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Bioaccumulation of trace metals in banded Persian bamboo shark (*Chiloscyllium arabicum*) from the Persian Gulf: A food safety issue

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ABSTRACT

Persian bamboo shark (*Chiloscyllium arabicum*) was collected from two sites of the Khozestan province, northern basin of Persian Gulf, with the aim to identify differences in metal concentrations between fishing areas as well as the risk for human health due to consumption of the selected species. We analyzed Zn, Cu, Pb, Hg, Cd and Ni in muscle and liver tissues of specimens from both areas of study using atomic adsorption spectrometry. Statistical elaborations revealed higher bioaccumulation of metals in livers than muscle as well as in the site of worthy of Musa as regards Zn, Pb and Ni than the site of worthy of Darvis, due to the more intensive anthropogenic input. The risk for consumers is low for the most of metals, with the exception of the THQ for Hg, which resulted next to the level of risk with high frequencies of consumption.

1. Introduction

Among the environmental compartments, the aquatic ecosystem is the most affected by pollutants like metals, metalloids and organic contaminants, altering the aquatic ecological status (Ferrante et al., 2015). Some metal have shown the ability to biomagnify through the aquatic food chain, leading to a critical accumulation in top predators, such as sharks (Adel et al., 2016; Endo et al., 2008; Ferrante et al., 2017; Storelli et al., 2003a). Seafood consumption represents an important source of nutrients, e.g. proteins and essential fatty acids necessary for a healthy human life and in prevention of several diseases (Cederholm, 2017; de Matos et al., 2012; Gopinath et al., 2017; Rodrigues et al., 2017). Risk and benefits for human health associated to diet style are extensively highlighted by many scientific works. Nevertheless, toxicological studies have been shown that seafood consumption represents the major contributor of human exposure to heavy metals, drugs and several Persistent Organic Pollutants (POPs) (Adel et al., 2017; Bonsignore et al., 2013; Conte et al., 2015; Conte et al., 2016; Copat et al., 2013, 2014; Dadar et al., 2016; Karl et al., 2016; Maisano et al., 2016; Oliveri Conti et al., 2015; Storelli et al., 2003b). Mercury (Hg), lead (Pb), cadmium (Cd), copper (Cu) and arsenic (As), because of their lipophilic behavior, have been found to biomagnificate in fish, with concentrations above the international thresholds (Adel et al., 2016; Bosch et al., 2016; Cappello et al., 2016a; Conti et al., 2012a; Copat et al., 2012a; De Domenico et al., 2011, 2013; Pappalardo et al., 2017). Sharks are able to accumulate and biomagnificate metals quantities greater than other marine fish species, due to their predatory behavior, very long life and high trophic level (Adel et al., 2016; Endo et al., 2016; Lopez et al., 2013; Storelli et al., 2003a).

Shark flesh is used for meat, which is highly favored in some regions, most particularly in Europe with northern Italy and France as the major consuming countries and Spain as the world's largest exporter of shark meat. Meat is a high protein, low fat and healthy product, as long as those specimens with a high mercury content are avoided. Consumption of shark's meat have been recognised as a traditional seafood of some Pacific and Asian areas, where shark intestines and skin are also eaten, chiefly in some Asian countries (FAO, 2012, 2017). The *Chiloscyllium arabicum* (family Hemiscylliidae), also known as Persian bamboo shark, is a small benthic shark found at a maximum depth of 85 meters. It is spread from the Persian Gulf to the coasts of southern India and it represents the most common shark of Persian Gulf (Compagno, 2001). Worldwide, all species of bamboo sharks are classified as Near

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Threatened by the Red List of the International Union for Conservation of Nature. The major threats to these sharks are primary the loss of their habitat (primarily due to pollution) and extensive hunting not only for its meat consumption, but for their fins too, especially in Asian country. In the past, the Persian bamboo shark has been seriously threaten during the Gulf war, causing the drastic reduction of the population (Compagno, 2001).

The Persian bamboo shark inhabiting shallow coastal waters can be affected by several pollution sources, e.g. urban and industrial wastewaters, whose represent the major sources of metals released in the environment (Adel et al., 2016). Persian bamboo shark, and others, might represent a possible alternative food for Iranian costal population; however, as mentioned before, shark's tropisms can be a potential hazard for the adverse effects associated to metals.

Hence, the main objectives of our study was in a first instance to analyse zinc (Zn), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and cadmium (Cd) concentrations in muscle tissues and livers of 40 specimens of *C. arabicum* caught from two areas of the Iranian coastal waters of the Persian Gulf. Then we compared the differences in the degree of pollution between two sites and finally we estimated the potential human health risks derived from oral consumption of *C. arabicum* by the Exposure Daily Intake (EDI) and the Target Hazard Quotient (THQ) for all studied metals.

2. Material and methods

2.1. Sampling and study area

Forty samples of Persian bamboo shark (*Chiloscyllium arabicum*) (n = 20 male, n = 20 female) were collected by fishing trawler from Khozestan province, northern basin of Persian Gulf in worthy of Musa and worthy of Darvis from September to January 2016 (n = 10 male, n = 10 female from each worthy) (Fig. 1). The sex of shark has been assessed by examining clasper (in male sharks) and macroscopic examination. The bamboo sharks were transported to the central laboratory and approximately 50 g of muscle and 10 g of liver from each individual shark were collected in sterile polythene bags and kept in the laboratory deep freezer (−80 °C) to prevent deterioration until further analysis.

2.2. Analytical procedures

The procedure used for measuring trace elements concentrations in shark samples has been previously described (Dadar et al., 2014). Briefly, the muscle of shark was dried in an oven at 110 °C for 48 h until a constant weight was obtained and then finely grounded separately. Trace elements concentrations were measured with the standard addition method with minor modification. To determine the concentration of heavy metals, 0.3 g of fish sample was accurately weighed. Samples were digested by using high pressure decomposition vessels according to the previous method (Dadar et al., 2014). Each sample was mixed with 5 mL of 68% nitric acid (Super Purity quality; Romil Ltd., Cambridge, UK), 4 mL of 30% hydrogen peroxide (Suprapur quality; Merck, Darmstadt, Germany) and 1 mL concentrated perchloric acid (Suprapur quality; Merck, Darmstadt, Germany).

For mercury digestion, 45 mg of V2O5 were added to samples. Then, they were diluted to 50 mL with 20 mL distilled water and K2Cr2O7 (% 2). Digestion was performed on a hotplate, at 200 °C, for at least 4 h or until clear and all particles had turned white color. Digested samples were filtered through a 0.45 µm nitrocellulose membrane filter, and diluted 1:5 with high purity deionized water.

Concentrations of Zn, Cu, Pb, Hg, Cd and Ni in edible muscles and liver of bamboo shark samples were extracted in triplicate with a laboratory fortified matrix (LFM) per batch and determined using atomic adsorption spectrometry (Thermo SOLAAR M6, Thermo Scientific). A digestion blank was analysed in the same way.

The overall LFM recovery rates (mean ± SD) of Zn, Cu, Ni, Hg, Cd and Pb were 90 ± 3.3%, 95 ± 3.9%, 94 ± 9.6%, 90 ± 2.6%, 90 ± 12.4% and 88 ± 8.1%, respectively. The limit of detection (LOD) for Zn, Cu, Ni, Hg, Cd and Pb were 0.17, 0.08, 0.02, 0.001, 0.006 and 0.005 µg/g, respectively. Concentrations of trace elements are expressed as mg/Kg wet weight (w.w.).

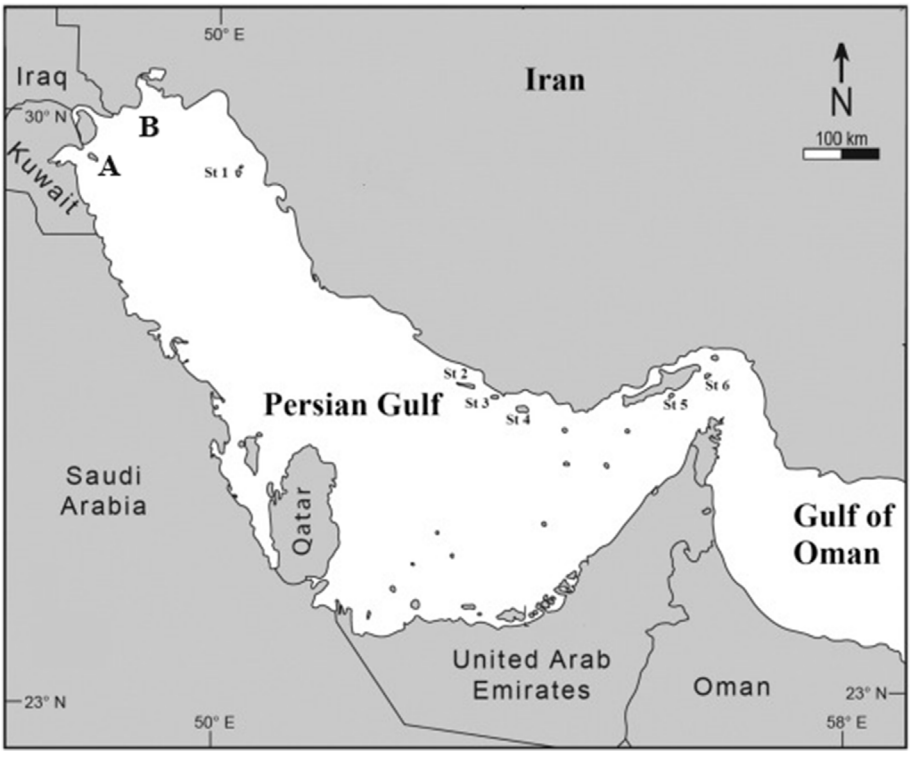

Fig. 1. Sampling localities along the northern basin of Persian Gulf (A Worthy of Musa; B Worthy of Darvis).