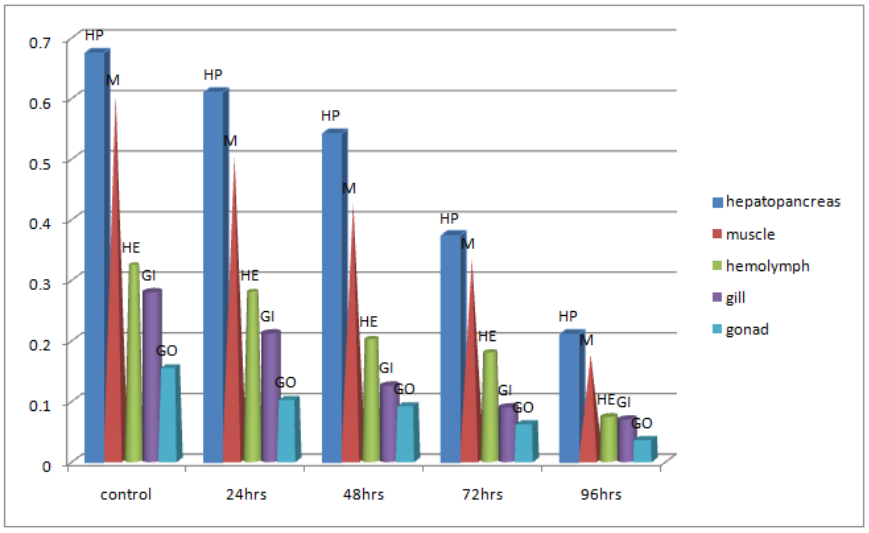


Fig. 1: Carbohydrate content in various organs of controlled *Barytelphusa gureini*

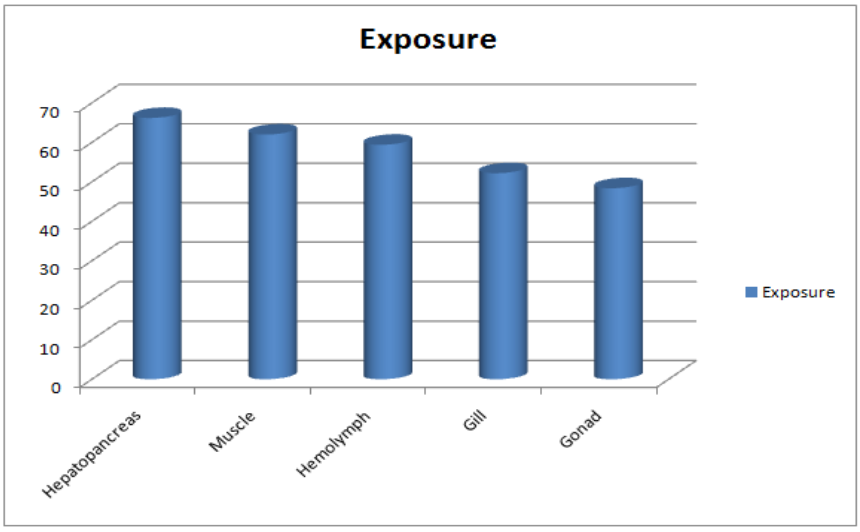
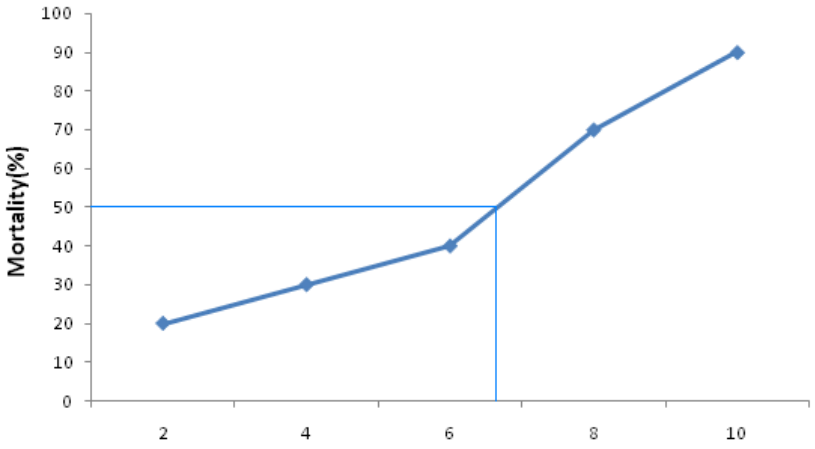


Fig. 2: Total carbohydrate content (%) in various organs of exposed *Barytelphusa gurieni*



Concentration(µg/mL)

Fig. 3: Mortality against concentration

DISCUSSION

Hepatopancreas, muscle and hemolymph

Carbohydrates play a very important role as a reserved food material in form of glycogen. Any stress is found to change the course of events associated with carbohydrate synthesis. Carbohydrates also contribute to energy production as they are having high calorific value. It plays a vital role during the biochemical adaptation of animals to stress conditions. Heavy metal contamination exerts an extra stress on metabolically active tissues and organs. Heavy metals can increase or decrease total carbohydrates depending on the species of crabs, concentration and duration of exposure. Majority of crabs undergo a period of natural depletion of carbohydrates for a part of their life cycle. Carbohydrate, an important cellular content and energy rich compound was quantitatively assessed in the present investigation in various organs of *Barytelphusa gureini* namely hepatopancreas, muscle, hemolymph (powder form), gills and gonad.

The hepatopancreas is an important organ performing vital functions including glycogen storage, bio transformation, migration of lipids, release of glucose into the hemolymph, contains many enzymes and proteins. Heavy metal chelating may disrupt the hepatopancreas tissues by disintegrating the functional and structural properties of the cells. Hepatopancreas and muscle, being the organs for inter conversion and storage of food stuff and a centre of all oxidative and detoxification mechanisms shows maximum alteration in its tissues and chemical composition. Hepatopancreas is concerned with storage and export of hexose units for maintenance of glucose in hemolymph and that of muscle glycogen to act as a readily available source of hexose units for glycolysis within the muscle itself [6].

The activity of the enzyme phosphorylase in the hepatopancreas and muscle was found to reduce the carbohydrate level in the crab *Oziotelphusa senex senex* [7]. Lorenzon *et al*., [8] reported the changes in the haemolymph glucose level in the shrimp *Palaemon elegans* due to heavy metal toxicity. Decrease in carbohydrate content was observed in the tissues of the marine prawn *Metapenaeus monoceeros* exposed to pesticide methyl parathion [9]. Stimulation of glycogenolysis was observed in the crab *Oziotelphusa senex senex* on exposure to cadium [10]. Depletion of hemolymph glucose, tissue glycogen and total free sugars were observed in *B.guerini* in response to chromium [6]. Decline in glycogen content was observed in *B. guerini* in response to zinc sulphate [11]. Significant changes observed in the catabolism of carbohydrate in the tissues of the marine prawn, *Metapenaeus monoceros* exposed to methyl parathion [12]. The carbohydrate content was found decreased in *Scylla serrata* in response to cadmium toxicityand in *U.annulipes* exposed to cadmium and mercury [13, 14]. DDT and Lead acetate bring changes in the glucose level in the fresh water prawn *Macrobrachium kistensis* [15]. Significant decrease in glucose and glycogen levels has been reported in the muscle and hepatopancreas of the cray fish *Porcamarus clarkia* exposed to cadmium toxicity [16].

In the present investigation *Barytelphusa gureini* exposed to sub lethal concentration of cadmium chloride showed decrease carbohydrate in hepatopancreas, muscle and hemolymph, while in control the carbohydrate level was found to be highest in hepatopancreas, as it is the chief organ of carbohydrate metabolism followed by muscle and hemolymph. The observed reduction in carbohydrate level in hepatopancreas, muscle and hemolymph of the experimenatal crab could be due to glycogenolysis of hepatopancreas and muscles glycogens or inhibited glycolytic pathway. Tissue acidosis due to reduced oxygen transport may favoured the process of glycogenolysis in the tissues of the experimental animal. Further, the decrease in carbohydrate may also be due to hypoxia, since hypoxia increases carbohydrate consumption. The depletion of carbohydrate in the *Barytelphusa gureini* may be due to its rapid utilization to meet the energy demands under the impact of cadmium chloride and thereby decreasing its nutritive value.

Ovary and gill

Declined in glycogen contents was reported in ovary, gill and muscle of *Barytelphusa guerini* exposed to zinc sulphate[11]. Similar results were observed in *Scylla serrata* in response to cadmium toxicity [13]. Mane and Kulkarni [17] reported significant decrease in the glycogen content in vital organs of bivalve, *Lamelidens marginalis.* Kharat *et al*., [18] revealed the lethal concentrations of TBTCl produced a significant decrease in glycogen content of ovary, gill and muscle in *Macrobrachium kistnensis.* Suresh [14] has reported the depletion in glycogen content in *U. annulipes* exposed to cadmium and mercury. Mali [19] observed decline in glycogen content in muscle, gill and hepatopancreas of freshwater crab, *Barytelphusa guerini* when exposed to copper sulphate. Vijayavel [20] studied the effect of naphthalene on carbohydrate metabolism of crab, *Scylla tranquebarica* and found depletion in carbohydrate level in various organs.

Carbohydrate is an important source of energy and a biochemical constituent of ovary, its role in ovarian growth, oogonium multiplication, oocyte enlargement and yolk protein synthesis is very prominent. It was observed that female gonads acquire highest amount of carbohydrates for ripening. A number of workers reported the increased uptake of triglycerides and carbohydrate in the ovary with the advancement of ovarian growth in *Platichthys flesus* [21]. Deposition of triglycerides, phospholipids and

carbohydrates were also observed in the ovary of *Heteropneustus fossilis* [22]. In the present investigation carbohydrate in ovary was lesser than other organs both in treated and controlled *Barytelphusa gureini.* It is suggested that the carbohydrate is utilized as a source of energy in the ovary for the ripening of gonadal cells.and yolk protein synthesis.

Toxicants are excreted by one or more of the routes such as the body surface, gut wall, gills and fecal matter. They induces alteration in gill structure, disintegration, rupture of respiratory epithelium and agglutination of mucus film over the gill surface of exposed animals. It is of the opinion of author that decline in carbohydrate content in gills of the present experimental crab, *Barytelphusa gureini* may be due to utilization of energy for combating the stress and hypoxic condition caused by cadmium chloride which result in extra expenditure of carbohydrate. It is further suggested that the carbohydrate may be consumed as a source of energy in the repair of alteration of gill structure, wear and tear of gill epithelium, removal of mucus film over the gill surface and excretion of cadmium chloride under stress condition.

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