IF : 4.547 | IC Value 80.26

VOLUME-6, ISSUE-6, JUNE-2017 • ISSN No 2277 - 8160

Original Research Paper

Zoology

CHROMIUM, AN INDUSTRIAL EFFLUENT INDUCED CHANGES IN CARBOHYDRATE METABOLISM IN FRESHWATER CARP FISH CATLA CATLA

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ABSTRACT Catla catla, the major fresh water carp fish is a very rich source of protens, carbohydrates and lipids, because of its high nutritive value it has great demand in the market. Chromium, an industrial effluent from electroplating, paints, dye industries etc., into the fresh water aquatic habitats leads to bioaccumulation affecting human health through biomagnifications. The present study evaluates toxicity of trivalent and hexavalent chromium on biochemical constituents like blood glucose, liver and muscle glycogen content in Catla catla exposed to sublethal concentrations for various periods (1, 8, 16 and 32days). In carbohydrate metabolism, the blood glucose level significantly decreased at day1and 8 in the fish exposed to trivalent chromium, But a significant increase and decrease was observed at days 16and32. In the fish exposed to hexavalent chromium also a significant decrease in the blood glucose was observed at day 1 and 8 followed by a significant increase at day 16 and decrease at day 32. The liver and muscle glycogen level decreased at all exposure periods in fish exposed to both trivalent and hexavalent chromium except at day 32 of trivalent chromium there is an insignificant increase was observed.

KEYWORDS : Chromium, Biochemical parameters, sublethal studies, Catla catla.

INTRODUCTION

The contamination of freshwater with a broad spectrum of pollutants has become a matter of concern all over the world (Voegborlo et al., 1999; Vutukuru, 2005; Rauf et al., 2009). Of the total environment that is disturbed, aquatic system is one of the worst affected. Million tons of toxicants like metallic wastes, phenols, aldehydes, ketones, amines cyanides plasticizers, toxic acids, corrosive alkalies, dyes, biocides, radioactive wastes and thermal pollutants are entering into the aquatic environment. Heavy metals constitute a core group of aquatic pollutants and additional concentrations of these metals accumulate in the aquatic ecosystems as a result of land-based activities (Vutukuru, S. S., 2003). Aquatic organisms have the ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air depositions of dust and aerosol, and discharges of waste water (Labonne et al., 2001; Goodwin et al., 2003). Heavy metals can also adversely affect the growth rate in major carps (Hayat et al., 2007).

Chromium is a naturally occurring element found in rocks, animals, plants and soil predominantly in its insoluble trivalent form. In aquatic environments the major sources of chromium are the electroplating and metal finishing industries and publicly owned treatment plants. Relatively minor sources are iron and steel foundries inorganic chemical plants, tanneries, textile manufacturing runoff from urban and residential areas (Towill et al. 1978, Ecological analysts 1981). Intense industrialization and other anthropogenic activities have led to the global occurrence of soluble Hexavalent chromium which is readily leached from soil to ground water or surface water in concentrations above permissible levels. The ecotoxicology of hexavalent chromium is linked to its environmental persistence and the ability to induce a variety of adverse effects in biological systems, in aquatic ecosystems Hexavalent chromium exposure poses a significant threat to aquatic life. The health hazards associated with exposure to chromium are dependent on its oxidation state ranging from, trivalent low toxicity of the metal form to the high toxicity of Hexavalent form. Trivalent chromium plays an important role in glucose metabolism by serving as a cofactor for insulin action. The different oxidation states of Cr exhibit different levels of toxicity. Cr (VI) also has the potential to be carcinogenic. Occupational exposure to Cr species is of concern since they have been linked to respiratory, renal and dermatological disorders.

Catla catla (Hamilton, 1822), the Indian major carp is an economically important edible fish, having a great commercial value, occurs abundantly in fresh water tanks and ponds native to India, Bangladesh, Myanmar, Nepal, Pakistan and introduced in many other countries as exotic species. . Catla catla is a very rich source of proteins, carbohydrates and lipids and is reported to attain a maximum size of 182 cm and weight of about 50 Kilograms (may vary). It is a surface and mid-water feeder, mainly omnivorous with juveniles feeding on aquatic and terrestrial insects, detritus and phytoplankton. It has a characteristically large, upturned mouth with a prominent protruding jaw. Because of its high nutritive value, it is a highly priced food fish and of great demand in the market.

Unfortunately less attention has been paid on the acute and sublethal effects of metal pollution particularly in these xenobiotics. In view of this an attempt has been made in the present investigation to study the sublethal effects of trivalent and hexavalent chromium on biochemical analysis which includes some aspects of carbohydrate metabolism, such as blood glucose levels, liver and muscle glycogen levels in the selected fresh water teleost fish, Catla catla.

MATERIALS AND METHODS

Catla catla were collected from the department of fisheries, Anantapur, Andra Pradesh, and were immediately transported in big fish containers to the laboratory. Then they were released into large cement tanks contained of chlorinated tap water. The fish were fed with commercial fish pellets having around 40% protein content, and allowed to acclimatize for 15 days. Then the fish were isolated into batches having weight of 10±2gms were maintained in static water without any flow. Water was renewed every day to provide fresh water rich in oxygen. During experimentation water was aerated once a day to prevent hypoxic conditions. As the level of toxicity reported to vary with the interference of extrinsic and intrinsic factors like temperature, salinity, PH, hardness of water, exposure period, density of the animals, size, sex etc., (Sivaramakrishna et al., 1991), and precautions were taken throughout this investigation to control all these factors as far as possible.

Lethal concentration (LC50) of chromium chloride (trivalent chromium) to fish Catla catla was determined by "Probit method" of Finney (1971). Based on the fact that the effect of a metal on fish becomes consistent within 96 hour of exposure (Eisler, 1977), LC50S/96 hours of trivalent and hexavalent chromium are considered as lethal concentrations. The LC50/96 hrs of hexavalent chromium (K2Cr2O7) to Catla catla is 100mg/l (Cr as 35.40 mg/l), So, about 1/10 th of the 96 h LC50 lethal concentration was taken as sublethal concentration i.e., 59.68mg/l, 100 mg/l(Cr as 35.40mg/lit) were the lethal concentrations, 5.96 mg / l of trivalent chromium and 10 mg /l(Cr as 3.54 mg/lit) of hexavalent chromium respectively was taken as the sublethal concentration for further studies.

Since the duration of exposure is having a great influence on the toxicity of a metal in an organism (Radhakrishnaiah and Busappa, 1986), The biochemical studies in this investigation were carried out on glucose levels in blood and glycogen levels in liver and muscle of the fish at 1, 8, 16 and 32 days on exposure to the sublethal concentrations of trivalent and hexavalent chromium. At the end of it, the healthy fishes were taken out and blood was collected from incision at the caudal vein region into the heparinized capillary tubes for studying blood glucose levels, and then the fishes were sacrificed, stunned to death and the required organs were dissected out from each animal using sterilized instruments. The organs were weighed accurately on an electrical semi-microbalance and transferred into ice jacketed micro beakers containing fish ringer solution. The fish ringer was prepared as per the composition given by Ekberg (1958). The biochemical analysis of each experiment was carried out in the organs from six animals at each exposure period and the mean of six is taken into consideration. Similar studies made in animals from normal medium served as controls.

The level of blood glucose was estimated by Mendel et al., (1954) method. Liver and muscle glycogen content was estimated by using the anthrone reagent method described by Caroll et al., (1956).

RESULTS AND DISCUSSION

The data on the levels of blood glucose (mg/100ml), liver and muscle glycogen (mg/gm wet wt), of the fish at 1, 8, 16 and 32 days on exposure to sublethal concentrations of trivalent and hexavalent chromium, besides controls are presented in the Tables 1. Blood glucose (mg/100ml.) And Table 2 Glycogen content (mg/gm wet wt.), Graphs 3 and 4 (Blood glucose levels), 5 and 6 (Glycogen levels). In carbohydrate metabolism, the blood glucose level significantly decreased at day1and 8 in the fish exposed to trivalent chromium, But a significant increase and decrease was observed at days 16and32 which were in the order 1>8<16>32. In the fish exposed to hexavalent chromium also a significant decrease in the blood glucose was observed at day 1 and 8 followed by a significant increase at day 16 and decrease at day 32 in the order 1>8<16>32.

relative to controls, In the fish exposed to trivalent chromium, the liver glycogen levels decreased at days 1, 8 and 16 of exposure periods except at day 32 where there was an insignificant increase was observed, they were in the order 1<8<16<32, and in muscle the glycogen levels decreased at day 1 and 8 and increased at days 16 and 32 which were in the order 1>8<16<32. In the hexavalent chromium exposed fish, the liver and muscle glycogen was decreased at days 1, 8, 16 and 32 relatively greater than the decrease observed in trivalent chromium exposed fish, and the decrease was gradual and significant at all four days of exposure which was in the order: day 1>8>16>32. The liver and muscle glycogen level decreased at all exposure periods in fish exposed to both trivalent and hexavalent chromium except at day 32 of trivalent chromium there is an insignificant increase was observed. In contrary to the trivalent chromium exposed fish, the decrease and increase in blood glucose level and depletion and increase in liver and muscle glycogen content of fish exposed to trivalent chromium indicate the metabolic imbalance and failure of metabolic haemostasis. This could be due to the interaction of metal with neuroendocrinal coordinative centers which might have lead to the continuous breakdown of glycogen reserves in liver and muscle of fish by improper stimulation of enzyme machinery. A fall in the glycogen level clearly indicates its rapid utilization to meet the enhanced energy demands in fish exposed to toxicant through glycolysis or Hexose Monophosphate pathway. It is assumed that decrease in glycogen content may also be due to the inhibition of hormones which contribute to glycogen synthesis.

TABLE-1

Blood glucose(mg/100ml.) in Catla catla at different periods of exposure to sublethal concentration of trivalent and hexavalent chromium. Each value is a mean of six replicants. Percent change over the respective control is given in parentheses.

S.D. ± : Standard Deviation P : Level of Significance

ORGAN	EXPOSURE PERIOD IN DAYS									
	TRIVALENT CHROMIUM					HEXAVALENT CHROMIUM				
	CONTROL	1	8	16	32	1	8	16	32	
BLOOD GLUCOSE mg/100ml	Mean S.D. %	92 ±4.20	72 ±3.82(-21.73)	60 ±3.65(-34.78)	84 ±6.29 (-8.69)	77 ±3.8-16.30)	52 ±4.4(-43.47)	42 ±3.26(-54.34)	81 ±3.05 -11.95)	65 ±2.16(-29.34)

The differences between control and experimental are statistically significant (P<0.005). All are statistically significant.
*Denotes not significant with control (P>0.005)

TABLE-2

Glycogen content (mg/gm wet wt.) of Liver and Muscle in Catla catla at different periods of exposure to sublethal concentration of trivalent and hexavalent chromium. Each value is a mean of six replicants. Percent change over the respective control is given in parentheses.

S.D. ± : Standard DeviationP : Level of SignificanceP : Level of Significance

ORGAN		EXPOSURE IN DAYS								
		TRIVALENT CHROMIUM					HEXAVALENT CHROMIUM			
		CONTROL	1	8	16	32	1	8	16	32
LIVER	Mean S.D. %	14.176 ±0.0342	7.126 ±0.0454 (-49.73)	10.260 ±0.0350 (-27.62)	12.671 ±0.0267 (-10.61)	16.546 ±0.0411 (+16.71)	11.645 ±0.0343 (-17.85)	10.188 ±0.0344 (-28.13)	9.248 ±0.0370 (-34.76)	8.128 ±0.0359 (-42.66)
MUSCLE	Mean S.D. %	1.981 ±0.0291	1.681 ±0.0334 (-15.14)	1.480 ±0.0342 (-25.29)	1.851 ±0.0291 (-6.56)	2.228 ±0.0371 (+12.46)	1.855 ±0.0281 (-6.36)	1.525 ±0.0386 (-23.01)	1.325 ±0.0386 (-33.11)	1.163 ±0.033 (-41.29)

The difference between control and experimental are statistically significant (P<0.005) All are statistically significant.
*Denotes not significant with control (P>0.005).

FIGURE-3: Blood glucose (mg/100ml) in trivalent Cr exposed fishes

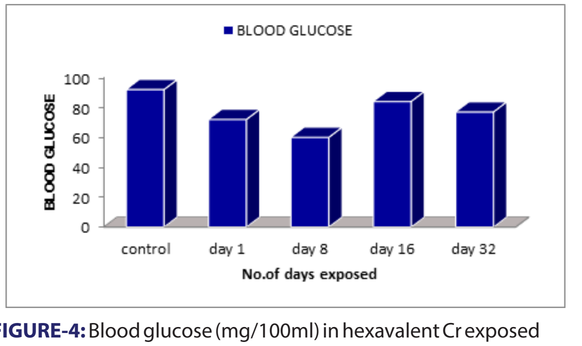


FIGURE-4: Blood glucose (mg/100ml) in hexavalent Cr exposed fishes

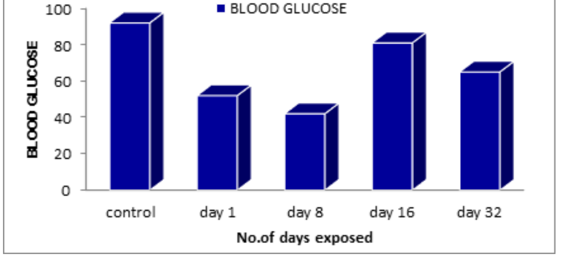


FIGURE: 5. Glycogen content in trivalent Cr exposed fishes

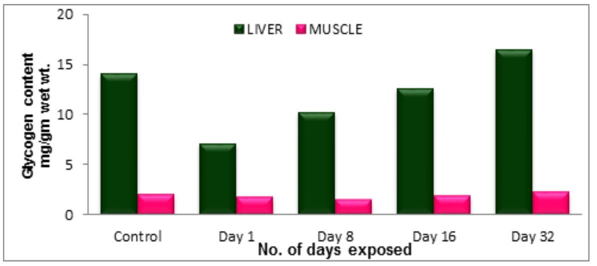
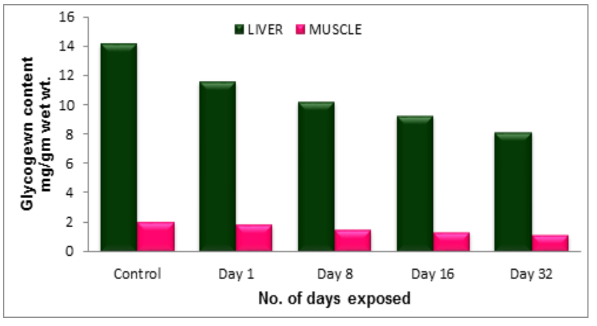


FIGURE: 6. Glycogen content in hexavalent Cr exposed fishes



CONCLUSIONS

Chromium is an essential element in trace amounts; however, it is toxic above permissible limits (Sreenath, et al., 2003). Chromium is considered as a heavy metal and pollutant as well as an essential micronutrient. Wastewater pollution by chromium originating from electroplating, dyeing, tannery, hard-alloy steel and stainless steel manufacture, has affected the life on earth. The rapid breakdown of glycogen is to meet the energy demands due to stress. Since glycogen is readily available energy source which will be metabolized first through glycolysis, (Gills et al., 1992) found decreased glycogen content during long term exposure to copper and mercury in tissues of liver and muscle tissue of test animals. The same trend was observed by several workers in different animal tissues (Almedia et al., 2002 and Lomte et al., 1996). The interpretation of metal induced changes in oxidative metabolism becomes complicated by the fact that such alterations differ not only from metal to metal and from species to species, but from one experimental period to another. More work should be carried out to identify and employ the useful strains of microbes for effective removal of the heavy metal toxicants so that cultured fish with high nutritive value could safely be utilized for human consumption.

REFERENCES

1. Almeida J.A, Novelli E.L, Dal Pai Silva, M, Junior R.A. 2002. Environmental cadmium exposure and metabolic responses of the Nile tilapia, Oreochromis niloticus. Environ Pollut. 114 (2): 169-175.
2. Ambrose, T.; Cyril Arun Kumar, L.; Vincent, S. Roselyn Lambert. 1994: Biochemical responses of Cyprinus carpio communis to toxicity of tannery effluent. J. Ecobiol. 6(3), 213-216.
3. Das, K.K. and Benerjee, S.K. 1980. Cadmium toxicity in fishes. Hydrobiologia. 75(2):177-182.
4. Gill T.S. and Pant J.C. 1983. Cadmium toxicity inducement of changes in blood and tissue metabolites in fish. Toxicol. Lett. 18: 195-200.
5. Gill, T.S. and Pant, J.C. 1981. Effects of sublethal concentration of mercury in teleost, Puntius chonchonius, Biochemical haematological responses. Indian J. exp. Boil., 19:571-573.
6. Harper, H.A. Rodwell, V.M. and Mayer, P.A. 1979. In: Review of physiological chemistry, 17th edition, Longe Medical Publications, Maruzer company Limited, California.
7. Levesque HM, Moon TW, Campbell PGC and Hontela A 2002. Seasonal variation in carbohydrate and lipid metabolism of yellow perch (Perca flavescens) chronicallyexposed to metals in the field. Aquatic Toxicology. 60(3-4): 257-267.
8. Prasada Rao, P., Vijay Joseph, K. and Jayantha Rao, K. 1990. Histopathological and biochemical changes in the liver of a fresh water fish exposed to Heptochlor. J. Nat. Con., 2(2) : 133-137.
9. Prosser, C.L. 1973. Comparative Animal Physiology 3rd edition, W.B. Saunder Company, Philadelphia, pp. 165-167.
10. Silbergeld, E.R. (1974). Blood glucose – a sensitive indicator of environmental stress in fish. ., 11 : 20 - 25.
11. Radhakrishnaiah, K., and Busappa, B. 1986. Effect of cadmium on the carbohydrate metabolism of the fresh water field crab Oziotelphusa senex senex (Fabricus). Proc. Indian nation. Sci. Acad., B57:347-352.
12. Tewari, H., Tejendra S. Gill, T.S. and Jaishree Pant, 1987. Impact of chronic lead poisoning an haematological and biochemical profiles of fish Barbus chonchonius (Ham) Bull. Environ. Contam. Toxicol. S. 38:748-752.
13. Umminger, B.L. 1975. Low temperature resistence adaptations in the kill fish Fundus heterocitus. In: physiological ecology of esturine organisms. (ed). F.J.Vernberg, University of South Carolina press, pp.59-71.
14. Usha Rani, A. and Ramamurthi, R. 1987. Effect of sublethal concentrationof cadmium on oxidative metabolism in the fresh water teleost, Tilapia mossambica. Indian. J. comp. anim. Physiol., 5(2):71-74.
15. Venkataramana, P. and Radhakrishnaiah, K.1987. Lethal and sublethal effects of copper on the protein metabolism of the fresh water teleost fish Labeo rohita. Trends in Life Sci., 2(2):1-7.