

## Levels and Health Risk Assessments of Cd and Pb in *Pomadasys maculatus* Marketed by Karachi Fish Harbor, Pakistan

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### Abstract

Aim of this study was to measure cadmium and lead concentrations in the edible tissues of Saddle grunt *Pomadasys maculatus* (Bloch, 1793) from Karachi Fish Harbor different seasons of the year 2011. Results showed that the concentration varied from 0.18 to 1.14 with a mean of  $0.59 \pm 0.05 \text{ mg.kg}^{-1}$  for Cd and from 0.02 to 1.54 with a mean of  $0.54 \pm 0.05 \text{ mg.kg}^{-1}$  for Pb. These concentrations are higher than the maximum permissible values in European and other international regulations (Global Agricultural Information Network Report for China, Russian Federation, Australia New Zealand Food Standards, Georgian Food Safety Rules, Turkish Food Codex and the Ministry of Agriculture, Fisheries and Food). However the average weekly intakes of Cd and Pb per body weight values (minimum-maximum) were 0.021 (0.0063-0.0399) and 0.019 (0.0007-0.0539)  $\text{mg.week}^{-1} \cdot 70 \text{ kg body weight}^{-1}$ , respectively and not exceeded the Provisional Tolerable Weekly Intake (PTWI) established. Consumption of Saddle grunt from the Karachi coasts of Pakistan can therefore be said to constitute no health risks so far as the heavy metals investigated are concerned. However, due to the Cd and Pb muscle levels exceeded the maximum levels of fish permitted for human consumption, a plausible health risk could be posed by long-term exposed through Saddle grunt consumption.

**Keywords:** Lead, Cadmium, *Pomadasys maculatus*, Karachi coast, Pakistan

### Introduction

It is being recognized for years that heavy metal levels found in marine coastal areas, whether they are in the dissolved or particulate phase may be derived from a variety of anthropogenic and natural sources (Burrige *et al.*, 1999). Heavy metals still play vital role as contaminants affecting marine environment (Mitra *et al.*, 2010). Some heavy metals found in the edible tissues of fish may be essential as they play substantial role in biological system of the biota including fish as well as in human being, non-essential metals may be toxic and cause crucial harm in human health even at very low concentrations. It is well-known that heavy metals are able to concentrate in edible tissues of fish. The common heavy metals including Cu, Fe, Zn, Mn, Hg, Pb and Cd are readily found in fish (Robisch and Clark 1984; Fernandes *et al.*, 2008) and afterwards transferred to human beings through the food. Toxic heavy metals can be detrimental at certain concentrations when consumed for a long time period. The essential heavy metals may also be toxic if their uptake is intense (Celik and Oehlenschlaeger, 2007). For example, Cd damages the kidney and may cause chronic toxic symptoms such as tumors, hypertension, adverse reproductive capacity, hepatic

dysfunction and impaired kidney function (Al-Busaidi *et al.*, 2011). Similarly, Pb induces renal insufficiency and liver injury (Lee *et al.*, 2011). Furthermore, long-term exposure to Pb may end up coma, mental retardation and even death (Al-Busaidi *et al.*, 2011).

Speedy industrialization and economic development in Pakistan has ensued increased coastal pollution in Karachi of Arabian Sea. Pollutants effect on coastal ecosystem, create extensive damage to marine life especially fish due to their high toxicity (Ahmed and Bat 2015a,b; Ahmed *et al.*, 2015).

The Saddle grunt, *Pomadasys maculatus*, is an amphidromous species that is found in coastal inshore waters. Haemulidae family is small to medium sized fishes, generally inhabiting shallow coastal waters. They occur in coral reef areas, as well as in muddy or weedy waters. Grunts are commonly found in marine and brackish water (Indian, Pacific and Atlantic) rarely in fresh water. Several of the species belonging to this family are rather common in Pakistan. *P. maculatus* is one of the important Grunt fish of Karachi coast, found in coastal waters over sand near reefs. Indo-West

Pacific: throughout the Indian Ocean and the western Pacific, north to China, south to Australia. *P. maculatus* is fished commercially and is taken by bottom trawl, hand-line, set net, trap, and spear (FAO, 2001). Marine fish production was 339.4 thousand tonnes in 2011 (Memon, 2012).

The aim of the present study to determine Cd and Pb concentration in *P. maculatus* fish marketed by Karachi Fish Harbor during different seasons (Pre-monsoon, Mon-soon, and Post-monsoon) of the year 2011 and compared with the Provisional Tolerable Weekly Intake (PTWI) established. Besides, the edible tissues are the part of fish that is ingested by human. It is necessary to verify if heavy metals especially nonessentials are within the maximum levels for human diet. Thus the Cd and Pb levels in the edible tissue of *P. maculatus* were analyzed in this study.

### Materials and Methods

A total of thirty six (36) *P. maculatus* specimens were obtained from Karachi fish Harbor, during pre-monsoon, monsoon and post-monsoon season of the year 2011. The fish samples in each season were transported to the laboratory and were washed with distilled water and then measured. The total length (cm) and body weight (g) were measured. The fish samples were taken randomly and only consumed sizes were used.

The fish were rinsed with distilled water and approximately 5-10 g of muscle of each sample were dissected and stored in a deep freezer at -21 °C until ready for analysis. The muscle and liver tissues of the samples were prepared for heavy metal analysis according to the method described by Bernhard (1976).

Samples were placed in a vented drying oven at 70°C and allowed to dry to constant weight. The samples were then calcined at 500°C for 3 hours until it turned to white or grey ash and ground. Each ash sample was weighed again and dissolved with 0.1 M HCl in beaker. The beakers then cooled to room temperature and one milliliter filtered solution diluted with 25 ml distilled water. Working standards were prepared from stock solutions. A calibration curve was established using standard solutions to every analysis. The solutions were analyzed by Atomic Absorption Spectrophotometer (AAS), with background correction and acetylene as fuel. AAS was chosen as the analysis primarily because of the ease with the samples could be handled and the potential accuracy that could be obtained (Lajunen 1992; Cresser 1994). Detection

limits of Cd and Pb were 0.385 and 0.285, respectively. The weekly intake levels were estimated using the maximum Cd and Pb levels in *P. maculatus*. EWI (Estimated Weekly Intakes) = maximum levels of Cd and Pb (mg.kg<sup>-1</sup>) multiplied by fish consumption (kg.70 kg body weight<sup>-1</sup>.week<sup>-1</sup>).

The samples were analyzed in triplicate and the average results were used to represent the data. A one-way analysis of variance (ANOVA) was carried out and followed by Tukey post hoc comparisons for the source of statistically significant difference (Zar, 1984). The significance was set at 0.05 and statistical software were performed by SPSS-21 and Excel 2010 to examine the effect of seasons (pre-monsoon, monsoon and post-monsoon) and the metal concentrations in *P. maculatus*. All values were being expressed on mg.kg<sup>-1</sup> dry wt. basis.

### Results and Discussion

In this study consumed sizes of Saddle grunt were collected directly from the local fishing boat in Karachi Harbor of Pakistan. The mean lengths (cm) and weights (g) with standard deviations and ranges of *P. maculatus* from Karachi Harbor are summarized in Table 1. The number of Saddle grunt samples in each season was 12.

The results obtained for Cd and Pb levels in Saddle grunt during various seasons is presented in Figure 1. Results showed that the concentration varied from 0.18 to 1.14 with an average of 0.59 ± 0.05 mg.kg<sup>-1</sup> for Cd and from 0.02 to 1.54 with an average of 0.54 ± 0.05 mg.kg<sup>-1</sup> for Pb.

The Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO, 2010) has stated limit for heavy metal intake based on body wt. Provisional Tolerable Weekly Intake (PTWI) of Pb and Cd for an average adult (70 kg) are 0.025 and 0.007 mg.kg<sup>-1</sup>, respectively (Table 2). Estimated Weekly Intake (EWI) and Estimated Daily Intake (EDI) for a 70 kg body weight of an adult person on basis of this study were presented in Table 3.

**Table 1.** Mean±SD, length (cm) and weight (g) of *P. maculatus* during different seasons of the year 2011.

Seasons	Length (cm)	Weight (g)
Pre-Monsoon (N=12)	34.65 ± 1.47	196 ± 9
Monsoon (N=12)	33.22 ± 1.81	188 ± 10
Post-Monsoon (N=12)	35.24 ± 2.00	199 ± 12
Total	38.00	216

In this study Cd levels are higher in pre-monsoon and lower in monsoon, whereas Pb shows the opposite trend. There was no significant difference between Cd levels in edible tissue in seasons of the year 2011 ( $F= 2.646$ ;  $P>0.05$ ), but Pb levels in seasons were statistically different ( $F= 4.134$ ;  $P<0.05$ ). It can be said that, seasonal variation of Cd and Pb in *P. maculatus* is related mostly to environmental variations because of similar size of fish used in this study. Ahmed *et al.* (2014) showed that Fe, Mn, Cd, Pb and Cr concentrations in *Magalaspis cordyla* varied significantly with seasons. The differences of metal levels in *M. cordyla* at different seasons most probably depend on fish condition and its habitat (Ahmed and Bat, 2015b). *M. cordyla* showed positive allometric growth in post-monsoon indicating the fish feeds more in that time (Ahmed *et al.*, 2013).

Cd and Pb are classified in fish as chemical hazards and maximum residual levels have been prescribed for human by various organizations. The Commission Regulation (EC), Global Agricultural Information Network (GAIN) Report for China and Turkish Food Codex (TGK) standard for Cd in fish is  $0.1 \text{ mg.kg}^{-1}$  (EC, 2001; GAIN Report, 2006; TGK, 2009), whereas Georgian Food Safety Rules and GAIN Report for Russian Federation authorities proposed concentration of  $0.2 \text{ mg.kg}^{-1}$  for Cd (Georgian Food Safety Rules, 2001; GAIN Report, 2002). In this study mean Cd concentration in *P. maculatus* from Karachi Harbor was detected as  $0.59 \pm 0.05 \text{ mg.kg}^{-1}$  and was above the standard values. It may be suggested that long term uptake of Cd in fish may toxic. Non-essential Pb is a toxic metal that can affect humans when consumed with contaminated fish. The maximum validated level of Pb proposed by the Turkish Food Codex (TGK) and

**Table 2.** Internationally accepted safe levels for Cd and Pb (modified from Bat *et al.*, 2012).

Metal	Standard	References
Cd	PTWI of $0.007 \text{ mg.kg}^{-1}$	WHO, 2000; Council of Europe, 2001; FAO/WHO, 2010
Pb	PTWI of $0.025 \text{ mg.kg}^{-1}$	WHO, 2004; Council of Europe, 2001; FAO/WHO, 2010

\*body weight.week<sup>-1</sup>

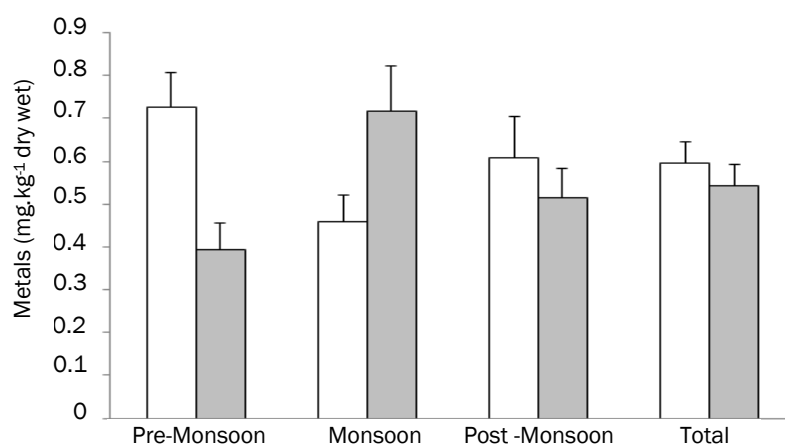
**Table 3.** Estimated Weekly Intakes (EWI) and Estimated Daily Intakes (EDI) of Cd and Pb in edible tissues of Saddle grunt *P. maculatus* from Karachi Fish Harbor different seasons of the year 2011(modified from Bat *et al.*, 2012).

Metal	PTWI <sup>a</sup> (mg.week <sup>-1</sup> )	PTDI <sup>b</sup> (mg.day <sup>-1</sup> )	EWI (mg.week <sup>-1</sup> )	EDI (mg.day <sup>-1</sup> )
			Minimum - Maximum	Minimum - Maximum
Cd	0.49	0.07	0.0063-0.0399	0.0009-0.0057
Pb	1.75	0.25	0.0007-0.0539	0.0001-0.0077

<sup>a</sup>Provisional Tolerable Weekly Intake

<sup>b</sup>Permissible Tolerable Daily Intake

\*70 kg body weight



**Figure 1.** Mean  $\pm$  SD of Cd and Pb concentrations in edible tissues of *P. maculatus* during different seasons of the year 2011. Values are means of three replicates. **Note.** □ = Cd, ■ = Pb

the Commission Regulation (EC) and is 0.30 mg.kg<sup>-1</sup> as wet wt. basis (EC, 2006; TKG, 2009). According to GAIN Report for China and Australia New Zealand Food Standards, Pb level in fish should not go over 0.5 mg/kg as wet wt.basis (GAIN Report, 2006; Australia New Zealand Food Standards, 2011). Georgian Food Safety Rules and GAIN Report for Russian Federation legislation level for Pb is 1.0 mg.kg<sup>-1</sup> (Georgian Food Safety Rules, 2001; GAIN Report, 2002), whereas The Ministry of Agriculture, Fisheries and Food, UK (MAFF) Food Safety limits the level for Pb 2 mg.kg<sup>-1</sup> (MAFF UK, 1995).

The findings of the study showed that Pb levels in *P. maculatus* from Karachi Harbor was above the proposed acceptable limits of EC (2006), TKG (2009), GAIN Report (2006) and Australia New Zealand Food Standards (2011), but below the standard values of Georgian Food Safety Rules (2001), GAIN Report (2002) and MAFF UK (1995) for human consumption. Pb is a widespread metal that finds its way into the Karachi Harbor through discharges from several industries and domestic sewage in Pakistan (Elahi *et al.*, 2015; Ahmed and Bat, 2015a, 2015b; Ahmed *et al.*, 2015).

Furthermore, the PTWI value is an estimate of the level of a metal which may be taken by human over a lifelong without ratable risk. PTWI is established by the Joint Food and Agricultural Organization for the United Nations (FAO) / World Health Organization (WHO) Expert Committee on Food Additives (JECFA). The Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO, 2010) set up PTWIs for Cd and Pb were presented in Table 2, which was equivalent to 1.75 and 0.49 mg.week<sup>-1</sup> for an adult, respectively.

The mean daily fish consumption in Pakistan is 5 g per person (FAO, 2010), which is equivalent to 35 g.week<sup>-1</sup>. The minimum and maximum Cd and Pb levels in Saddle grunt, weekly intake calculated per person for these metals in edible muscles of *P. maculatus* from Karachi Harbor. As it can be seen from the Table 2, the estimated weekly intakes of Cd and Pb per kg of body values were not overstep the limit of the PTWI (Table 3). Similarly, Tariq *et al.* (1993) reported lower values of Pb from offshore waters of Pakistan. This study indicated that intake of *P. maculatus* for the current consumption rate in the Karachi Harbor of Pakistan had no possible hazard to consumers. However, bear in mind that Cd and Pb muscle levels exceeded the maximum levels of fish permitted for human consumption, a plausible health risk could be posed by long-term exposed through Saddle grunt consumption.

## Conclusion

There was no significant difference between Cd levels, but Pb levels in seasons were statistically different. Although some values of Cd and Pb were higher than the allowable levels for these metals by European legislation, the weekly intakes of Cd and Pb per kg of body values was below the PTWI established. This study emphasizes that due to continuous exposure to pollution the accumulation of Cd and Pb in Saddle grunt can rise. If this prosecute then it can be very detrimental for the coastal area in future and especially if nonessential metals are taken up and transferred to higher food chain. It is also postulated that the neat bio-monitoring of fish in coastal areas of the is pivotally necessary.

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