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Comparison of Pb and Cd concentration in tissues of fish *Alepes djedaba* (Forsskål, 1775) collected from Karachi fish Harbour

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Abstract
This study was conducted to investigate the contamination of four heavy metals in the tissues of *Alepes djedaba* and to evaluate risks to human health associated with seafood consumption, and to compare it with the provisional tolerable weekly intake. Fish samples were collected from Karachi fish harbour on monthly basis during the year of 2011 for metal analysis. The concentrations of Pb in muscle, liver, gills and kidney tissues ranged from 0.02 (April) to 0.94 (May), 0.19 to 3.10 (both in February), 0.16 (November) to 2.24 (April) and 0.11 (June) to 1.84 (March) mg/kg dry wt., respectively. The concentrations of Cd in muscle tissues, liver, gills and kidney ranged from 0.13 (January) to 1.21 (December), 0.19 (April) to 2.93 (February), 0.62 (February) to 2.91 (December) and 0.18 (September) to 2.51 (January) mg/kg dry wt., respectively. The mean (±SD) concentration of Pb (0.335±0.213 mg/kg dry wt.) and Cd (0.386±0.233 mg/kg dry wt.) were recorded in muscle. In general, the findings from this study revealed that Pb concentrations based on wet wt. in the edible tissues were lower than the maximum permissible limit as recommended by the Commission Regulation (EC), Ministry of Agriculture, Fisheries and Food, UK and other international organizations, whereas Cd levels were slightly higher than the maximum permissible limit as recommended by the EC. This study found that levels of the metals in the liver, gills and kidney tissues in some samples were higher than the recommended concentrations. However, consumers do not routinely consume the viscera and gills. The average weekly intakes of Pb and Cd per body weight values were also not exceeded the Provisional Tolerable Weekly Intake (PTWI) established.

Keywords: Pb, Cd, *Alepes djedaba*, Provisional Tolerable Weekly Intake, Karachi coast, Pakistan.

1. Introduction
The pollution of marine coastal environment with contaminants especially heavy metals has become one of the most important problems of countries. As a result of the heavy metals transport from industrial areas into the environment and their persistence, many marine ecosystems are faced with alarming high levels. Lead (Pb) and cadmium (Cd) and their inorganic compounds are potentially toxic metals in the marine environment. They have no known any beneficial effects on human health but are ubiquitous in nature and present in coastal water, so that some level of exposure is not readily preventable. Karachi is the biggest city of Pakistan and there are more than 65 categories of industrial plants in the established industrial estates including, textile industries, tanneries, pharmaceuticals, plastic and rubber industries, steel foundries, metallurgical industries, electroplating and metal coating industries, glass, ceramics and tiles industries, cement industry, soap and detergents, fish processing industries, chemical industries, power plants, fertilizers and pesticides edible oils, automobile cable and conductor manufacturing etc., with a resultant increase in risk for exposure and toxicity. Heavy metals tend to accumulate in fish through the food chain and may enter into human body. Chronic assimilation of heavy metals is a known cause of cancer. Fish is a healthy food because of its nutritional benefits related to its proteins of high biological quality, desirable lipid composition, valuable mineral compounds and vitamins. Siyal *et al*. (2013) [18] pointed out that Karachi Harbour is the most important fishing area in Pakistan. Shrimp scad, *Alepes djedaba*, which is reef-associated, amphidromous, marine fish (Riede, 2004) [17], is commercial and found in large schools near inshore reefs (Sommer *et al*., 1996) [19]. They feed on shrimps, copepods, decapod larvae and other crustacean larvae and small fish (Allen and Erdmann, 2012) [5]. This study was carried out to Pb and Cd concentrations in *A. djedaba* from Karachi fish harbour of Pakistan on monthly basis during the year of 2011 and potential health risk for local population due to their consumption.

2. Materials and Methods

A. djedaba were collected from Karachi coast in 2011. Four fish samples were collected in each month of the year. The sample was immediately transported to the laboratory, thawed and rinsed in distilled water to remove any particles. Length (cm) and weight (g) were measured (Figures 1 and 2). Approximately 5 g of muscle tissues, liver, gills and kidney of the fish from each sample were dissected washed with distilled water, dried in filter paper, weighted, packed in polyethylene bags and kept at -20°C until analysis. An Analyst 700 Atomic Absorption Spectrophotometer was used in this study in Centralized Science Laboratory, University of Karachi. Due to the lack of a reference standard material, accuracy of the analysis and the effect of the matrices in the media were controlled with the standard addition method. Pb and Cd were tested with standard addition method for 3 randomly selected samples. The samples taken from the tissues were dried first and cut into pieces as small as possible. Then, placed into Teflon cylindrical vessels and digested with 3 mL of H_2O_2/HNO_3 (1:2 v/v) at 250ºC and the remaining part was diluted with demineralized water to 50 ml in a graduated flask (Bernhard, 1976). Detection limits (µg/l) of Pb and Cd were 0.285 and 0.385, respectively. The mean heavy metal weekly intake for both Cd and Pb was calculated as mean Cd or Pb level (as mg/kg wet wt.) multiplied by consumption of fish per person (kg/week) / body weight (kg).

2.1 Statistical analysis

Data below limit of detection were not used in statistical analysis. Statistical analysis of data was carried out using Statistica 7.0 statistical package program. A one-way analysis of variance (ANOVA) was performed, followed by Duncan comparisons for the source of statistically significant differences of Pb and Cd concentrations between tissues and organs and months (Zar, 1984) [24]. Statistically significant differences were observed in the mean metal values from different months and tissues ($p<0.05$).

3. Results and Discussion

In this study nonessential heavy metals Cd and Pb concentrations in *A. djedaba* collected directly from the local fishermen in Karachi Harbour of Pakistan were measured monthly in 2011. The mean lengths (cm) and weights (g) with standard deviations of Shrimp scad are given in Figures 1 and 2, respectively. Total number of fish samples in this study was 48.

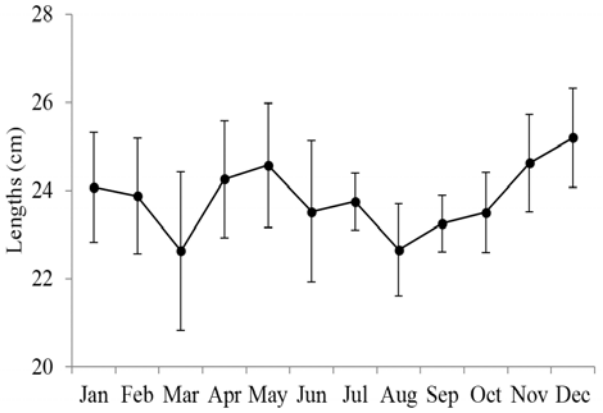

Fig 1: Lengths (cm) of *Alepes djedaba* collected from Karachi fish Harbour between January and December of 2011.

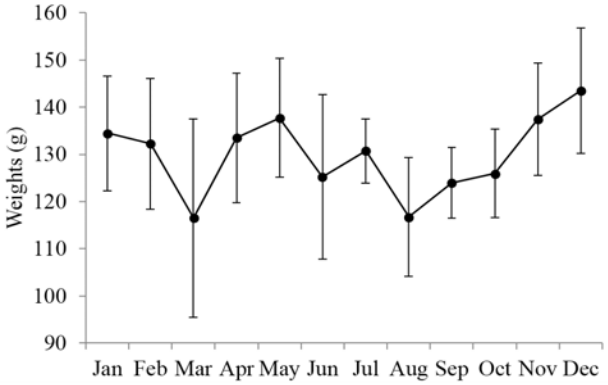

Fig 2: Weights (g) of *Alepes djedaba* collected from Karachi fish Harbour between January and December of 2011.

Figures 3 and 4 showed Pb and Cd levels in tissues and organs of *A. djedaba* from Karachi Harbour, Pakistan between January and December of 2011. The concentrations of Pb in muscle tissues, liver, gills and kidney ranged from 0.02 (April) to 0.94 (May), 0.19 to 3.10 (both in February), 0.16 (November) to 2.24 (April) and 0.11 (June) to 1.84 (March) mg/kg dry wt., respectively (Figure 3). The concentrations of Cd in muscle tissues, liver, gills and kidney ranged from 0.13 (January) to 1.21 (December), 0.19 (April) to 2.93 (February), 0.62 (February) to 2.91 (December) and 0.18 (September) to 2.51 (January) mg/kg dry wt., respectively (Figure 4). The mean (±SD) concentrations of Pb and Cd were given in Figure 5.

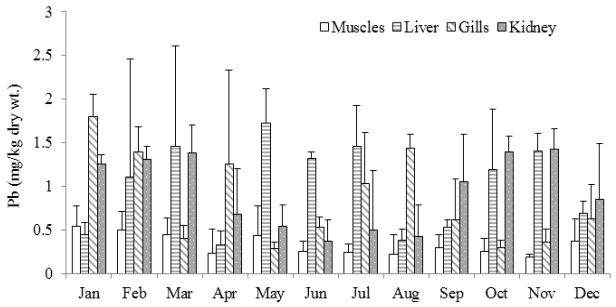

Fig 3: Mean Pb levels in muscle tissues, liver, gills and kidney of *Alepes djedaba* collected from Karachi fish Harbour on monthly between January and December of 2011.

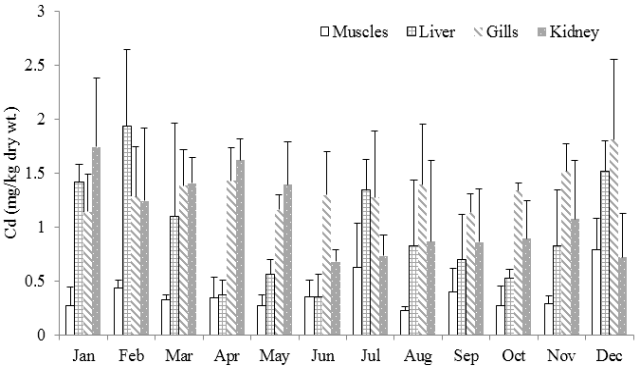

Fig 4: Mean Cd levels in muscle tissues, liver, gills and kidney of *Alepes djedaba* collected from Karachi fish Harbour on monthly between January and December of 2011.

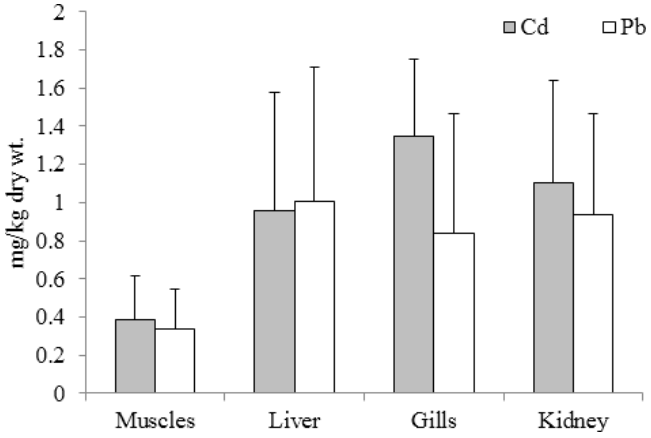

Fig 5: Mean Pb and Cd levels in muscle tissues, liver, gills and kidney of *Alepes djedaba* collected from Karachi fish Harbour in 2011.

The mean (±SD) concentration of Pb (0.335±0.213 mg/kg dry wt.) and Cd (0.386±0.233 mg/kg dry wt.) were recorded in muscle. However Pb and Cd levels in liver, gills and kidney of fish samples were higher than those in muscle tissues. Heavy metals are accumulated in the organ of metabolic activity like liver, their deposition also occur later in the muscle tissues (Ahmed and Bat, 2015) [4]. Similar findings were found by many researchers (Dallinger *et al*., 1987; Bat *et al*., 1996; Agusa *et al*., 2005 and 2007; Uluozlu *et al*., 2007; Bat *et al*., 2012; Yousuf *et al*., 2013; Ahmed *et al*., 2014) [1, 2, 3, 6, 7, 9, 21, 23] these studies suggested that the liver, gills and kidney play an important role in the metabolic processes of heavy metal in fishes.

A poisonous Pb has been in widespread use for thousands of years. A powerful neurotoxin, even in trace quantities, it is currently used in batteries, a1loys, shot, paints and gasoline, and as a building material (The Earth Report 3, 1992) [20]. The maximum permitted concentration of Pb proposed by the Commission Regulation (EC) is 0.30 mg/kg as wet weight basis (EC, 2006) [10], whereas The Ministry of Agriculture, Fisheries and Food, UK (MAFF) Food Safety limits the levels for Pb at 2 mg/kg wet wt. (MAFF, 1995) [15]. Acute Pb poisoning causes stomach pains, headaches, tremor, irritability and, in severe cases, coma and death. It is known to affect the nerves and the brains at very low concentrations of Pb commonly found in the blood of urban children are having a small but significant effect on their mental functioning (The Earth Report 3, 1992) [20]. Results of this study showed that mean Pb concentration (0.117±0.075 mg/kg as wet wt.) in edible tissues of *A. djedaba* from Karachi Harbour, Pakistan was below the standard values.

The Commission Regulation (EC) standard for Cd in fish is 0.1 mg/kg (EC, 2006) [10], whereas Georgian Food Safety Rules and GAIN Report for Russian Federation authorities proposed concentration of 0.2 mg/kg for Cd (Georgian Food Safety Rules, 2001; GAIN, 2002) [12, 13] In this study mean Cd concentration in edible tissues of *A. djedaba* from Karachi Harbour, Pakistan was detected as 0.135±0.082 mg/kg wet wt. and was slightly above the EC standard values but below other standards. It may be suggested that long period of accumulation of Cd in Shrimp scad may pose more health hazards. Prolonged exposure of Cd results in a loss of calcium from the bones, which then become brittle and break easily which is known as "itai-itai" disease, meaning "it hurts, it hurts" after industrial effluent contaminated rice supplies in Japan (The Earth Report 3, 1992) [20] However it is not typical of Cd toxicity, the main target organs for Cd are kidney and liver (O'Neill, 1993) [16]. Therefore viscera should be removed from fish before consumption. Because of its widespread use, Cd frequent1y occurs at high levels in sewage sludge, as domestic wastes are rarely separated from industrial wastes that contain heavy metals.

Furthermore, the Provisional Tolerable Weekly Intake (PTWI) value is an estimate of the level of a metal that may be taken by people over a lifetime without appreciable 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). PTWI values were used in this study to serve as reference values for safe levels of Pb and Cd. The Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO, 2010) [11] has set limit for heavy metal intake based on body weight (bw). For an average adult (70 kg), Provisional Tolerable Weekly Intake (PTWI) for Pb and Cd are 0.025 and 0.007 mg/kg, which was equivalent to 1.75 and 0.49 mg/week for a 70 kg adult, respectively (FAO/WHO, 2010) [11]. The average daily fish consumption in Pakistan is 5 g per person, which is equivalent to 35 g/week (FAO, 2010) [11]. By using the means of weekly fish consumption in Pakistan, the estimated weekly intake of metals by people from Karachi Harbour were 0.004±0.003 mg/kg wet wt. bw for Pb and 0.005±0.003 mg/kg wet wt. bw for Cd. The estimated weekly intakes of Pb and Cd from edible tissues of *A. djedaba* were below the recommended values of the Provisional Tolerable Weekly Intake (PTWI). This study showed that there was no possible health risk to consumers under the current consumption rate in the Karachi Harbour of Pakistan.

4. Conclusion

The results of this study on concentration of Pb and Cd in *A. djedaba* from Karachi Harbour, Pakistan show that the levels of Pb and Cd were lower than the recommended standards but the liver, gills and kidney in some samples were higher than the recommended concentrations. However, consumers do not routinely consume the viscera and gills. Therefore it is worth noting that consumption of *A. djedaba* from the studied area as food may not possible health hazards to humans at the time of the study.

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