Pakistan Journal of Marine Sciences, Vol. 29(1), 39-45, 2020.

HEAVY METAL LEVELS IN ELONGATE SOLE (*Solea elongata* Day, 1877) FROM THE KORANGI FISH HARBOUR, KARACHI, PAKISTAN

Farzana Yousuf, Semra Benzer and Quratulan Ahmed
University of Karachi, Department of Zoology, Karachi, Pakistan (FY, QA);
Gazi University, Education Faculty, Science Education,
Teknikokullar Ankara, Turkey (SB).
email: farzanaseth@yahoo.com

ABSTRACT: In this study, fish samples collected from Elongate Sole (*Solea elongata* Day, 1877) caught on the Korangi Fish Harbour in 2018 (South-west Monsoon and North-east Monsoon) were analysed to determine concentrations of heavy metals: Fe, Zn, Cu, Pb, Mn and Cd by an atomic absorption spectrophotometer, expressed per unit of dry weight of each sample. The average measured level of Fe, Zn, Cu, Pb, Mn and Cd for *Solea elongata* was 38.716±11.321 μg g^{-1}, 16.638±3.344 μg g^{-1}, 1.067±0.404 μg g^{-1}, 0.022±0.043 μg g^{-1}, 0.273±0.100 μg g^{-1} and 0.022±0.010 μg g^{-1}, respectively. Although the contamination values obtained from *Solea elongata* are below the limits, it is important to follow the metal accumulation values.

KEYWORDS: *Solea elongata*; heavy metal; accumulation; elongate sole; Korangi Fish Harbour

INTRODUCTION

Environmental pollution, which is one of the most important problems of our last century, is increasing gradually as a result of rapid urbanization, industrial activities and population growth. Heavy metals enter the marine environment through mining activities, industrial activities, domestic waste and atmospheric fallout. Some of the metals (Fe, Mn, Zn, Cu, Co, Mo) that are considered to be important contaminants are necessary for the life of organisms. The smallest change in the concentrations of these metals, which have vital functions within the organism and it can damage the tissues (Merlini, 1980).

Fish take in heavy metals from the external environment through food, water, gills and skin (AnvariFar *et al.*, 2018). Heavy metals taken up by fish are transported to tissues and organs through the blood tract, bound to carrier proteins, and reach high concentrations by binding by metal-binding proteins in the tissues (Cicik, 2003).

Soleidae are marine marine forms of high economic value. Its economic value has led to an increase in interest in its cultivation in recent years. Soleidae are carnivorous fish. Their food consists of various invertebrates (mollusca, annelida, crustacea) that live on the bottom, as well as small fish and flames at the bottom (Kahraman, 1993). *Solea elongata* Day, 1877 is a demersal fish distributed from western Indian Ocean (Red Sea and Arabian Gulf) to the west and east coast of India, Sri Lanka and China. Adults inhabit shallow sand and mud bottoms in coastal waters to a depth of 8 – 28 m (Menon, 1984).

Investigation of heavy metal pollution in marine ecosystems is extremely important in terms of environment and human health. Many studies have been conducted on heavy metal pollution in these ecosystems using different species of solea such as (Usero *et al.* 2004; Türkmen, 2011; Monikh *et al.*, 2013; Aytekin *et al.*, 2019; Munoz-Cueto *et al.*, 2019).

The aim of this current study is to establish mean concentration values for certain of these metals namely Fe, Zn, Cu, Pb, Mn and Cd in muscle tissues of *Solea elongata* from Korangi Fish Harbour, Karachi, Pakistan in seasons (South-west Monsoon and North-east Monsoon).

MATERIALS AND METHOD

Totally twenty-four (24) fishes collected during seasonal (South-west Monsoon and North-east Monsoon) from Korangi Fish Harbour. All samples were immediately transferred to the laboratory for analysis of heavy metals.

Analyst 700 Atomic Absorption Spectrophotometer was used to perform the analysis in Centralized Science Laboratory of the University of Karachi. The absorption wavelengths (λ) used for the determination of the analyzed metals are as follows: Fe: 248.30 nm; Zn: 213.90 nm; Cu: 324.70 nm; Pb: 217.00 nm; Mn: 279.50 nm and Cd: 228.80 nm. 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. All studied elements were tested with standard addition method for 3 randomly selected samples. Approximately 20 ml filtered water and fish sample solution was taken for heavy metal analysis. Typical detection limit was 0.1, 0.018, 0.035, 0.012, 0.01 and 0.025 µg/mL for Fe, Zn, Cu, Pb, Mn and Cd respectively, were calculated by regression analysis as suggested by the US Environmental Protection Agency. A 1-2 gr aliquot of each dry sample was placed in cylindrical Teflon vessel and digested with 3 mL of a 1:2 v/v mixture of H_2O_2 and HNO_3 at 250 ^oC. The organic part was discarded, and the remaining part was diluted with demineralized water to 50 mL in a graduated flask (Bernhard, 1976).

All heavy concentrations of the metals in *Solea elongata* among seasons groups were determined by carrying out analyses of variance (ANOVA) using Tukey's HDS post-hoc comparison method. The results were assessed on the basic of homogenous groups with a significant level of ($p<0.05$). The heavy metal elements which were common in the muscle tissue of *Solea elongata* were assessed by means of Pearson's correlation coefficients.

RESULTS AND DISCUSSION

The *Solea elongata* that were analyzed were 8.20–10.50 cm long and weighed between 14.03 and 26.94 g for south west monsoon; 8.20–11.20 cm long and weighed between 14.54 and 21.31 g for north east monsoon (Table 1).

The metal concentrations found in *Solea elongata* collected in seasons (south west monsoon and north east monsoon), and the average concentrations for the whole sampling period, are shown in Table 2.

Table 1. Length and weight values of *Solea elongata*

	Seasons	N	Median ± SD	Std. Err.	Min Value	Max Value
Length (cm)	SW Monsoon	12	9.8417 ± 0.713	0.206	8.20	10.50
	NE Monsoon	12	9.6333 ± 0.997	0.288	8.20	11.20
	All Season	24	9.7375 ± 0.854	1.118	8.20	11.20
Weight (g)	SW Monsoon	12	19.5675 ± 3.874	0.577	14.03	26.94
	NE Monsoon	12	18.5833 ± 1.998	0.577	14.54	21.31
	All Season	24	19.0254 ± 3.048	0.623	14.03	26.94

SW: South West; NE: North East

Table 2. Metal concentrations of *Solea elongata*

Season	Metal concentration (µg g^{-1})					
	Fe	Zn	Cu	Pb	Mn	Cd
	Median±SD (Min-Max)	Median±SD (Min-Max)	Median±SD (Min-Max)	Median±SD (Min-Max)	Median±SD (Min-Max)	Median±SD (Min-Max)
I	39.700±13.461 16.84-63.05	17.077±3.881 10.36-24.87	1.211±0.264 0.68-1.56	0.041±0.056 0.00-0.16	0.234±0.092 0.11-0.41	0.022±0.011 0.01-0.04
II	37.733±9.200 24.68-56.32	16.193±2.808 11.35-22.15	0.923±0.477 0.34-1.86	0.003±0.001 0.00-0.01	0.313±0.096 0.18-0.46	0.022±0.009 0.01-0.04
III	38.716±11.321 16.84-63.05	16.638±3.344 10.36-24.87	1.067±0.404 0.34-1.86	0.022±0.043 0.00-0.16	0.273±0.100 0.11-0.46	0.022±0.010 0.01-0.04

I: South west Monsoon; II: North east Monsoon; III: All Season.

None of the correlations between the metal concentrations were highly significant, as can be seen from Table 3, but the Cd (South West Monsoon) and Mn (North East Monsoon) concentrations correlated reasonably with the Fe and Zn concentrations, respectively.

Statistical test of significance using Tukey test and analysis of variance (ANOVA) showed significant differences in the concentration of Pb in *Solea elongata*, which is obtained from the different seasons. Other metals (Fe, Zn, Cu, Mn and Cd) did not show a significant difference (Table 4).

The mean concentrations of metals in the muscle tissues of *Solea elongata* are given in Table 5. The concentration ranges of trace elements in muscles tissue of *Solea elongata* were found as follows: Fe: 16.84 - 63.05 µg g^{-1} ; Zn: 10.36 - 24.87 µg g^{-1}; Cu: 0.34 -1.86 µg g^{-1}; Pb: 0.00 - 0.16 µg g^{-1}; Mn: 0.11 - 0.46 µg g^{-1} and Cd: 0.01 - 0.04 µg g^{-1}. Metal concentrations in muscle tissues of *Solea elongata* were decreased as follows; Fe>Zn>Cu>Mn>Pb=Cd (Table 2).

Table 3. Pearson correlation coefficients for the relationships in *Solea elongata*

	Fe	Zn	Cu	Pb	Mn	Cd
	South West Monsoon					
Fe	1.000					
Zn	-0.458	1.000				
Cu	0.489	-0.381	1.000			
Pb	0.269	-0.002	-0.533	1.000		
Mn	0.015	0.311	-0.056	-0.139	1.000	
Cd	0.626*	-0.555	0.195	0.555	-0.202	1.000
	North East Monsoon					
Fe	1.000					
Zn	0.200	1.000				
Cu	-0.410	-0.320	1.000			
Pb	-0.451	-0.134	0.189	1.000		
Mn	0.195	0.234	-0.583*	-0.117	1.000	
Cd	0.215	0.263	0.045	0.066	0.312	1.000

* Indicates a significant correlation ($p<0.05$)

Table 4. Analysis of variance (ANOVA) of heavy metals in *Solea elongata*

Metals		Sum of squares	df	Mean square	F	P
Fe	Between groups	23.226	1	23.226	0.175	0.680
	Within groups	2924.571	22	132.935		
	Total	2947.797	23			
Zn	Between groups	4.638	1	4.638	0.404	0.532
	Within groups	252.486	22	11.4771		
	Total	257.123	23			
Cu	Between groups	0.496	1	0.496	3.340	0.081
	Within groups	3.267	22	0.148		
	Total	3.762	23			
Pb	Between groups	0.008	1	0.008	5.385	0.030
	Within groups	0.034	22	0.002		
	Total	0.43	23			
Mn	Between groups	0.037	1	0.037	4.155	0.054
	Within groups	0.195	22	0.009		
	Total	0.232	23			
Cd	Between groups	0.000	1	0.000	0.042	0.840
	Within groups	0.002	22	0.000		
	Total	0.002	23			

Table 5. Comparison of concentration found in fish from literatures.

Location	Fish	Metal concentration (µg g^{-1})						References
		Fe	Zn	Cu	Pb	Mn	Cd	
Persian Gulf	*Euryglossa orientalis*	-	-	3.12	0.63	-	0.17	Monikh *et al.*, 2013
Iskenderun Gulf	*S.solea* April	23.0	22.2	3.75	37.6	-	2.92	Aytekin *et al.*, 2019
	S.solea July	42.8	32.3	6.20	79.5	-	6.83	
	S.solea Oct.	34.8	25.2	3.58	45.9	-	2.04	
	S.solea Jan.	23.7	22.1	2.64	36.7	-	1.98	
Iskenderun Gulf	*S. solea*	59.7	5.66	1.82	1.13	1.11	-	Türkmen, 2011
Atlantic coast of Spain Bacuta	*S. vulgaris*	311	21.3	68.6	0.40	4.42	0.22	Usero *et al.*, 2004
Korangi Fish Harbour	*Solea elongate*	38.72	16.64	1.07	0.02	0.27	0.02	This study
International limits		-	40	10-100	0.50	-	0.50	FAO, 1983
		100	50	-	2.00	1.00	1.00	WHO, 1989

Fe values are lower than reported data from literature (Usero *et al.* 2004; Türkmen, 2011) while Fe values are higher than reported data from some studies of the literature (Aytekin *et al.*, 2019). Zn values are lower than reported data from literature except Türkmen, (2011). Cu, Pb, Mn and Cd values are lower than all literatüre (Usero *et al.*, 2004; Türkmen, 2011, Monikh *et al.*, 2013; Aytekin *et al.*, 2019) (Table 5).

Compared to the results of literatüre (Table 5), generally, our results were much lower than their findings, except for Zn in *Solea elongata*. Metal accumulation in different fish species depends on the bioavailability of metal concentration in the abiotic components of their habitats, nutritional habits, ecological needs, metabolism, age and size of the fish (Ajima *et al.*, 2015).

It can be summarized that the contents of Fe, Zn, Cu, Pb, Mn and Cd concentrations in muscle of the studied samples of *Solea elongata* were in compliance with the maximum residue limits and within the acceptable limits according to FAO (1983) and WHO (1989).

CONCLUSION

Contaminants including heavy metals in fish for human consumption should not exceed levels established by Community legislation or other relevant standards FAO (1983) and WHO (1989). In the cause of their toxicity and their possible bio accumulation, these metals should be subject to mandatory monitoring. The present study provides a useful baseline against which to measure any future changes in metal pollution in Karachi coasts (Korangi Fish Harbour) of Pakistan.

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