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Metal concentrations in fillet and gill of parrotfish (*Scarus ghobban)* from the Persian Gulf and implications for human health

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ABSTRACT

Despite the benefits of seafood's consumption, the bioaccumulation of metals in fish can endanger consumers' health. This study analyzed lead (Pb), mercury (Hg), Arsenic (As), and Cadmium (Cd) concentrations in fillet and gill of parrotfish (*Scarus ghobban*) using flame atomic adsorption spectroscopy (FAAS). The potential non-carcinogenic and carcinogenic health risks due to consumption of *Scarus ghobban* fillet were assessed by estimating average target hazard quotient (THQ) and total target hazard quotient (TTHQ) and Incremental Lifetime Cancer Risk cancer risk (ILCR) of the analyzed metals. This study indicated that Cd, Pb, As and Hg concentrations were significantly ($p < 0.05$) lower than Food and Agriculture Organization (FAO) and national standard limits. The meal concentrations (μg/kg dry weight) in both fillet and gill were ranked as follows Pb > Cd > As > Hg. THQ and TTHQ were lower than 1 for adults and children, indicating that consumers were not at considerable non-carcinogenic risk. However, ILCR value for As was greater than 10^{-4}, indicating that consumers are at carcinogenic risk. Overall, this research highlighted that although the consumption of parrotfish from the Persian Gulf does not pose non-carcinogenic health risks, carcinogenic risks derived from toxic As can be detrimental for local consumers.

1. Introduction

Seafood is a great source of many important minerals, vitamins, essential fatty acids (e.g., polyunsaturated omega-3 fatty acids), and proteins that decrease risk of heart diseases (Adel et al., 2016a; Longo et al., 2013; Miri et al., 2017; Bourre and Paquotte, 2008; Sikorski, 2012; Wall et al., 2010). However, higher concentration of inorganic (toxic metals and metalloids) (Fakhri et al., 2018a; Dadar et al., 2017; Shahsavani et al., 2017; Saha et al., 2016a, 2016b) and organic contaminants (Tierney et al., 2013) in seafood has raised concern for human health through their consumption. Contamination of seafood from metals has become a serious issue due to their stable, non-biodegradable, and longtime persistence in food chain (Adel et al., 2016b; Dadar et al., 2017; Ouédraogo et al., 2015; Seixas et al., 2014; Shahsavani et al., 2017; Zafarzadeh et al., 2017). Bioaccumulation of metals in fish influenced by their nutritional habits, ecological requirements, concentration of metals in water and sediments, fish's life, seasonal changes, and physicochemical properties of water (Fakhri et al., 2018b; Conte et al., 2015; Dadar et al., 2016; Başyiğit and Tekin-Özan, 2013; Malik et al., 2010). Among heavy metals, cadmium (Cd),

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lead (Pb), mercury (Hg), arsenic (As), copper (Cu) have higher potential to be accumulated in fish to concentrations above the standard limits (Bosch et al., 2016a, 2016b; Vandermeersch et al., 2015). Chronic and acute exposures to heavy metals can endanger human health (Fakhri et al., 2018c; Fathabad et al., 2018; Ghasemidehkordi et al., 2018; Adel et al., 2016a; Dórea, 2008; Copat et al., 2012). For example chronic exposure to Pb can cause cerebral diseases and gastrointestinal colitis (Flora et al., 2012), Cd can results in bone pain and cardiovascular diseases (Fagerberg et al., 2017; Kobayashi, 1978), Hg can impair the senses of hearing, touch and sight (Duruibe et al., 2007; Lohren et al., 2015).

More than 80 species of parrotfish are known in relatively shallow and subtropical oceans in the world. They show varying degrees of habitat preferences and utilize coral reef habitats. Some species spend majority of their life stages in coral reefs, while others use seagrass beds, algal beds and rocky reefs (Comeros-Raynal et al. 2012). Due to local and global anthropogenic pressures, parrotfish are losing their reef habits at an accelerated rate. Inshore coral reefs are more vulnerable to local environmental contamination due to their close proximity to the land and various contamination sources (Saha et al., 2016b). Since *Scarus ghobban* lives mostly near shallow shores they are more prone to bioaccumulation of contaminates such as heavy metals (Glynn et al., 2014). Although the consumption of various fish species, including *Scarus ghobban,* in Iran is gradually increasing, estimation of accumulated metal content in different fish organs and associated health risks through consumption of such fish are relatively underexamined. Therefore, it is highly essential to measure metal concentrations in fish to better inform the consumers regarding metal induced health risk (FAO, 2014). Hence, key objectives of this study were to assess the concentrations of four toxic metals (Cd, Pb, Hg, and As) in fillet and gill of *Scarus ghobban* from the Persian Gulf, and to estimate associated human health risks through their consumption.

2. Material and methods

2.1. Study area and sampling

This cross sectional study was performed in Hendijan beach of Khuzestan province, north of the Persian Gulf. The population of Hendijan (30°15′12.22″ N, 40°30′19.22″ E) is ∼50,000 and it has ∼90 km border with the Persian Gulf (Fig. 1). Sixty same-sized *Scarus ghobban* fish samples (harvested at 5 m depth of Hendijan beach) were purchased in 2013 (August to December). Approximately same size fish were selected for this study considering that fish length and weight has significant influence on metal accumulation (Eroğlu et al., 2017). Samples were collected in plastic bags containing ice powder and then transferred to the laboratory where they were kept at - 20 °C temperature until further processing and analysis.

2.2. Sample preparation and analysis

Fish samples were washed with distilled water and then 20 gm of gill tissue and 20 gm of fillet from each fish were removed. Gill and fillet tissues were dried in oven at 65 °C for 48 h. Average moisture content of fish tissue was 79%. One gm of dried gill and 1 gm of dried fillet for every fish sample were carefully weighed and digested with 4 ml of 30% H_2O_2 (Suprapur; Merck, Darmstadt, Germany), 5 ml of 68% HNO_3 (Suprapur; Romil Ltd., Cambridge, UK), and 1 ml of concentrated $HClO_4$ (Suprapur; Merck, Darmstadt, Germany). For measuring total Hg, solutions were additionally digested with 45 mg of V_2O_5 (Dadar et al., 2014). Then, the solutions were diluted with 50 ml of distilled water and 20 ml of 2% $K_2Cr_2O_7$. Digestion was carried out on a hotplate at 140 °C for ∼5 h until the solutions turned to white color. Digested Samples were filtered through 0.42 μm nitrocellulose membrane filter (Whatman's filter) and then diluted with distilled water to 1:5 ratio. Analyses of Cd, Pb and As were performed using flame atomic absorption spectrophotometry (Perkin-Elmer 4100 ZL) and total Hg with cold vapor generation method. The concentration of metals was reported on dry weight (d.w) basis. Overall recovery of Cd, Hg, Pb and As was 90%, 90%, 88%, and 93%, respectively. Limit of detection (LOD) for Cd, Hg, Pb and As were 0.006, 0.001, 0.005 and 0.003 mg/g, respectively. Wet weight was converted to dry weight using 79% moisture content (Saha et al., 2016a).

2.3. Non-carcinogenic risk assessment

Non-carcinogenic risk for the consumers of *Scarus ghobban* fish was estimated using Target Hazard Quotient (THQ) (equation (1))

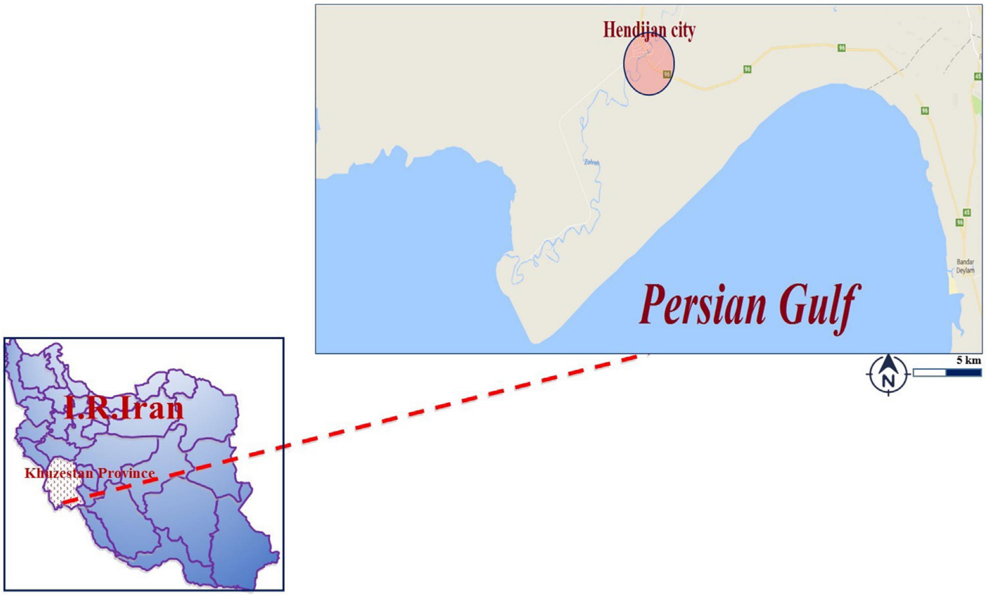

Fig. 1. Location of Hendijan city in the north of Persian Gulf.