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EFFECT OF HEAVY METAL, CADMIUM CHLORIDE ON LIPID LEVEL ALTERATIONS IN FRESHWATER EXOTIC FISH, *HYPOPTHALMICHTHYS MOLITRIX*

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Abstract:

Water quality deteriorates mostly due to human activities. Those activities which lead to the aquatic pollution include industrialization, urbanization, mining, power station, agriculture and transport. Human destructive influence on the aquatic environment is in the from sublethal pollution, which results in chronic stress conditions that have negative effect on aquatic life. Hence an attempt was made to study the impact of sublethal concentration of cadmium chloride on the lipid level alterations in gill, liver and kidney of the freshwater exotic fish, Hypopthalmichthys molitrix. As the period of exposure to sublethal concentration of cadmium chloride has considerable influence on the metabolic changes the study was made at 7, 14 and 21 days. The lipid levels alterations in gill, liver and kidney were estimated in control and experimental fishes. Significant decreased lipid level in gill, liver and kidney of fish treated with sublethal concentration of cadmium chloride when compared with control fish. But the maximum decrease of lipid levels were observed in all tissues at 21 days. These results suggest that the cadmium chloride causes deleterious effects on lipid content in gill, liver and kidney.

Key words: *Hypopthalmichthys molitrix, cadmium chloride, lipid, gill, liver, kidney*

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INTRODUCTION:

Metals in the environment can occur from both natural processes such as erosion, volcanic eruptions, forest fires and from anthropogenic inputs such as mining and manufacturing [1]. Heavy metals constitute a serious type of pollution in fresh water and being stable compounds, cannot be readily removed by oxidation, precipitation or other processes and directly affects the activity in recipient animals [2]. Heavy metal pollution of water is a major environmental problem throughout the modern world [3].

Heavy metal contamination in the environment is a severe problem, particularly in estuaries, coastal areas and fresh water ecosystem [4]. Cadmium is a non-essential and toxic to both marine organisms and humans which would enter into the environment from various anthropogenic sources, and by-products from zinc refining, coal combustion, mine wastes, electroplating, iron and steel production, fertilizers and pesticides [5].

Heavy metals are natural trace components of the aquatic environment, but background levels in the environment have increased especially in areas where industrial, agricultural and mining activities are widespread [6-7] all heavy metals are released into the environment and find their way into the aquatic phase as a result of direct input, atmospheric deposition and erosion. Heavy metal contamination has been reported in aquatic organisms [7-8]. These metals build up in the food chain and are responsible for chronic illness and subsequent death in aquatic organisms [9].The environmental persistence of metals in concert with their intensive use by modern society has, over the years, created the concentration of metals in the biosphere [10].

The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades [11-14]. The natural aquatic systems may extensively be contaminated with heavy metals released from domestic, industrial and other man-made activities [15-16].Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms [17]. Among animal species, fishes are the inhabitants that cannot escape from the detrimental effects of these pollutants [18-19]. Fish are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death in the aquatic systems [10, 20-21].

Cadmium is a toxic ubiquitous environmental pollutant. It is released into aquatic environment from industrial and natural sources [22-23]. Cadmium is a widespread environmental pollutant, arising primarily from battery, electroplating, pigment, plastic and fertilizer industries. The animals are exposed to cadmium via contaminants found in drinking water and food [24-25, 3], cigarette smoke and alcoholic beverages [26], while occupational exposure to cadmium usually takes place during manufacturing processes. Cadmium is considered as one of the most toxic transition metal elements and a potent industrial hazard that causes severe damage to a variety of tissues and organs [27-28]. Even though many studies are available in heavy metal toxicity study of various fishes of lipid levels [29-33] our best of knowledge there is no report available on lipid levels in *Hypopthalmichthys molitrix* exposed to cadmium chloride. Investigation on toxicity makes it possible to evaluate the effects of sublethal concentration on growth, behavior, physiology and biology of organisms, to determent their adaptation capabilities and to forecast possible consequences to toxic effect [47] Hence the present investigation has been carried out on changes in the lipid content in gill, liver and kidney of *Hypopthalmichthys molitrix* exposed to sublethal concentration of cadmium chloride.

MATERIALS AND METHODS:

The fish *Hypopthalmichthys molitrix* having mean weight 14 - 16 gm and length 12 – 14 cm were collected from PSP fish farm, at Puthur and acclimatized to laboratory conditions. They were given the treatment of 0.1% KMNO4 solution and then kept in plastic pools for acclimatization for a period of two weeks. They were fed twice daily i.e. morning and evening on rice bran and oil cake daily. The cadmium chloride was used in this study and stock solutions were prepared. Cadmium chloride, LC 50 was found out for 96 h (28 mg/L) [45] and $1/15^{th}$ (1.86 mg/L), $1/10^{th}$ (2.8 mg/L) and $1/5^{th}$ (5.6 mg/L) taken as sublethal concentrations for this study. Forty fish were selected and divided into 4 groups of 10 each. The first group was maintained in free from cadmium chloride and served as the control. The other 3 groups were exposed to sub lethal concentration of cadmium chloride, 10 litre capacity aquaria. The 2^{nd}, 3^{rd} and 4^{th} groups were exposed to cadmium chloride, for 7, 14 and 21 days respectively. At the end of each exposure period, the fish were sacrificed and the required tissues were collected for lipid estimation. The lipid content in gill, liver and kidney of *Hypopthalmichthys molitrix* were estimated by the method of [34]. The data obtained were analyzed by applying analysis of variance DMRT one way ANOVA to test the level of significance [35].

RESULTS:

The present study shows a significant decrease in the level of lipids in gill, liver and kidney of *Hypophthalmichthys molitrix* exposed to low, medium and high sublethal concentrations of cadmium chloride for a period of 7, 14 and 21 days (Table 1).

Table 1: Lipid (mg/g) levels in the gill, liver and kidney of *Hypophthalmichthys molitrix* exposed to sublethal concentration of cadmium chloride

Treatments	7 days	14 days	21 days
Gill			
Control	3.94 ± 0.31^{a}	3.95 ± 0.30^{a}	3.96 ± 0.31^{c}
Low concentration	3.91 ± 0.30^{a}	3.85 ± 0.31^{a}	3.74 ± 0.29^{c}
% change over control	(-0.76)	(-2.53)	(-5.55)
Medium concentration	3.86 ± 0.29^{a}	3.76 ± 0.30^{a}	3.42 ± 0.27^{b}
% change over control	(-2.03)	(-4.81)	(-13.63)
High Concentration	3.78 ± 0.30^{a}	3.64 ± 0.29^{a}	3.00 ± 0.24^{a}
% change over control	(-0.04)	(-7.84)	(-24.24)
Liver			
Control	11.06 ± 0.85^{b}	11.88 ± 0.85^{b}	11.12 ± 0.86^{c}
Low concentration	9.98 ± 0.77^{a}	8.84 ± 0.69^{a}	6.70 ± 0.52^{ab}
% change over control	(-9.76)	(-25.58)	(-39.74)
Medium concentration	9.90 ± 0.76^{a}	8.72 ± 0.68^{a}	8.46 ± 0.58^{b}
% change over control	(-10.48)	(-26.59)	(-23.92)
High Concentration	9.76 ± 0.77^{a}	8.56 ± 0.66^{a}	5.94 ± 0.46^{a}
% change over control	(-11.75)	(-27.94)	(-46.58)
Kidney			
Control	5.20 ± 0.41^{b}	5.21 ± 0.41^{b}	5.23 ± 0.41^{c}
Low concentration	4.88 ± 0.39^{ab}	4.54 ± 0.37^{a}	4.26 ± 0.33^{b}
% change over control	(-6.15)	(-12.85)	(-18.54)
Medium concentration	4.76 ± 0.38^{ab}	4.40 ± 0.34^{a}	3.68 ± 0.29^{a}
% change over control	(-8.46)	(-15.54)	(-29.63)
High Concentration	4.64 ± 0.37^{a}	4.22 ± 0.33^{a}	3.30 ± 0.26^{a}
% change over control	(-10.76)	(-19.00)	(-36.90)

All the values mean ± SD of six observations
+/– indicates the % change over control
values which are not sharing common superscript differ significantly at 5% ($p < 0.05$)
Duncan multiple range test (DMRT)

DISCUSSION:

Lipid content is an essential organic constituent of the tissues of all animals, and plays a key role in energy metabolism. Lipids are the best energy producers of the body next to carbohydrates. The lipid content of gills, hepatopancreas and muscle showed decreased levels in the fish exposed for 10, 15 and 20 effluent exposure. The decreased level of tissue lipid content may be due to liver dysfunction or mobilization of glycerol or inhibition of oxidative phosphorylation [41-42] reported that lipids are vital to embryogenesis, providing two third of energy by oxidation. [43] Observed that an elevated level of serum cholesterol in *Channa punctatus* exposed to mercuric chloride effluent might be an indication of liver damage, which normally esterifies cholesterol, and excrete a part of it with the bile. [36] demonstrated that blood cholesterol elevation might be due to the inhibition of the activity of enzymes of lipid metabolism such as lipoprotein lipase by toxic effluents leading to a retarded clearance of lipids from blood.

Lipids act as reversed depot of energy from where the energy is supplied as and when required. [37] Reported decreased cholesterol and lipid levels in brain, testis and ovary of *Clarias batrachus* when exposed to lead nitrate. In the present study, there was a decrease in the lipid content of gill, liver and kidney of *Hypophthalmichthys molitrix* exposed to sublethal concentrations of cadmium chloride. The present results agree with [38] reported that decrease in the lipid levels of *Clarias batrachus* when exposed to cadmium. [39] Observed that exposure of fish *Anabas testudineus* to a sublethal concentration of lead nitrate for the period of 30 days during the preparatory phase of its annual reproductive cycle reduced the total lipids. This suggests that lead nitrate affects the lipid metabolism of the fish and thus may reduce the fecundity of the fish since lipids are known to play important role in teleost reproduction as an energy source and a precursor of steroids.

Lipids are also the storage form of energy like glycogen. The lipid levels decreased in the gill, liver, kidney, muscle and heart of *Catla catla* exposed to the sub-lethal and lethal concentration of cadmium chloride [31]. Effect of cadmium on the lipid content was reported by earlier investigators [30, 40, and 9] have reported that the lipid contents were decreased in gill, liver and muscle of *Oreochromis mosambicus* exposed to hexavalent chromium.

CONCLUSION:

A reduction in the protein content in the present investigation in *Hypopthalmichthys molitrix* suggests that the tissue protein undergoes proteolysis, which results in an increase in the production of amino acids. These amino acids are utilized for energy production during stressful situation in the intoxicated fishes. It is evident that proteins are degraded to meet the energy requirements during cadmium chloride exposure. It can be concluded that in *Hypopthalmichthys molitrix* exposed to cadmium chloride at sublethal concentration causes energy crisis and alter protein metabolism.

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REFERENCES:

1.Klinck, J.S and C.M. Wood. *In vitro* characterization of cadmium transport along the gastro-intestinal tract of freshwater rainbow trout (*Oncorhynchus mykiss*). *Aquatic Toxicol.*, 2011; **102:** 58–72.

2.Nammalwar, P., 1985. Heavy metal pollution in Adyar Estuary, Madras, *Indian Proc. Symp. Assess. Environ. Poll*., **235-**238.

3.Dushenkov, V., P.B.A.N. Kumar, H. Motto and I. Raskin. Rhizofiltration: the use of plant to remove heavy metals from aqueous streams. *Eniron. Sci. Tech*., 1995;**29:** 1239-1245.

4.Garcia-Santos, S., L. Vargas-Chacoff, I. Ruiz-Jarabo, J.L. Varela, J.M. Mancera, A. Fontaınhas-Fernandes and J.M. Wilson. Metabolic and osmoregulatory changes and cell proliferation in gilthead sea bream (*Sparus aurata*) exposed to cadmium. *Ecotoxicol. Environ. Safety*, 2011;**74:** 270–278.

5.USEPA, 2001. Update of Ambient Water Quality Criteria for Cadmium. EPA-822-R- 01 001. *United States Environmental Protection Agency* (USEPA), Washington, DC, USA.

6.Bryan, G. and W.J. Langston. Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries: a review. *Environ. Poll.,1992;* **76:** 89-131.

7.Langston, W.J., 1990. Toxic effects of metals and the incidence of marine ecosystems *In*: Furness, R.W. and Rainbow P.S. (ed) Heavy metals in the Marine environment, 256 pp. CRC Press New York.

8.Rashed, M.M. Cadmium and lead levels in fish *Tilapia nitotica* tissues as biological indicator for lake water pollution. *Environ. Morit. Assess*, 2001;**68:** 75-89.

9.Adham, K.G., S. Hamed Sherifa, H. Ibrahin, M. Salch and A. Ramadan. Impaired functions in Nile tilapia, *Oreochromis niloticus* from polluted waters. *Acta Hydro Chemica et Hydrobiol.,2002;* **29:** 278-288.

10.Farkas, A., J. Salanki and A. Specziar. Relation between growth and the heavy metal concentration in organs of bream *Abramis brama* L. populating lake Balaton. *Arch. Environ. Contam. Toxicol.*, 2002;**43:** 236-243.

11.Poonam, K and F.N. Jaffery. Biological markers for metal toxicity. *Environ. Toxicol. Pharmacol.,2005;* **19:** 335-349.

12.Vutukuru. S.S. Acute effects of Hexavalent chromium on survival, oxygen consumption, hematological parameters and some biochemical profiles of the Indian Major carp, *Labeo rohita. Int. J. Environ. Res. Public Health,* 2005;**2:** 456- 462.

13.Dirilgen, N. Accumulation of heavy metals in freshwater organisms: Assessment of toxic interactions. *Turk. J. Chem., 2001;***25:** 173-179.

14.Voegborlo, R. B., A.M.E. Methnani and M.Z. Abedin. Mercury, cadmium and lead content of canned Tuna fish. *Food Chem.,* 1999;**67:** 341–345.

15.Canli, M., O. Ay and M. Kalay. Levels of heavy metals (Cd, Pb, Cu, and Ni) in tissue of *Cyprinus carpio*, *Barbus capito* and *Chondrostoma regium* from the Seyhan river. *Turk. J. Zool.,* 1998;**22:** 149-157.

16.Velez, D. and R. Montoro. Arsenic speciation in manufactured seafood products: a review. *J. Food. Protect.,* 1998;**61:** 1240-1245.

17.Conacher, H.B., B.D. Page and J.J. Ryan. Industrial chemical contamination of foods [Review]. *Food Addit. Contam.,* 1993;**10:** 129-143.

18.Farombi, E.O., O.A. Adelowo and Y.R. Ajimoko. Biomarkers of oxidative stress and heavy metal levels as indicators of environmental pollution in African Cat fish (*Clarias gariepinus*) from Nigeria Ogun river. *Int. J. Environ. Res. Pub. Hlth.,2007;* **4:** 158-165.

19.Olaifa, F.G., A.K. Olaifa and T.E. Onwude. Lethal and sublethal effects of copper to the African Cat fish (*Clarias gariepnus*). *Afr. J. Biomed. Res.,* 2004;**7:** 65-70.

20.Clarkson, T.W. Human toxicology of mercury. *J. Trace. Elem. Exp. Med.,1998;* **11:** 303-317.

21.Yousuf, M.H.A. and E.I. Shahawi. Trace metals in *Lethrinus lentjan* fish from Arabian Gulf: Metal accumulation in Kidney and Heart Tissues. *Bull. Environ. Contam. Toxicol.,* 1999;**62:** 293-300.

22.Vinodhini, R and M. Narayanan. Bioaccumulation of heavy metals in organs of fresh water fish *Cyprinus carpio* (common carp). *Int. J. Environ. Sci. Tech.,2008;* **5:** 179-182.

23.Choi, C.Y., K.W. An, E.R. Nelson and H.R. Habibi. Cadmium affects the expression of metallothionein (MT) and glutathione peroxidase (GPX) mRNA in goldfish, *Carassius auratus. Comp. Biochem. Physiol. C,* 2007;**145:** 595-600.

24.Dietrich, M.A., G.J. Dietrich, P. Hliwa and A. Ciereszko. Carp transferrin can protect spermatozoa against toxic effects of cadmium ions. *Comp. Biochem. Physiol. Part C,* 2011;**153:** 422-429.

25.WHO, 2000. Cadmium. Air quality guidelines. World Health Organization. Regional Office for Europe, Copenhagen, Denmark.

26.USEPA, 2001. Update of Ambient Water Quality Criteria for Cadmium. EPA-822-R- 01 001. *United States Environmental Protection Agency* (USEPA), Washington, DC, USA.

27.Jarup, L., M. Berglund, C.G. Elinder, G. Nordberg and M. Vahter. Health effects of cadmium exposure – a review of the literature and a risk estimate. *Scand. J. Work Environ. Health.* 1998;**24:** 1–51.

28.Foulkes, E.C., 1986. Absorption of cadmium. In: Foulkes EC, editor. Cadmium. Handbook of Experimental Pharmacology, Vol. 80. Berlin: Springer-Verlag, pp. 75–97.

29.Nogawa, K. and T. Kido, 1996. *Itai-Itai* disease and health effects of cadmium. In: Chang LW, editor. Toxicology of metals. New York: CRC Press, p. 353–69.

30.Levesque, H.M., T.W. Moon, P.G.C. Campbell and A. Hontela. Seasonal variation in carbohydrate and lipid metabolism of yellow perch (*Perca flavescens*) chronically exposed to metals in the field. *Aquat. Toxicol.,2002;* **60:** 257-267.

31.Shobha, K., A. Poornima, P. Harini and K. Veeraiah. A study on biochemical changes in the freshwater fish, *Catla catla* (Hamilton) exposed to the heavy metal toxicant cadmium chloride. *Kathmandu Univ. J. Sci. Eng. Technol.,* 2007;**1:** 1-11.

32.Shelke abhay, D. Comparative study of cholesterol alterations in a freshwater teleost fish, *Amblypharyngodon mola* exposure to heavy metals. Bioscan, 2013;8(3): 1001-1003.

33.Rajee, O and Jamila, P. Effect of anthraquinone dyes on the carbohydrate, protein and lipid content in the muscle of *Channa punctatus* and *Cyprinus carpio.* International Journal of Pharmaceutical Applications, 2013; 4(1):11-18.

34.Folch, J., M. Lees and S.G.H. Solane. A simple method for isolation and purification of total lipids from animal tissues. *J.Biochem., 1957;***226:** 497-509.

35.Duncan, B.D. Multiple range tests for correlated and heteroscedastic means. Biometrics, 1957;13: 359 – 364.

36.Janderko, G. and S. Kossmann, 1965. Arch *Gewerbehyg*, **21:** 107.

37.Katti, S.R and A.G. Sathyanesan. Lead nitrate induced changes in lipid and cholesterol levels in the freshwater catfish *Clarias batrachus. Toxicol. Lett.,* 1983;**19:** 93-96.

38.Katti, S.R and A.G. Sathyanesan. Changes in tissue lipid and cholesterol content in the freshwater catfish *Clarias batrachus* exposed to cadmium chloride. *Bull. Environ. Contam. Toxicol.,* 1984;**32:** 486 - 490.

39.Tulasi, S.J., P.V. Reddy and J.V. Rao. Accumulation of lead and effects on total lipids derivatives in the freshwater fish *Anabas testudineus. Ecotoxicol. Environ. Safe, 1992;***23:** 33- 38.

40.Dubale, M.S and S. Punita. Biochemical alterations induced by cadmium in the liver on *Channa punctatus*. *Environ. Res.,* **1981;26:** 110-118

41.Chezhian, A., N. Kabilan, T. Suresh Kumar, D. Senthamilselvan and K. Sivakumari. Impact of Common Mixed Effluent of Sipcot Industrial Estate on Histopathological and Biochemical Changes in Estuarine Fish *Lates calcarifer. Curr.Res.J.Biol.Sci.* 2010;**2:** 201-209.
42.Gilbert, I. and J.D. O'Connor, 1970. Lipid Metabolism and Transport in Arthropods. In: Florkin M. and B.T. Scheer (Eds.), Chemical Zoology. Vol. 5, Part A, Arthropoda.
43.Garcia-Santos, S., L. Vargas-Chacoff, I. Ruiz-Jarabo, J.L. Varela, J.M. Mancera, A. Fontaınhas-Fernandes and J.M. Wilson. Metabolic and osmoregulatory changes and cell proliferation in gilthead sea bream (*Sparus aurata*) exposed to cadmium. *Ecotoxicol. Environ. Safety*, 2011;**74:** 270–278.
44.Klinck, J.S and C.M. Wood. *In vitro* characterization of cadmium transport along the gastro-intestinal tract of freshwater rainbow trout (*Oncorhynchus mykiss*). *Aquatic Toxicol.,* 2011;102**:** 58–72.
45.Nammalwar, P., 1985. Heavy metal pollution in Adyar Estuary, Madras, *Indian Proc. Symp. Assess. Environ. Poll*., 235-238.
46.Sprague, J.B., 1971. Measurement of Pollution Toxicity to Fish III. Sublethal Effects and Safe Concentrations. Academic Press, New York, pp. 479.
47.Pichaimani N.,Pugazhendy K.,Tamizhazhagan V.,Sakthidasan V.,Jayanthi C.,Sasikala P.Antioxidant Enzyme Activity Effect of Solanam Virginianum Against Lead Acetate Toxicity of the Fresh Water Fish *Cyprinus Carpio*, International Journal of Current Advanced Research, 207;06(12):8031-8037. DOI:http://dx.doi.org/10.24327/ijcar.2017.8037.1276