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Bioaccumulation of mercury (Hg) in Tigertooth croaker fish tissues (muscle and skin) from Makoran, Oman Sea

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Abstract

In this investigation 18 Tigertooth croaker fishes (Big and small sizes) were samples from Macoran(Chabahar bay, Pozm and Ramin), the Oman Sea, in January 2018 to evaluate mercury levels in muscle and skin tissues and compare the potential of each tissue in mercury accumulation.
After dissecting the fish tissues, muscle and skin samples were digested in laboratory using nitric acid and hydrogen peroxide and their mercury levels were analyzed using ICP-MS, HP 4500.
Mercury accumulation in tissues of small fishes were higher than that in big sizes (except for fish muscle tissue from Ramin), which could be related to dilution factor. The accumulation pattern of mercury in the fish muscle and skin tissues, according to the sampling stations were as: Chabahr >Posm >Ramin and Posm>Chabahr>Ramin.
In this study mercury levels in muscle tissues were compared with WHO maximum consumption limit (0.5 ppm) and also the correlations between mercury accumulation in muscle and skin tissues of big and small sizes of Tigertooth croaker fish, as well as in between sampling stations were investigated (ANOVA, $P<0.05$). The maximum mercury level was found in muscle and skin of small size of fishes in Posm, which was lower than WHO maximum consumption limit.

Keywords: Bio-accumulation, Mercury, Tigertooth croaker fish, Chabahar, Oman Sea

INTRODUCTION

Among the toxic metals, mercury is one of the most hazardous aqua environment pollutants (Agah et al, 2007), which enters to environment through natural and anthropogenic sources (Youn-Joo, 2003). Mercury (Hg) and its organic compounds pose a significant threat against human health, particularly on children and pregnant women (Bjerregaard and Hansen et al., 2000; Vahter et al., 2000, Agah et al., 2007, 2008). Although most of total mercury in aquatic biota (benthic microorganisms and fish) exists in the form of methyl mercury, as the major source of human exposure (US NRC, 2000); but fish consumption cannot be banned in the diets, due to the great source of protein, low levels of saturated fat, which reduce the risk of coronary heart disease (Salonen et al. 1995).

Oman Sea is input path of fresh water flows to the Persian Gulf via Arabian Sea and Indian Ocean. Also it is an important (*and vital*) shipping route for the oil-producing countries in the ROPME Sea Area. Chabahar Bay, which is situated in the Makran Coastline in Sistan and Baluchestan Province, South-east of Iran, is a free port and the only industrial zone in the coast of the Gulf of Oman.

Form the toxicological point of view, the evaluation of the mercury levels in different fish species, which are commonly consumed in the Oman Sea, is important.

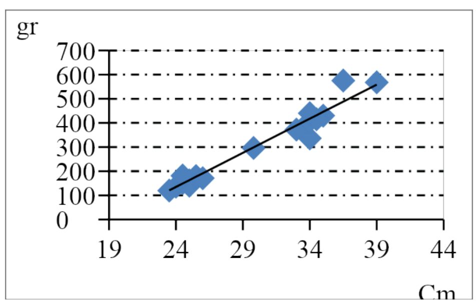
The main goals of this study were I) to investigate mercury distribution in *Tiger tooth* fish tissues (Muscle and skin) from Posm, Chabahar and Ramin, Oman Sea, II) to assess relationship between mercury accumulation in two analyzed matrixes and III) to compare pollution level with guidelines and other marine ecosystems.

MATERIALS AND METHODS

18 fishes (*Tiger tooth*) was collected at Posm (60.2-60.25E; 25.3-25.35N), Chabahar (60.6-60.65E; 25.25-25.3N) and Ramin (60.75-60.8E; 25.2-25.3N) in January 2018, 6 fishes (3 small and 3 bigger ones) per station (Figure 1). The samples were transferred to labeled plastic bags, stored on ice and the same day transported to the laboratory for further treatment and analysis. Prior to analysis, length and weight of the fish were determined (Table1). The muscle and skin tissues were separated and weighted. The samples were deep frozen and lyophilized and again weighted to determine the water content. Then, the samples were homogenized by manual grinding in a ceramic mortar and kept in the deep freezer until analysis (Saei-Dehkordi et al., 2010).

Table 1. Lengths and weights of the fish samples as well as their correlation

Stations	n	Size	Weight	Length
Posm	3	Small	132±11	24.2±0.8
	3	Big	335±38	32.3±2.2
Chabahar	3	Small	177±5	25.3±0.8
	3	Big	421±17	34.2±0.3
Ramin	3	Small	165±16	24.7±0.3
	3	Big	524±82	36.8±2



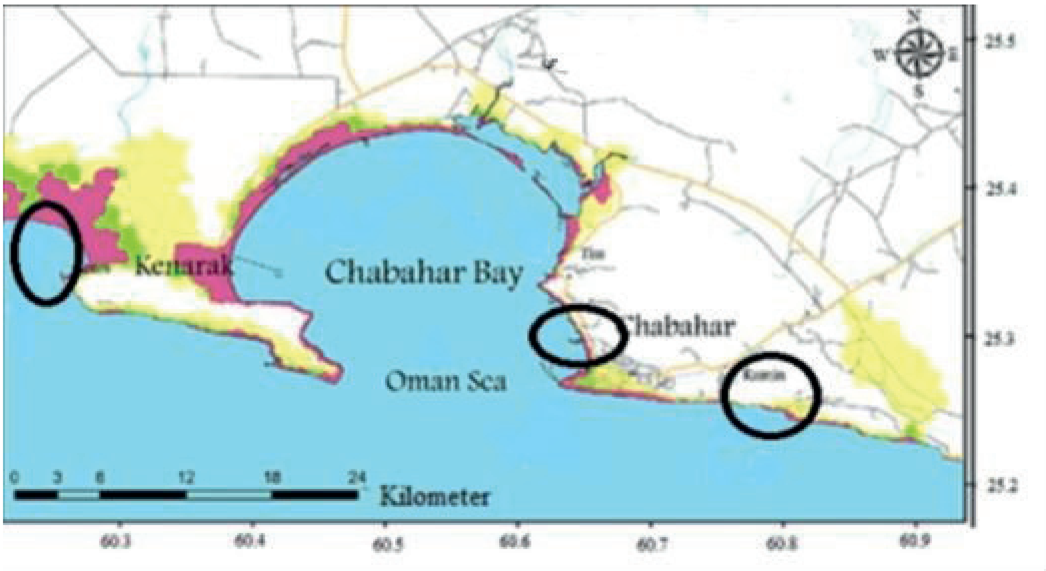


Figure 1. The location of the sampling site in the Chabahr Bay

The results of biometry showed that length of small and big fishes were in the range of 24-26 and 29.8-39 and their corresponding weight were in the range of 120-182 and 296-575, respectively. There was a strong significant correlation between fish weight and length ($y = 28.25x - 543.08$ and $R^2 = 0.95$, Table 1). In this study the length of fishes was used as an indicator of its size. The humidity in fish muscle was 48%.

One gram of each tissue was digested by mixture of glacial nitric acid and Perchloric acid in during 12 hours and subsequently was treated by Hydrogen peroxide at 80℃ for 1 hour and the 3 hours at 150℃ (Liu et al., 2018; Salgado-Ramírez et al., 2017, US.EPA B3050). The digested sample was filtered and its volume was adjusted to 25 ml. Mercury was detected using ICP-MS (HP 4500, equipped with auto sampler Asx-520)

Standard addition method was used to detect the recovery (91±3%). The limits of detectionwere set as three times of the standard deviation on the procedural blanks. All the reported data were over than the detection limit (2 μg.kg^{-1}) of analyzing instrument.

Statistical analyses of the data including correlation and regression calculations were carried out by using SPSS V19 and Excel. A Kolmogorov-Smirnov test was executed to analyze thenormality of data distribution. Spearman correlations were calculated between mercury concentrations in the two matrix at three stations and different matrixes.

RESULTS

The mercury level in fish muscle was in the range of 0.11-0.33 (0.23±0.04) μg g^{-1} and 0.11-0.44 (0.31±0.03) μg g^{-1} for big and small fish sizes. The mercury level in fish skin was in the range of 0.12-0.46 (0.28±0.03) μg g^{-1} and 0.31-0.65 (0.46±0.04) μg g^{-1} for big and small fish sizes (Table 2). There was significant correlation between mercury accumulations in fish muscle and skin per stations (ANOVA, $P<0.05$). There was weak correlation (0.66, $p=0.95$) between mercury levels in skin and muscle fish tissues.

The results showed that mercury accumulation in edible tissue (muscle) were less than its accumulation in non-edible (skin) tissue. Among studied stations, the fish caught from Posm had higher amounts of mercury.

Total Hg concentration in the muscle of all fishes was lower than the WHO warning consumption limit in fish muscle (0.5 μg g^{-1} w.w). Total Hg concentration in small Tigertooth croaker fishes from Ramin were in the range of values reported for unpolluted fishes (<0.05 μg g^{-1} w.w). This finding showed consumption of small Tigertooth fishes in Ramin presented no health risk to consumers.

Table 2. Mercury levels (ppm) in skin and muscle fish tissues

Stations	Fish size	Skin	Average	Muscle	Average
Posm	Big	0.46±0.037	0.554	0.111±0.012	0.273
Posm	Small	0.648±0.059		0.435±0.041	
Ramin	Big	0.123±0.014	0.264	0.106±0.011	0.065
Ramin	Small	0.405±0.039		0.024±0.003	
chabahar	Big	0.255±0.026	0.285	0.325±0.031	0.352
chabahar	Small	0.314±0.033		0.38±0.004	

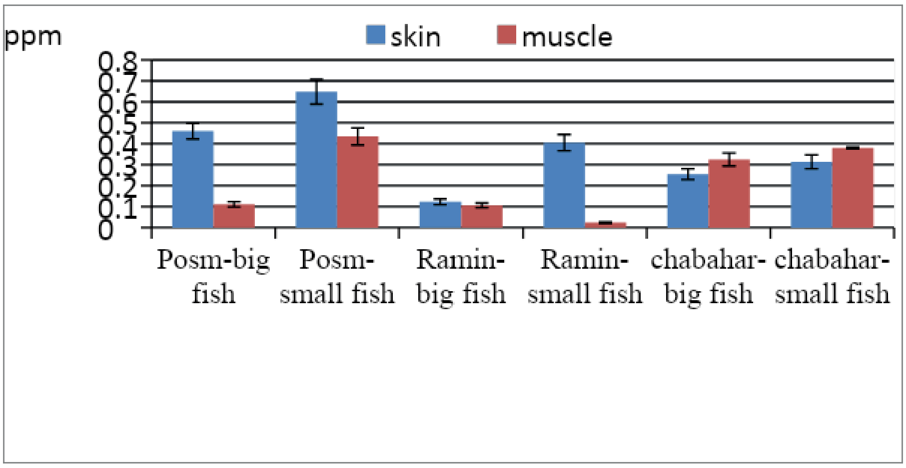


Figure 2. Mercury levels (ppm) in skin and muscle fish tissues.

Big Tigertooth fishes from Posm and Ramin displayed values in the lower range of slightly polluted fishes (0.05 -0.3 µg g^{-1} w.w) and remaining samples, small fishes from Posm and all the fishes Chabahar Bay were in the range of polluted range (Zhou and Wong, 2000).

Mercury accumulation in tissues of small fishes was higher than that in big sizes (except for fish muscle tissue from Ramin). Generally, the concentration of heavy metals in the small size fish were more than the big size, this was due to dilution factor which occur during fish growth.

The accumulation pattern of mercury in the fish muscle and skin tissues, according to the sampling stations were as: Chabahr>Posm>Ramin and Posm>Chabahr>Ramin.

CONCLUSION

The results of this investigation demonstarted that mercury levels in fish skin was higher than fish muscle. Higher mercury levels in skin tissue in comparing with mscle tissue was reported in other investigations (Langston et al, 1995; Roesijadi and Robinson, 1994; Al-Yousuf *et al.,* 2000; Turkmen et al., 2007, 2008 a,b, 2010). Mercury accumulation in almost all the small fish samples were higher than the big ones. Tigertooth fishes from Ramin had lower mercury accumulation in their muscles.

Stability of toxic heavy metals (Especially mercury) and their accumulation in food chain is a threat for human health (Zhou et al, 2007; De Astudillo et al., 2005). According to literature review more than 90% of mercury in fish muscle is methylmercury, the most mercury toxic compound. In this study average body weight (75 kg for adults and 25 Kg for children), mercury reference dose (0.1 µg methylmercury, Agah et al, 2007), average mercury level of 0.23 ppm (equal to 0.21 ppm methylmercury) and 250 gr Tigertooth fish per meal, were used to calculate maximum allowable fish meal per month. It was revealed from the results that from mercury point of view adults can use one Tigertooth fish meal per week, while children should use one fish meal per 3 weeks from the study area.

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