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Toxicity and bioaccumulation of cadmium in the freshwater bivalve *Lamellidens marginalis*

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Abstract
The influence of different concentrations of cadmium on Bivalve *Lamellidens marginalis* was examined by a toxicity experiment. Acute toxicity was analyzed by measurement of the 96hrs LC50 and daily survival rates. Results indicated that the mortality rate of *Lamellidens marginalis* was proportional to the concentration of cadmium. LC50 after 96 hrs. the bioaccumulation value of the pollutant in the *Lamellidens marginalis*'s soft parts. The bioaccumulation of cadmium in the organism increased by increasing the concentration of cadmium in solution. The increase of cadmium in the organism was not steady, but it took the form of sudden increase after increasing the concentration of cadmium in solution.

Keywords: *Lamellidens marginalis*, cadmium, bioaccumulation, survival, soft tissue

Introduction
Heavy metal contamination is a serious problem around the world because of the metals' non-biodegradable properties. Their bioavailability and adverse effects on living organ-isms with long-lasting toxic effects can have environmental risks (Ukoha *et al*. 2014; Sthanadar *et al*. 2015) [40, 39]. They persist indefinitely and cause pollution of the air, water, and soils (Yasmeen, 2019; Shinde, 2021Yasmeen, *et al.*, 2021) [48, 33, 49]. Thus, the main strategies of pollution control are to reduce the bioavailability, mobility, and toxicity of metals. Heavy metals are natural constituents of the environment, where they are generally found in low concentrations; however, anthropogenic activities contribute to increase their concentration. The impact of these metals in the environment is a serious and growing problem worldwide. Marine pollution has been documented of various kinds of pollutants, especially heavy metals (Romeo *et al*. 2005) [28]. However, some heavy metals are essential for the lives of organisms, while many are highly toxic, and play no significant biologicalroles (Cross and Sunda 1985; Rainbow 1985; Rainbow and White 1989; Sanders 1997) [12, 25, 51, 30].

Cadmium is a nonessential trace metal that is toxic at low concentrations for aquatic organ-isms (Cicik and Engin 2005) [10]. Pollution an undesirable changes in the physical, chemical and biological characteristic of air, water and soil, which is harmful to living organisms. Whatever may be the mode of contamination polluted environment is what suitable for existing life forms.

Cadmium is a metallic contaminant that has no known essential functions of human physiology (Barak & Mason, 1990) [5]. It has gained wide interest in the scientific community in recent years due to its potential human health hazards (Selvi *et al*., 2003) [31]. The main source of cadmium pollution is through soil. Cadmium released from factory wastes and mining operations also pollutes water and feed crops (Ibrahim *et al*., 1997) [17]. Some authors studied the effect of cadmium on some freshwater bivalves including Ibrahim *et al*. (1997) [17] on *Caelatura aegyptiaca*, Saad and Emam (1998) [29] *on Caelatura teretiuscula* and Abdel Gawad (2005) [2] on *Caelatura prasidense.*

The present work aimed to assess the toxicity of Cd, as one of the most toxic metals frequently encountered in polluted areas, on *Lamellidens marginalis* and the ability of this freshwater bivalve to accumulate this toxic metal. This animal belongs to Bivalvia class of phylum Mollusca, which is second largest phylum (Verma and Prakash, 2020) [41].

Materials and Methods
After collection of the animals from habitat, they were immediately transported to the laboratory. The fouling and mud on shell valves were removed without disturbing the siphonal regions.

The equal sized animals (90-100 mm shell length) were grouped and kept in sufficient quantity of water (animal/liter) in aquaria with aeration for 24 Hrs. to adjust the animals in laboratory conditions (with renewal of water at interval of 12 to 13 hrs.). No food was given during acclimation time and during experiments. After 24 Hrs. 05 groups of animals of almost equal size (90-100 mm shell length) were formed and each group with 10 animals including control group and exposed to different test concentrations of cadmium for static bioassay tests. The stock solution of cadmium was prepared by was made dissolving appropriate quantity of cadmium chloride (CdCl2 2½H2O AR Grade CDH Bombay) in double distilled water. The pH of the water is brought between 6.9 and 7.1 by adding 1N HCl (due to insolubility of cadmium in reservoir water having 7.6 to 8.1).

Results and Discussion

Table (1) shows the relation between the Cadmium concentration and the mortality rate of *Lamellidens marginalis*. The mortality rate did not exceed10% during 96hrs at Cadmium concentrations of 1.5, 5.0 and 8.0 mg/l, in different season i.e., summer, monsoon and winter respectively while it was100% at 6.0, 14.0 and 17.0 in summer, monsoon and winter respectively. The value of 96hrs LC50 of Cadmium on this species was found to be3.0, 9.0 and 12.0 in summer, monsoon and winter respectively.

Table 1: 96-hour acute toxicity results of Cadmium on *Lamellidens marginalis* indifferent season.

Concentration of Cd (mg/l)			Number of *L. marginalis*	Number of *L. marginalis* dead	Mortality rate (%)
Summer	Monsoon	Winter			
1.5	5.0	8.0	10	1	10
2.0	6.0	9.0	10	2	20
2.5	7.0	10.0	10	3	30
3.0	8.0	11.0	10	4	40
3.0	9.0	12.0	10	5	50
4.0	10.0	13.0	10	6	60
4.5	11.0	14.0	10	7	70
5.0	12.0	15.0	10	8	80
5.5	13.0	16.0	10	9	90
6.0	14.0	17.0	10	10	100

Table 2: Bioaccumulation of Cd in soft tissue of *Lamellidens marginalis* after 96hrs acute toxicity to different concentrations of Cd solution.

Concentration of Cd in solution(mg/l)	Concentration of Cd in soft tissue (mg/gm)
Experimental Control	70.70
6.0	172.5
14.0	257.0
17.0	969.9

Bivalves are commonly available organisms that are abundant in the fresh water as well as in the marine environment. They have been suggested as ideal contamination indices in aquatic ecosystems because of their wide distribution, extensive population, sedimentary nature and the ability to accumulate contaminants (El Shenawy, 2004) [13]. Moreover, they close their shells for an extended period of time as escape behaviour or to exclude themselves from the outside environment when exposed to a contaminant (Wildridge *et al*., 1998) [45]. Increasing use of contaminating chemicals in many industrialized parts of the world makes the development of ecotoxicity measurement techniques is an absolute necessity (Brandao *et al*., 1992) [9]. The first step is the acute toxicity test which can be carried out using bacteria, invertebrates and fish in order to show the potential risks of these chemicals (OECD, 1993; Yilmaz *et al*., 2004) [23, 50].

The 96 hrs. LC50 of Copper and Zinc for the same species were 0.50and 17.5 mg/l respectively (Abdel Gawad, 2001) [1] compared to 0.52 mg/l for Cd. This means that the toxicity of Cu> Cd> Zn and so this species is more tolerant to Zinc than to Cadmium or Copper. The differences between the values of LC50 of Cadmium for different bivalve species agree with Widerholm (1984) [44] and Voshell *et al*. (1989) [42], who stated that some marine organisms are very sensitive to heavy metals while others are resistant. In this study, the bioaccumulation of Cadmium in *Lamellidens marginalis* was increased by increasing the concentration of Cadmium solution, while the concentration factors decreased. This agree with Wolf (1975) [46]; Kay (1985) [18]; Augier *et al*. (1992) [4]; Ramadan *et al*. (1997) [27] and Abdel Gawad (2005) [2].

The extent of contamination has been carried out to assess the status of pollutant concentrations in the water, sediment, and in organic tissue samples. The use of bioindicator species also provides additional information to survey environmental contaminations. Previous studies have determined the concentration of heavy metals (Beldi *et al*. 2006) [8] and investigated the impact of pollution on *D. trunculus* from the Gulf of Annaba (Amira *et al*. 2011; Soltani *et al*. 2012) [3, 38]. Moreover, the accumulation of heavy metals in *D. trunculus* is caused by human activities that affect the physiology of both genders of this species (Hamdani and Soltani-Mazouni 2011; Hamdani *et al*. 2014) [15, 16]. Indeed, high bioconcentration of heavy metal has been found in various Mollusk organisms, such as bivalves in many areas of the world (Neuberger-Cywiak *et al*. 2003; Sifi *et al*. 2007, 2013; Feldstein *et al*. 2003) [22, 34, 35, 14]. Bioconcentration is influenced by the physico-chemical properties of contaminants involved in the surrounding environmental conditions (e.g., biotope characteristics) and the biochemical/physiological adaptation of each organism (Barron 1990; Connell 1988) [6, 11]. Thus, compounds that accumulate in the tissues of aquatic organisms depend on several endogenous factors, namely species characteristics and trophic interactions (Mendez *et al*. 2001; Skinner *et al*. 2004) [21, 36], since Cd is a non-essential metal that is not physiologically present in organisms and can be toxic to humans, even at very low concentrations. In addition, this metal is relatively soluble, and tends to bioaccumulate rapidly by aquatic organisms such as bivalves (Shi *et al*. 2016) [32]. Cd is considered to be a highly toxic environmental pollutant and potent cell poison that causes different types of damage (Pascal *et al*. 2010) [24]. Therefore, the present study has shown that after treatment with LC50 and LC25 at 48 and 96 h, accumulation of Cd in *D. trunculus* increased in a concentration- and time-dependent manner. A significant increase in the tissue concentration appeared 48 h after exposure in planarians after treatment with 0.63 mg/l of Cd (Wu *et al*. 2012) [47]. In fact, the accumulation of Cd was also observed in other species exposed to metal contamination under laboratory conditions or in their natural environment such as bivalves *R. decussates* (Bebianno *et al*. 1993; Smaoui-Damak *et al*. 2003) [7, 37], *C. fluminea* (Legeay *et al*. 2005) [19], and *D. polymorpha* (Marie *et al*. 2006) [20], or in Gastropods like *Austrocochlea constricta* (Walsh *et al*. 1994) [43].

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