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The comparison of Heavy metal concentration in commercial marine fish collected from Red sea and Arabian Gulf in between 2009-2013, with reference to national and international standards

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Abstract

An assessment of marine contamination due to heavy metals was made in Arabian Gulf and Red sea based on marine fish during (2009) and (2013). The concentration of three heavy metals Zn, Cd, and Pb on top predator fish commonly consumed in the region were < 0.4 μg g^{-1} and posed no threat to public health. High Cd concentration (up to 140 μg g^{-1}) was found in the liver in all collected fish.

Key words: Red sea, Arabian Gulf, Cadmium, Zinc, Lead, Tissue, Fish.

Introduction

Heavy metals are the most common in environment. Most of chemical elements can be tolerable, toxic or lethal depending on the individual dosage, several heavy metals, besides being toxic to human being are of significant impact of the biogeochemical cycles, like Cu, Cd, Pb, and Zn often cause contamination of soil, water and food chain[1,2]. Fish content a high quality of protein, high content of two kinds of omega[3] polyunder saturated fatty acids: elcosapentaeonic acid (EPA) and decosahexatenoic acid (DHA) and other nutrients[3,4], thus fish consumption is really recommended. However, the one potential risk of dietary fish eating is its content of heavy metals in which affects the health of people consuming large quantities[5,6]. Many studies suggest that eating affected fish by heavy metals may causes many diseases in human like damage of developing fetuses, neuronal loss in the cerebellum granule layer and bone diseases[7]. Most heavy metals have been included in the regulations of the European Union for hazardous metals. In recent years, the industrial development leads to an increased discharge of chemicals effluents into the ecosystem, leading to damage of marine environment. The discharge of heavy metals to the marine environment can damage marine species due to their toxicity and accumulative behavior[8,9]. Red sea and Arabian Gulf are surrounded by a number of industrial and man activities. Thus it is important to determine the concentration of heavy metals in commercial fish. Therefore, the aim of this study is to know the accumulation of selected heavy metals Cd, Hg, Pb in fresh collected fish were collected from different locations in the Red sea and Arabian Gulf and to compare this study with 2009 foundation, in order to evaluate the hazard level in relation to national and international standards.

Materials and Methods

During the year of 2009 and the year 2013, commonly commercial fresh and frozen *Chaetodon trifascialis* and *Pygoplites diacanthus*, fish samples were collected from Red sea Jazan coast and Arabian Gulf King Abdulaziz port. At both, the collection area and at the lab of frozen speciemt, are the specimens were dissected, and liver, muscle tissues were frozen individually at -27°C in polypropylene and polystyrene containers. All samples were taken to the King Saud University, College of Science, Zoology dept., in Riyadh, for analysis.

At the laboratory, about 10mg dried material of both liver and muscle tissues were digested for 1 hour at 46°C with nitric acid analar and a drop of hydrogen peroxide were added. The elements Cd, Pb, and Zn were assayed by using sequential multi element graphite tube atomic absorption spectroscopy (Varian Techtron, AA. 975, GTA-95, platform atomization). For Cd and Pb, a palladium nitrate-magnesium nitrate matrix modifier was employed. Zn was measured in an air-acetylene flame using a manual micro-injection method (100ml sample volume)[4]. The analyzed values for reference material (mg kg^{-1} dry wt.: mean ± 95% confidence intervals, N=number of independent determination) are in good agreement with the certified values: BCR CRM 278, muscle tissue (analyzed vs. certified). The distribution of these three heavy metals in three species was tested using the lilliefor test provided in SYSTAT software for windows[4].

Fig 1. Map of Saudi Arabia (Satellite), sowing the collection areas: dammam, Jubal and Jazan ports, at both (2009- 2013)

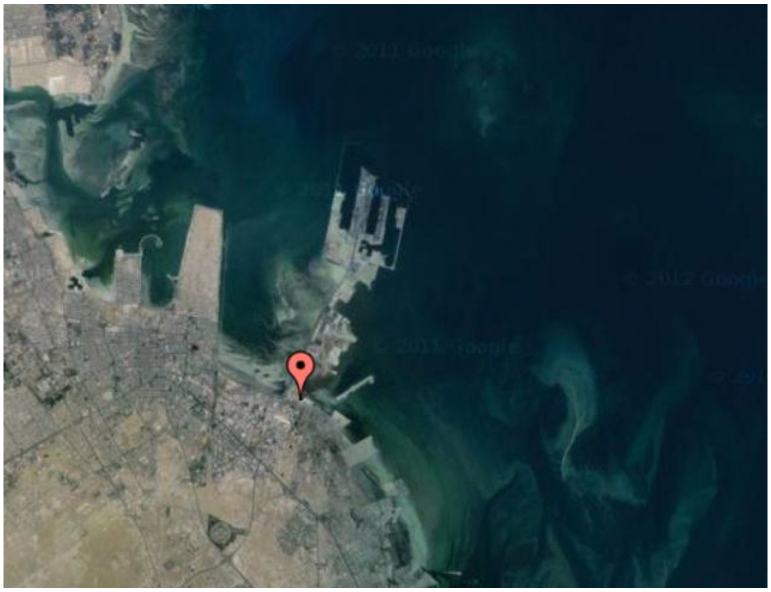

Fig 2.a. Map of Dammam Port (Satellite)

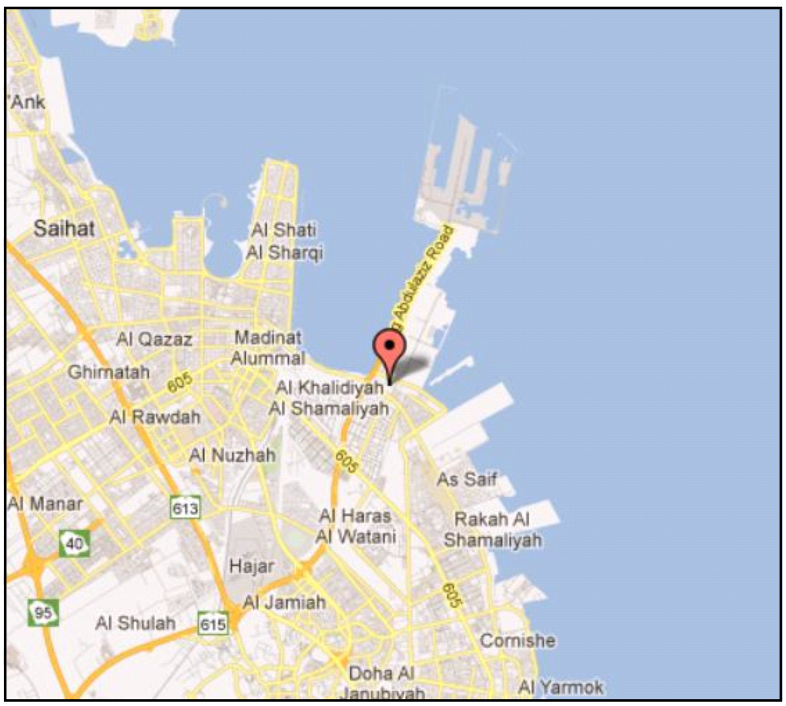

Fig 2.b. Map of Dammam Port (Terrain)

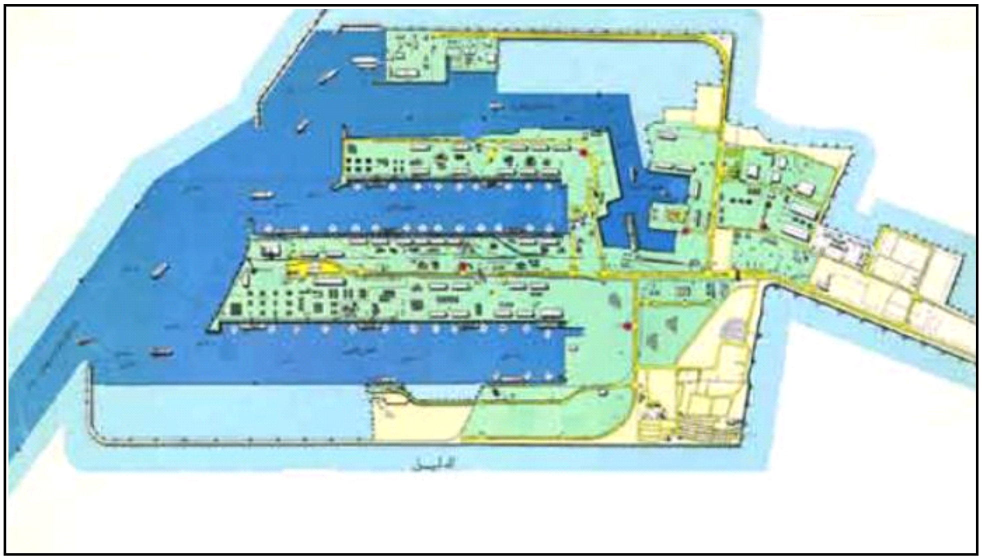

Fig 2.c. Map of Dammam Port, showing the collection area

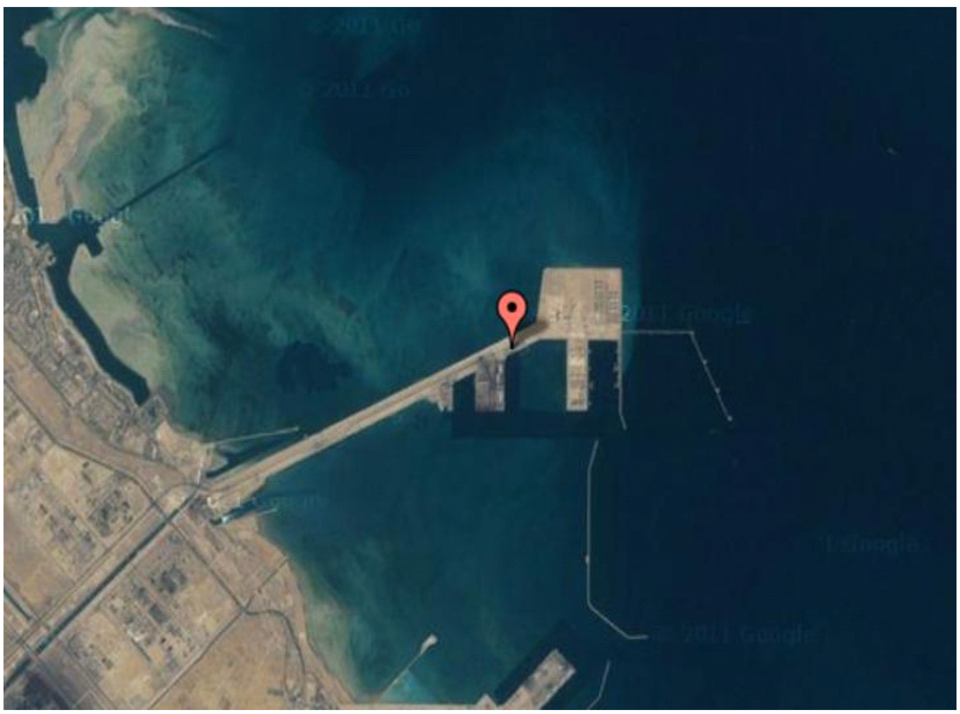

Fig. 3.a. Map of Jubail Port (Satellite)

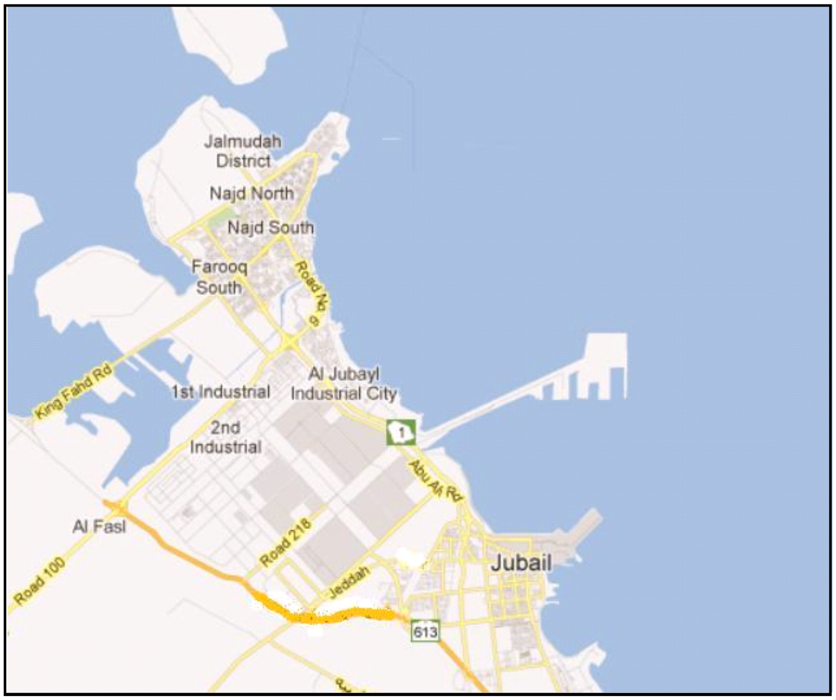

Fig 3.b. Map of Jubail Port (Terrain)

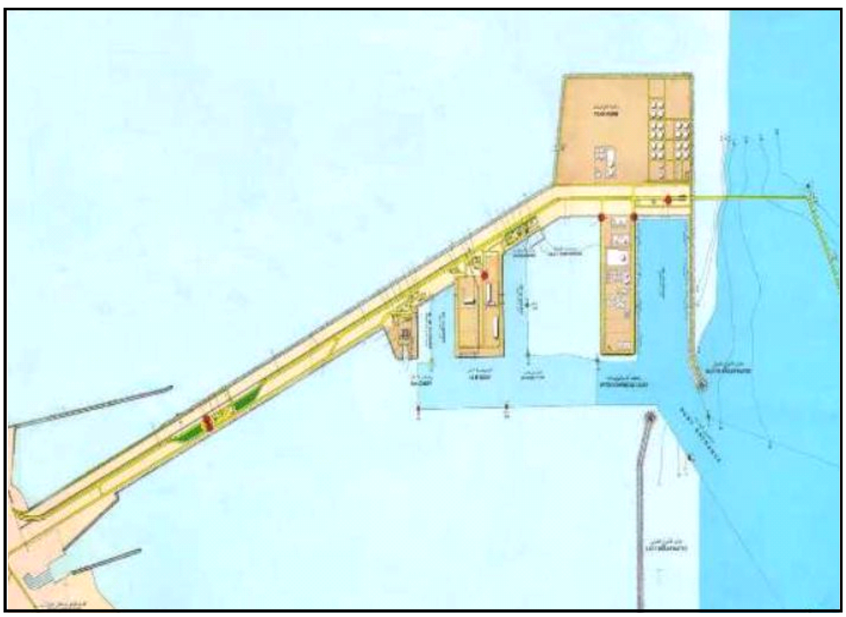

Fig 3.c. Map of Jubail Port, showing the collection area

Fig 4.a. Map of Jazan Port (Satellite)

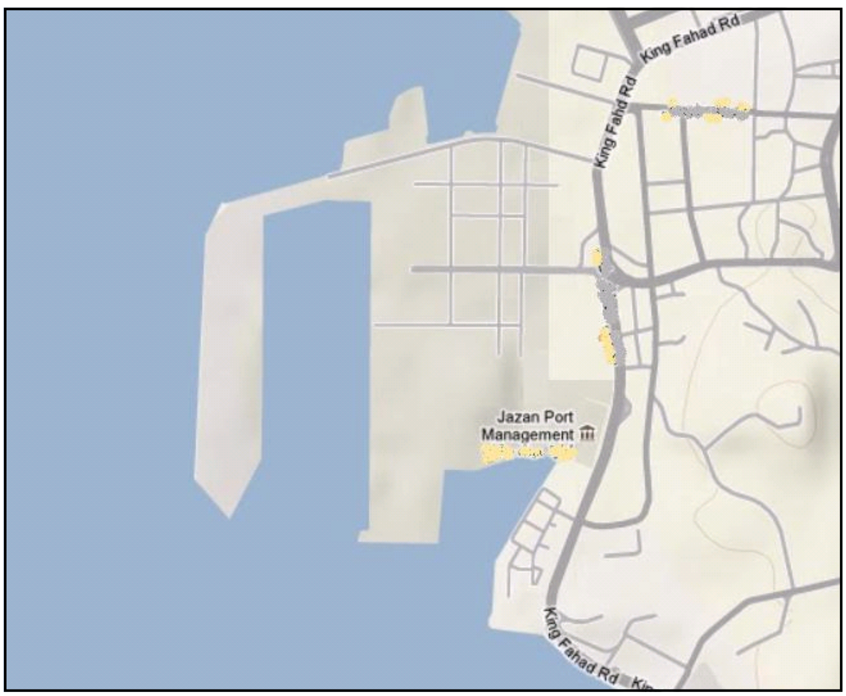

Fig. 4.b. Map of Jazan Port (Terrain)

Fig. 4.c. Map of Jazan Port, showing the collection area

Results and Discussion

For most of the elements, the average concentration of the element in the sample was closed to the world average[10,11]. The concentration of Pb, Zn and Cd in the liver and muscle tissues of *C. trifascialis* and *P. diacanthus* were shown in table (1, 2, and 3), and in water column asa well as in plankton were shown in table (4a, 4b). The measurement of heavy metals were detected in the year of (2009) and in the year of (2013) at Dammam port (King AbdulAziz port) and at Jazan port,Rea sea Saudi Arabia. The Student-Newman-Keul's test is used. Data shown with different letters are significant at the $P < 0.01$ level.

The patterns of heavy metals occurrence in muscle tissues of the studied species samples in order of increasing contents were Zη > Pb

Table 1. Concentration of Cadmium in various tissues of *C. trifascialis* and in *P. diacanthus* (µg/g wet wt.) (2009-2013)

Species	Tissue	2009		2013	
		Dammam port X ± SX	Jazan port X ± SX	Dammam port X ± SX	Jazan port X ± SX
C. trifascialis	muscle	05±0.08	0.8± 0.35	0.6±0.09	0.8±0.21
	liver	06±0.03	0.7±0.2	0.8±0.04	0.9±0.24
P. diacanthus	muscle	0.46±0.2	0.7±0.3	0.4±0.1	0.6±0.2
	liver	0.9±0.3	0.6±0.3	0.7±0.2	0.9±0.3

Table 2. Concentration of Zinc in various tissues of *C. trifascialis* and in *P. diacanthus* (µg/g wet wt.) (2009-2013)

Species	Tissue	2009		2013	
		Dammam port X ± SX	Jazan port X ± SX	Dammam port X ± SX	Jazan port X ± SX
C. trifascialis	muscle	6.1±13	7±1.1	7.1±1.3	5.6±0.1
	liver	5.2±1	8±1.2	9.4±1.7	10.1±0.5
P. diacanthus	muscle	7.1±1.2	6±1.1	7±1.1	6.3±1.1
	liver	9.1±1.2	7±1.2	1.1±1.5	11.2±1.7

Table 3. Concentration of Lead in various tissues of *C. trifascialis* and in *P. diacanthus* (µg/g wet wt.) (2009-2013)

Species	Tissue	2009		2013	
		Dammam port X ± SX	Jazan port X ± SX	Dammam port X ± SX	Jazan port X ± SX
C. trifascialis	muscle	0.8±0.6	0.9±0.4	0.9±0.06	0.9±0.5
	liver	0.9±0.6	0.3±0.09	0.8±0.7	0.9±0.6
P. diacanthus	muscle	0.4±0.1	0.6±0.4	0.6±0.3	0.7±0.5
	liver	0.9±0.03	0.7±0.5	0.9±0.05	0.8±0.6

Table 4. Measurement of Cd, Zn, Pb in water column and Plankton at both area of collection, Dammam port and Jazan port in (2009-2013).

(A) In water column (microgram / liter)

Location	Year	Pb	Zn	Cd
Dammam port	2009	6.52	6.68	1.69
	2013	6.8	7.01	1.8
Jazan port	2009	6.1	7.2	1.79
	2013	7.02	7.34	1.9
(B) In Plankton (2009-2013) (microgram /gram. dry wt.)				
Location	Year	Pb	Zn	Cd
Dammam port	2009	195.92	179.18	3.82
	2013	198.95	182.9	3.9
Jazan port	2009	200.91	180.12	2.01
	2013	203.92	190.3	3.2

> Cd. The heavy metals occurrence were Zn > Pb > Cd in the liver. Similar results were previously reported by other workers that high zinc level in 15 different species of marine organisms from the Barnet Sea[12,13].

This was to be expected since Zn is an essential element for fish and other aquatic organisms like crabs and therefore tends to be present at constant low levels for supporting cellular function[14]. Cd and Pb concentration in the tissue of *C. trifascialis* at both years (2009), (2013), is much lower that those of Zn. In the contrast, there is no evidence that Cd and Pb are biologically essential and it appears that even trace amounts animals are normally recorded in tissues of aquatic animals are acquired from the environment. Recent studies confirmed that Cd and other heavy metals may be found in Red sea and Arabian Gulf at elevated levels as a result of anthropogenic activities and they may eventually be accumulated in significant amount in their soft tissue. Measurable harmful effects on living organisms may result after prolonged exposure to heavy metal.

The present study also shown there is a slight different in the heavy metal accumulation in the studied fish, in between the two time collection (2009-2013).analysis of variance (ANOVA) for the heavy metals show significant difference for both season $P < 0.05$.

Conclusion

This study indicated that differences in heavy metals found in liver and muscle tissues of *Chaetodon trifascialis* and *Pygoplites diacanthus* in two locations of Red sea, Jazan Coast and Arabian Gulf, King Abdul-Aziz port. It can be overall concluded that Cd, Pb, and Zn contents in muscle tissues have been analyzed in this study were well below the limits by either the FAO and WHO (1984) for human consumption. Zinc was highest in liver, and muscle analyzed fish in all studies sites.

On the other hand, Cd and Pb were generally the lowest and similar to results reported in the (2009) studies. Consumption of muscle tissue may not be pose as a threat to human health and completely safe.

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