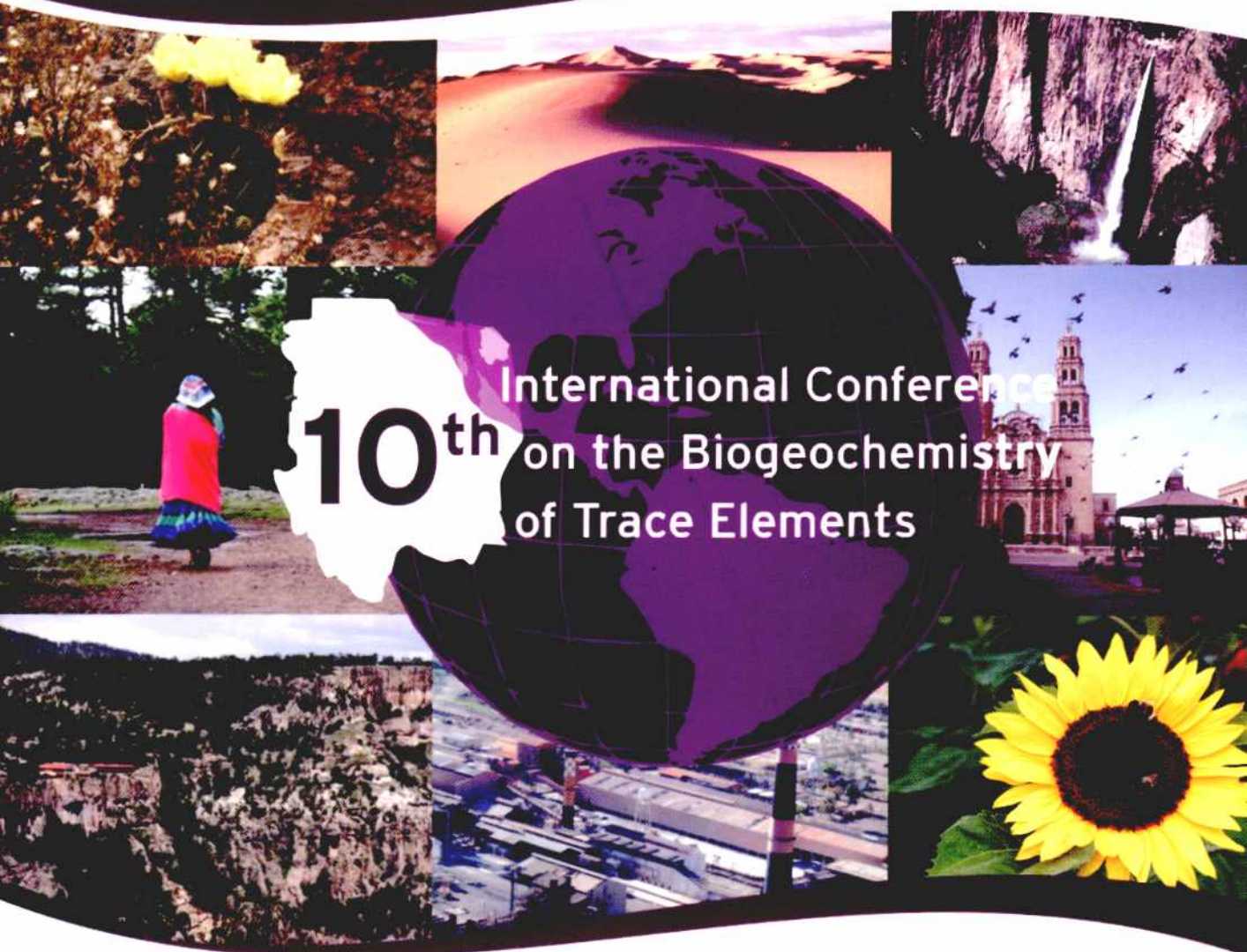


RESEARCH FRONTIERS IN TRACE ELEMENT BIOGEOCHEMISTRY



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Accumulation of Arsenic and Mercury in Mojarra, Catfish and Carp Fish Species From Three Water Reservoirs in Chihuahua State

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Key words: Arsenic, Mercury, fish, water reservoirs, muscle, gills.

Abstract

The levels of arsenic and mercury of fish samples collected in the water reservoirs El Granero, Las Virgenes y La Boquilla were determined by atomic absorption spectrometry with hydride generator. The accuracy of the method was determined by certified reference material (NRCC-DOLT-3 Dogfish Liver). Three factors were studied and their influence on the concentrations of arsenic and mercury in fish: water reservoir, species and tissue. The data were analyzed using analysis of variance (ANOVA) considering the sources of variation caused by the factors and their interactions, making comparison of means tests using Tukey's test when significant differences were detected by ANOVA.

Introduction

The contamination by arsenic and mercury actually is one of the major problems which confront us, mainly the negative effect that occurs in water, soil, sediment, air, plants, animals and human health. The importance of studying the levels of contamination by heavy metals and metalloids in aquatic environments is that they are not degradable, are bioaccumulative and can be easily incorporated into the food chain (Wang *et al.*, 2005; Franco *et al.*, 2008). In recent decades the aquatic environment has been threatened by discharges from agriculture, industrial waste and urban sources. Fish are the final step in the food chain in aquatic environments, because of this, it's important to know the levels of pollutants and verify that they are not harmful to the fish and human health (Uysal *et al.*, 2008; Türkmen *et al.*, 2008).

El Granero (Luis L. Leon), Las Virgenes (Francisco I. Madero) and La Boquilla, are considered within the major water reservoirs in the state of Chihuahua, and are recreational areas where water sports and fishing are practiced, which for many residents of the place are the main source of raising resources for the family.

Despite its economic and ecological importance, in these water reservoirs are present a wide range of pollutants, primarily by the result of anthropogenic activities, this is alarming because the fish from these water reservoirs are used for human consumption and the most important is to be distributed in a large part of the state for sale at supermarket and restaurants.

For that reason, the objectives of this investigation were to determine the levels of contamination by mercury and arsenic in muscle and gills of fish species that are preferred for human consumption in El Granero, Las Virgenes y La

Boquilla, and assess whether they are suitable for consumption.

Materials and Methods

Description of the Area of Study: Sampling was conducted in the water reservoirs El Granero located in the town of Aldama (UTM coordinates: 471689/3204730), Las Virgenes located in Rosales (UTM coordinates: 438266/3116750), and La Boquilla located in San Francisco de Conchos (UTM coordinates: 460239/3046107).

Description of Population: Fish species Mojarra (*Lepomis macrochirus*), Catfish (*Ictalurus punctatus*), and Carp (*Cyprinus carpio*) are of interest to this study because of their economic importance in the region and preference for human consumption.

Sampling: Samples were taken in October 2005, March and August 2006 and March 2007.

Analytical Method: Sected gills and muscle of the fish using plastic gloves and stainless steel knives. Homogenized samples were dried at 55 ± 5 °C in a drying oven of the mark Shel lab, model FX and 1350. For validation of analytical method was used certified reference material Dolt-3 (Dogfish Liver Certified Reference Material for Trace Metals) of the National Research Council Canada (NRCC). To the samples digestion a new method was developed to free the arsenic that is caught in the arsenobetaina, weighed 0.5 g of sample and add 5 ml of HNO₃, 5 ml of H₂SO₄ and 1 ml of H₂O₂, cooled to room temperature and filtered with filter paper of > 8 μm for muscle and > 2.5 μm, to gills; filtering is received in volumetric flasks of 50 ml. With this digestion recoveries obtained were from 99.75% to arsenic and 99.57% to mercury. The samples were analyzed at the atomic absorption spectrophotometer,

GBC model Avanta Σ , using hydride generator HG 3000, as a system for sample introduction.

Statistical Analysis: In this research, three factors were studied and their influence on the concentrations of arsenic and mercury in fish: the first factor was water reservoir with three levels (El Granero, Las Virgenes y La Boquilla), species with three levels (Mojarra, Catfish and Carp) and tissue with two levels (gill and muscle). The data were analyzed using analysis of variance (ANOVA) considering the sources of variation caused by the factors and their interactions, making comparison of means tests using Tukey's test when significant differences were detected by ANOVA. For the analysis procedure was used GLM (General Linear Model) of the SAS statistical package.

Results and Discussion

The concentration of mercury exceeds the maximum allowed by Mexican Official Standard NOM-028-SSA1-1993 of 1.0 mg/kg in muscle of Catfish in water reservoirs La Boquilla with 1.278 mg/kg (Figure 1), so it's necessary to find alternatives for these species detoxification.

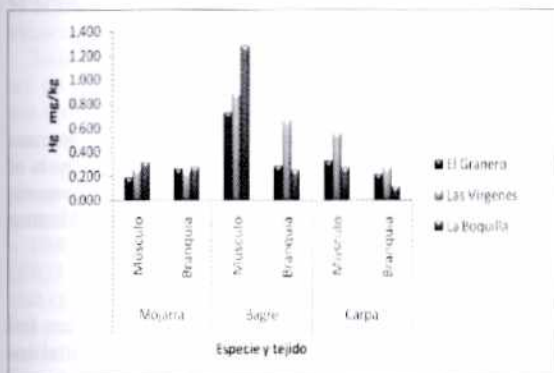


Figure 1. Comparison of the concentration of mercury respect to the Mexican Official Standard NOM-028-SSA1-1993.

Arsenic is also found in excess in all species and tissues and exceeds the permitted limits for water and food for human consumption, as the Mexican Official Standard NOM-127-SSA1-1994, considers a maximum allowable 0.025 mg/L in water for human use and consumption and NMX-F-025-1982 establishes a maximum of 0.1 mg/kg of arsenic in tomato paste (Figure 2). The arsenic highest concentration in muscle was reported in the species Mojarra in El Granero (3.978 mg/kg) y La Boquilla (5.136 mg/kg).

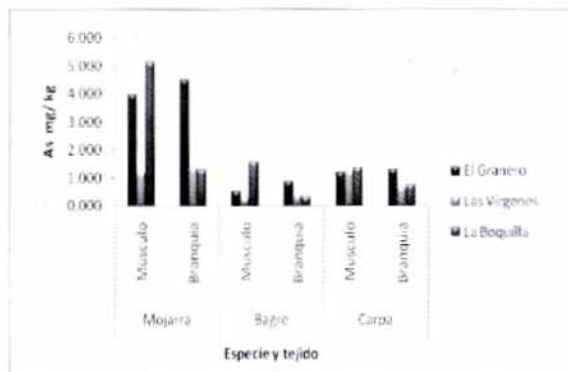


Figure 2. Comparison of the concentration of arsenic respect to the Mexican Standard NMX-F-025-1982.

Conclusions

The highest concentrations of arsenic were presented in the species Mojarra in La Boquilla and El Granero. Mercury highest concentration were presented in the catfish species in La Boquilla. Due to exceed the limits permissible by law for the species catfish in mercury and Mojarra in arsenic are advised not to consume these fish while performing a program of constant monitoring and detected that concentrations are below these limits.

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