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Toxicity test and Cd, Cr, Pb and Zn bioccumulation in *Phalloceros caudimaculatus*

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ABSTRACT

The use of animals as bioindicators has been useful, especially in the evaluation of environmental impact of pollutant discharges in aquatic ecosystems. This study, aims to assess the fish *Phalloceros caudimaculatus* (known as Guaru) as a heavy metal sbioindicator. LC50 (96 h) acute toxicity tests to potassium dichromate salts, cadmium nitrate, lead II nitrate and zinc sulfate, and bioaccumulation of metals such as cadmium, chromium, lead and zinc were conducted. In the bioaccumulation test, for three months standard tanks were used, with different contamination levels above the levels set by local law, a pollution control tank was also set. The following data was obtained in acute toxicity tests LC50 (96 h): Potassium dichromate 164.58 ± 18.75 mg/L, Cadmium nitrate was 29.5 ± 1.21 mg/L, Lead nitrate was 15.5 ± 0.47 mg/L and zinc sulfate was 62.8 ± 2.81 mg/L. The bioconcentration factor (BCF) maintained the order Zn > Pb > Cd > Cr, where the resulting values were considered high for the four elements ranging from 92.4 (Cr) to 1793.1 (Zn). Based on the test results, the Guaru fish proved resistant to the presence of these metals and a showed a high bioaccumulation rate. Thus, it can be used as a bioindicator of heavy metals.

Introduction

The gradual increase of industrial manufacturing and urban sprawl has contributed to the increase in the amount of pollutants in the environment [1]. This increase in environmental pollution may cause a change in the balance of aquatic ecosystems and may influence significant changes in their biota [1,2].

The use of animals as bioindicators is extremely important, especially for the evaluation of environmental impacts resulting from human action such as sewage and waste dump into water bodies [3–5]. Bioindicators are species that are used as primary indicators of environmental contamination [5], which are defined by responses or reactions of any kind, from an organism to an environmental contaminant that can be measured in biological individual matrix, indicating a deviation of its homeostasis [4]. Organisms such as aquatic plants, algae, crustaceans, mollusks, fish, mammals, birds, can be considered bioindicators [5,6].

An ideal bioindicator should live in a healthy environment, as well as survive while resisting contaminants to which it will be exposed. It is also important to consider the abundance of this species in the environment, and it's ability to adapt to laboratory tests [5,6].

Fish suffer bioaccumulation of heavy metals through the absorption and retention of such materials along the food chain. This is facilitated in the aquatic environment by water filtration and retention of particles in suspension by filtrating organisms like the phytoplankton and shellfish. Fish accumulate metals by feeding and also through the gills [5,7,8].

The toxicity of heavy metals is related to their ability to interfere in enzymatic processes and their low mobility in the organism due to their small size and their unsaturated chemical bonds, favoring their accumulation and consequent alteration in the metabolism of organisms [2]. This Heavy metal toxicity in aquatic organisms and its balance depends on several limnological factors which determine its concentration in the environment and the availability of aquatic biota such as pH, alkalinity, hardness, organic matter, total solids and sedimentation [8,9]. Since these metals interact chemically with other elements, binding to the suspended particulate material, being able to precipitate next to the sediment or to be in the water column, being available to the biota [2]. The elevation of pH, for example, can increase adsorption of Zn to suspended particulate matter, decreasing its dissolved concentration [2].

Fish are also good bioindicators because they react with these mutagenic agents even at low concentrations, and physiological

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characteristics allow fish to survive in different habitats, and in adverse environmental conditions, which makes them appropriate indicators of the environment they live in, especially in regard to persistent and cumulative effects along the food chain [8,10].

Among the species of fish commonly used in aquatic toxicology studies are the *Poecilia reticulata* [11,12] and Zebrafish *Danio rerio* [12]. Among the Brazilian native species that have been used for this purpose are: *Piaractus mesopotamicus* and *Hyphessobrycon eques* [13] and *Hemigrammus marginatus* [12]. The *Phallocerus caudimaculatus* was used by Henares et al. (2011) [14] in the assessment of herbicide toxicity in aquatic weeds and proved efficient for toxicological tests.

The organism used as test in this study was the *Phalloceros caudimaculatus* fish (Fig. 1), known as Guaru, the Cyprinodontiformes order, Poeciliidae Family [15], found in Laguna dos Patos drainage basin, in the lower parts of the Uruguay river drainage basin, Tramandaí and Mampituba rivers drainage and also in coastal areas of Uruguay and Argentina [16].

According to Akanksha et al. (2010) [6], a suitable test organism should have characteristics: be ecologically representative group, viviparous with short reproductive cycle, easy availability, cosmopolitan and also a native species of Brazil [15].

Fig. 1. Specimens of *Phalloceros caudimaculatus* (A1) male; (A2) female; (Lucinda, 2008).

The objective of this study is to evaluate the possibility of using *Phalloceros caudimaculatus* as a bioindicator of heavy metals through toxicity tests and bioaccumulation of Cd, Cr, Pb and Zn.

Materials and methods

This work was carried upon approval of the ethics board for the use of vertebrate animals in laboratory of the Instituto Federal de Educação, Ciência e Tecnologia Sul-rio-grandense (IFSul). The experiments were conducted at the Laboratory of Environmental Contaminants (LACA), at the Grupo de Pesquisa em Contaminantes Ambientais, of the same institution.

The fish were collected from a random sampling from an urban streams in "Laranjal" in the Pelotas, Rio Grande do Sul, Brazil (Fig. 2).

Sampling was carried out with a satin net. Thereafter, the fish were brought to the laboratory and acclimatized in standard tanks with a volume of 30 L, kept for 30 days under constant aeration, and stabilized temperature of 20 ± 2 °C and pH within the neutrality range. Water quality parameters were monitored and management comprised of periodic waste siphoning with 20% volume water change. In the acclimatization period the fish were supplied with a daily diet of commercial feed Sera Vipan flakes™ and Alcon Basic™ with composition for omnivorous fish. During the acute toxicity tests the fish were not fed. The acclimation procedures and experimentation with the fish followed ABNT NBR 15088 [17] determinations.

Preceding the experimental phase, a fish biometry was performed and weight and length measured results showed an average of 0.14 ± 0.15 g (0.4 g Maximum and Minimum 0.03 g) and 1.9 ± 0.71 cm (3.0 cm Maximum and Minimum 1.1 cm), respectively. For the experiments, the fish were separated into batches and those with an average biometrics data were selected.

Acute toxicity test

Acute toxicity tests were performed in triplicate in static environment without water change for 96 h. For these tests, the fish were separated into batches of 8 individuals per treatment, given five treatments with each test substance at different concentrations, and a control treatment, the same experimental conditions,

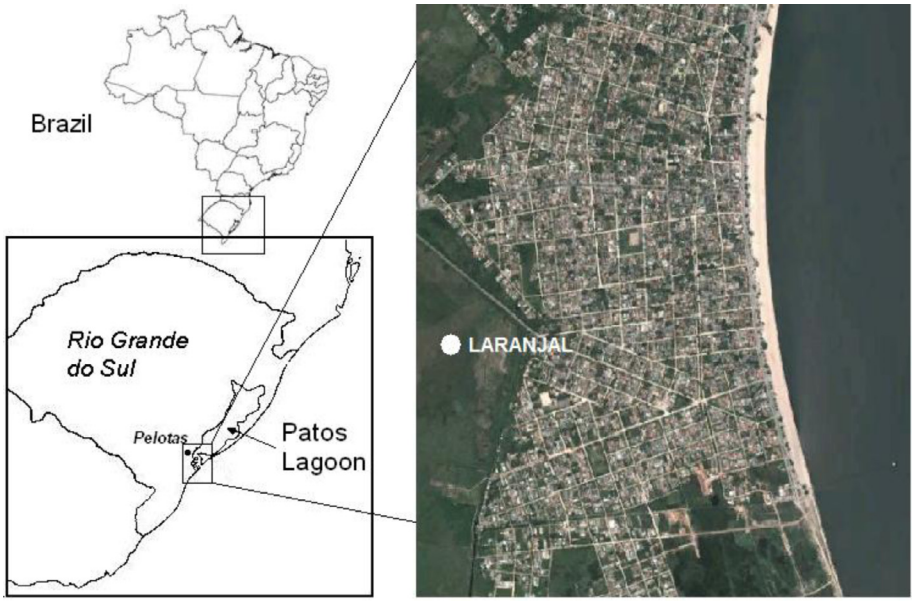

Fig. 2. Collection area location *Phallocerus caudimaculatus*, Google Earth.

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