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Original Article

SUPPLEMENTATION OF CALCIUM AND SELENIUM AGAINST CADMIUM INDUCED BIOACCUMULATION IN SELECTED TISSUES OF FRESH WATER FISH, *OREOCHROMIS MOSSAMBICUS*

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ABSTRACT

Objective: Cadmium (Cd) is one of the most hazardous heavy metals in aquatic environments and could threaten aquatic organisms including fish. The present study was carried out to know the protective effects of calcium (Ca) and selenium (Se) in reducing the Cd bioaccumulation in selected tissues of fresh water fish, *Oreochromis mossambicus*.

Methods: The fresh water fish, *Oreochromis mossambicus (Tilapia)* was brought from the local ponds and were allowed for acclimatization to the laboratory conditions. After acclimatization, fish were exposed to sublethal concentration of Cd ($1/10^{th}$ of LC_{50}/48h, i.e., 5 ppm) for 7, 15 and 30 d (d) period. 15d Cd-exposed fish were divided into three groups. The first group of fish were subjected to Ca (1 ppm) supplementation, second group received only Se (1 ppm) supplement and third group of fish were supplemented with the combination of both Ca and Se at the above said doses and observed for 7, 15 and 30d time periods. After specific time intervals, liver, kidney, gill and intestine tissues were isolated and used for Cd bioaccumulation studies.

Results: Cd concentration levels significantly ($P<0.05$) increased in the test tissues with increased period of exposure. Maximum Cd accumulation was found in 30d Cd-exposed fish kidney tissue (22.611±0.676 µg/gm wet wt. of the tissue). However, after supplementing with Ca and/or Se, there was a significant reversal in the levels of Cd concentration in all the test tissues. Maximum reduction was observed under Ca alone supplementation.

Conclusion: The present study clearly reveals that individual supplementation of Ca tends to detoxify the Cd body burden in the test tissues than the other modes of supplementation.

Keywords: Cadmium, Bioaccumulation, Supplementation, Fish

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INTRODUCTION

Metal pollution is one of the most dangerous consequences of industrial activities to the aquatic environment [1]. Because of their persistent nature and slow elimination from environmental compartments, metals are the largest and most widespread groups of contaminants [2]. The diverse deleterious health effect upon exposure to toxic heavy metals such as cadmium (Cd), lead (Pb) and mercury (Hg), etc. in the environment is a matter of serious concern and a global issue. Heavy metals accumulate in the tissues of aquatic animals and may become toxic when accumulation reaches a substantially high level. Studies carried out with different fish species have revealed that non-essential metals can produce toxic effects in fish by disturbing physiological activities [3], biochemical processes [4], reproduction and growth [5].

Cd was readily bioaccumulated and bioconcentrates in aquatic organisms. Tissue Cd concentrations build up at the site of exposure, gills in a waterborne exposure or gastrointestinal tract in a dietborne exposure and are transferred via the circulation to other tissues. Cd accumulates in nearly all tissues and organs with liver, kidney, and gill reaching relatively high levels. Available reports indicate that the kidney, liver, and gills were the critical targets for Cd in fishes [6-8] in which they have been reported to cause significant metabolic, biochemical and physiological effects. The bioaccumulation of heavy metals, biochemical, pathological and antioxidant alterations induced by different heavy metals and organic compounds has been studied by several investigators in the different tissues of rats and fish [9-15].

Despite many years of research, we are still far from effective treatment of heavy metal poisoning. The main therapeutic option for metal poisoning relies in chelation therapy. Chelating agents are capable of linking together metal ions to form complex structures which can be easily excreted from the body. We have reported here on the interactions between Cd, Se and Ca in *Tilapia*. Cd can compete and interact metabolically with essential nutrients such as Se, Ca, Zn, Cu and Fe in the body [16-17]. Se is important in many biochemical and physiological processes. It plays a major role in the modification of the thiol and hydroxyl groups in the Cys and Tyr. It was reported that Cd may inhibit the Se metabolism at many stages by interfering their absorption, distribution to different tissues, transport into cells and/or transport into several intracellular structures and also indirectly affecting the synthesis of various Se dependent enzymes and proteins [18-22].

Se is an essential nutrient for living organisms and is required for the synthesis of various selenoproteins (SeP). Se plays a vital role in the synthesis of a non-enzymatic antioxidant, GSH and also MT protein synthesis [23-25]. It can prevent cell damage through the activation of the antioxidant system [26-28]. Se is the most prevalent nutrient in the body and is involved in the structure and function of some enzymatic and nonenzymatic antioxidants, collectively representing all major biochemical categories and therefore is essential for normal cell function and metabolism.

Ca supplementation using the inorganic calcium chloride, protected against accumulation of Cd in kidney, liver and other selected tissues of fish [29]. Niyogi *et al.*, [30] reported that water hardness has an ameliorating effect against Cd uptake and toxicity in fish. As water hardness (defined as the sum of Ca and magnesium (Mg) concentrations) increases acute waterborne Cd toxicity decreases [31]. The major hardness cation, Ca changes gill permeability, competes with Cd for binding sites on the surface of gills and reduces toxicity.

Cd accumulation was reduced with the increase of waterborne and dietary Ca [32-34]. Higher water Ca levels reduce the amount of Cd binding to gills [17] and reduce branchial Cd uptake rates resulting