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Heavy metal concentrations in edible muscle of whitecheek shark, *Carcharhinus dussumieri* (elasmobranchii, chondrichthyes) from the Persian Gulf: A food safety issue

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ABSTRACT

Together with several health benefits, fish meat could lead to heavy metal intoxication of consumers. In this study, we discuss Zn, Cu, Pb, Hg and Cd concentrations in fillets of forty specimens of *Carcharhinus dussumieri*, analyzed with atomic adsorption spectroscopy (AAS). The potential human health risks due to consumption of C. *dussumieri* was assessed by estimating average daily intake (EDI) and target hazard quotient (THQ) of metals. The average concentrations of metals measured in this study were (ppm dry weight): Cu 7.49 ± 0.25; Zn 3.47 ± 0.26; Pb 0.12 ± 0.03; Hg 0.028 ± 0.02; Cd 0.11 ± 0.03. Our results showed that no metal exceeded the EC and FAO limits. Cu and Cd accumulate in muscles with a body length (age)-dependent manner. The exposure daily intake of all toxic metals analyzed was found lower than the PTDI provided by WHO and the THQ resulted lower than 1, suggesting no risk for human health derived from consumption.

1. Introduction

Aquatic environments are continuously threatened by inorganic contaminants including trace metals and metalloids (Sciacca and Oliveri Conti, 2009; Longo et al., 2013; Dadar et al., 2016), and organic contaminants (Conte et al., 2016; Oliveri Conti et al., 2012). Some metals show the ability to biomagnify through the aquatic food chain leading to levels of concern in top predators (Seixas et al., 2014; Ouédraogo et al., 2015).

Seafood is an important source of proteins and essential fatty acids necessary for a healthy human life (Oliveri Conti et al., 2015). Nevertheless, several studies have been highlight that seafood consumption is a major contributor to the uptake of heavy metals in the human body together with many other toxic substances such as algal bio-toxins and drugs (Adel et al., 2016; Oliveri Conti et al., 2015; Copat et al., 2012, 2014, 2015; Conte et al., 2015; Ferrante et al., 2010; Ferrante et al., 2013). Among metals, mercury (Hg), lead (Pb), cadmium (Cd), copper (Cu) and arsenic (As) have been frequently found to accumulate in fish fillet, with quantities above the legal limits (Bosch et al., 2016; Vandermeersch et al., 2015). Evidences of shark consumption have been available as early as the fourth century (FAO, 2016) and nowadays it represents a traditionally seafood of coastal areas.

For their predatory behavior, long life and high trophic levels, sharks accumulate higher metals concentrations than other marine fishes (Delshad et al., 2012).

The whitecheek shark, *Carcharhinus dussumieri*, is one of the most common sharks of the Persian Gulf. The species inhabits coastal waters affected by many urban and industrial wastewaters, which are sources of trace metals (Moore et al., 2015). This species is distributed in the northern Indian Ocean from the Persian Gulf to

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List of abbreviations

Mercury Hg
Lead Pb
Cadmium Cd
Copper Cu
Nickel Ni
Zinc Zn
Limit of detection LOD
Average Exposure Daily Intake EDIa
Target Hazard Quotient THQ
Exposure Daily Intake per meal size EDIm
Exposure frequency EF
Exposure duration for adults of 70 years ED
Oral Reference Dose (μg/g/day) RfDo
Averaging Time AT
Provisional Tolerable Daily Intake PTDI)
Meal sizeMS
Body Weight BW
Average Annual Ingestion Rate IR
Unites States – Environmental Protection Agency US-EPA
Vanadium Pentoxide V_2O_5
Potassium dichromate $K_2Cr_2O_7$)

India at depth of less than 100 m. White (2012) and, his meat is highly used for human consumption (Vannuccini, 2002; Delshad et al., 2012), representing a potential human health hazard for its content of certain metals (e.g. Hg, As, Pb etc.).

The main objectives of this study were:

- to analyze the total mercury (Hg), zinc (Zn), copper (Cu), nickel (Ni), lead (Pb) and cadmium (Cd) concentrations in muscle tissue of whitecheek sharks caught from the Iranian coastal waters of the Persian Gulf;
- to assess the relationship between body length and weight with metals levels in muscle;
- to estimate the potential human health risks derived from oral consumption of *C. dussumieri* by the average daily intake (EDI) and the target hazard quotient (THQ) for all metals studied.

2. Material and methods

2.1. Sampling and study area

Forty specimens of whitecheek shark (*Carcharhinus dussumieri*) (n = 20 male, n = 20 female) were collected between December and January 2014 by fishing trawler from Hurmozgan province. Sampling sites were located on the northern basin of Persian Gulf, between Larak and Lavan islands, in 4 coastal stations: A (26.55° N, 57.12° E), B (26.32° N, 56.55° E), C (26.20° N, 55.34° E) and D (26.09° N, 54.80° E) (Fig. 1). The sex of shark was recognized both by examining clasper in male shark and macroscopic examination. The whitecheek sharks were been transported to the central laboratory of Iranian Shrimp Research Center (Bushehr, Iran) and their total length (cm) and total weight (kg) were measured. Approximately 50 g of muscle from each individual shark were collected in sterile polythene bags and kept in the laboratory deep freezer (−80 °C) to prevent deterioration until analysis.

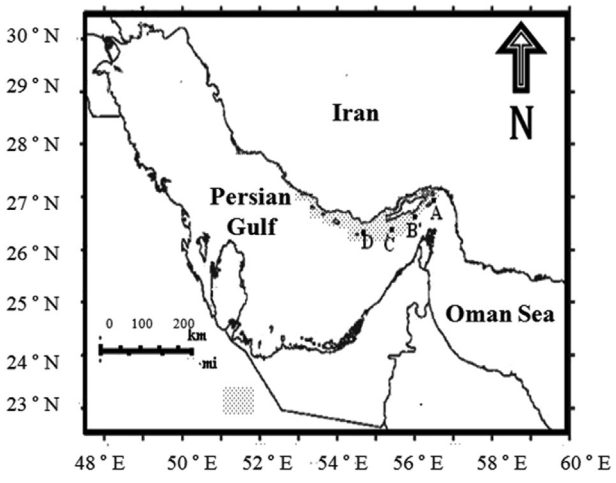

Fig. 1. Study area.

2.2. Analytical procedures

The procedure used to measure trace elements concentrations in shark samples was described previously (Dadar et al., 2014). Briefly, muscles of shark were been dried in an oven at 65 °C for a period of 48 h until a constant weight was obtained and ground separately. The average water content we found was of 76%. The tissue was measured using Walkey-Black titration and trace elements concentrations were been measured with the standard method with minor modification. Edible aliquots of muscle (0.3 g) were accurately weighed and digested by high pressure decomposition vessels according to the method described in our previous study (Dadar et al., 2014). Sample were mixed with 5 mL of 68% nitric acid (Suprapur; Romil Ltd., Cambridge, UK), 4 mL of 30% hydrogen peroxide (Suprapur; Merck, Darmstadt, Germany) and 1 mL concentrated perchloric acid (Suprapur; Merck, Darmstadt, Germany). For Hg digestion, 45 mg V_2O_5 was been added to the samples. Then they were diluted to 50 mL with 20 mL of distilled water and $K_2Cr_2O_7$ (2%). Digestion was been conducted on a hotplate, at 200 °C, for at least 4 h or until clear and all particles had turned white color. Digested samples were been filtered through a 0.45 μm membrane filter of nitrocellulose, diluted with high purity deionized water at a ratio of 1:5 and analyzed with flame atomic absorption spectrophotometry (Thermo M5 Series AA, Germany) equipped with a microcomputer-controlled acetylene flame. Samples were been analyzed in triplicate and, the results collected on a dry weight basis. Blanks were been processed in the same way of the samples. The overall 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) Zn, Cu, Ni, Hg, Cd and Pb were 0.17, 0.08, 0.02, 0.001, 0.006 and 0.005 μg/g, respectively.

2.3. Daily intake and risk assessment

The estimated daily intake per meal size (EDIm), per average annual ingestion rate of freshwater fish (EDIa), and target hazard quotient (THQ) were calculated according to the equation reported in previous reports (Copat et al., 2012; Oliveri Conti et al., 2012).