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Assessment of Heavy Metals in Sediment and Tissues of Gara Fish from the City of Khash, South East of Iran

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ABSTRACT: In the present study, some heavy metals (Zn, Cu, Ni and Pb) in sediment and their accumulation in Gara organs (gill, muscle, fin and gonads) were investigated. For this purpose, samples were collected from three rivers Eskel Abad, Dehpabid and Bidaster in the city of Khash,(South East of Iran) in spring 2013. Heavy metal levels in sediment and fish samples were analyzed by atomic absorption device Konic NOVAA300 according to the proportion of µg/g in dry weight.The analysis of heavy metals in sediments indicated that among the four heavy metals tested, Zn had the highest concentration, followed by Cu, Ni and Pb. Studies on all the different parts of the fish revealed Zn had the highest accumulating level in fish and Pb and Ni had the lowest. According to the results, heavy metal concentrations in the edible parts of Gara were well within the limits set by the FDA,WHO, NHMRC and UK MAFF recommendations and showed that the fish from investigated region are safety permissible level for human consumption.

***Keywords*:** Heavy Metals, Gara, Accumulation, Sediment.

INTRODUCTION

The aquatic environment with its water quality is considered the main factor controlling the state of health and disease fishes. But, the aquatic ecosystems pollution with contaminants has become a matter of great concern over the last decades. Three rivers Eskel Abad, Dehpabid and Bidaster are the major rivers in the city of Khash in the South East of Iran. These three sampling sites, have always played a key role in the water management of the city of Khash in the past, and were used as sources of water. But in recent years, the substantial development of urban and industrial activities result in increasing inputs of chemical contaminants which lead to the loss or alteration of Gara habitat. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems (Censi *et al.,* 2006). Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota (Camusso *et al.,* 1995). Sediment quality is a good indicator of pollution in water column, where it tends to concentrate the heavy metals and other organic pollutants. Some kinds of toxic sediments kill benthic organisms and decrease the food availability for larger animals such as fish. Bioaccumulation and magnification is capable of leading to toxic level of these metals in fish, even when the exposure is low. Many aquatic organisms have been used as bioindicators, including aquatic insects (Rayms-Keller *et al*., 1998), plants (Mohan and Hosetti., 1999), protozoans (Fernandez-Leborans and Olalla-Herrero, 2000), crustaceans (Allinson *et al*., 2000) and fish (Burger *et al*., 2002). Fish samples are often the top consumers in aquatic ecosystems (Dallinger *et al*., 1987), thus fish samples are considered to be one of the most indicative factors in freshwater systems, for the estimation of trace metals pollution potential (Papagiannis *et al*., 2004).
The aim of the present study was to determine the metals concentrations (Pb, Zn, Ni, and Cu) in sediments and in muscle, fin, gonads and gill tissues of Gara .

MATERIALS AND METHODS

Description of the study area

Three freshwater ecosystems Eskel Abad, Dehpabid and Bidaster are located in the city of Khash, Sistan and Baloochestan Province, South East of Iran (figure 1) and have a Mediterranean climate. Geographical location of the study areas are shown in Table 1. The selected species (Gara) are popular fishermen. This fish is an important component of the human diet in this zone. It is silvery grey above and fins , white beneath. But, the quality of this ecosystem has been degrading due to disturbance from human activity (agricultural, industrial, domestic or fishing). Since then, from literature review, no work has been carried out on the environmental quality of sediments and biota of three aquatic ecosystems, this is why the results obtained from this study would provide information for background levels of metals in the sediment and fish samples, contributing to the effective monitoring of both environmental quality and the health of the organisms inhabiting the freshwater ecosystems.

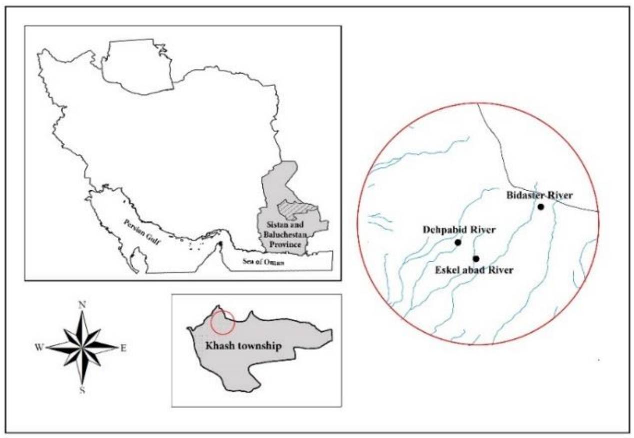

Figure1. Map showing study areas

Table 1. The position of sampling areas

Samples stations	Geographical Position	
Station 1: Dehpabid River	28°36'29.974"N	60°46'32.297"E
Station 2: Bidaster River	28°34'30.678"N	60°48'15.228"E
Station 3: Eskel Abad River	28°34'26.417"N	60°48'18.903"E

Sampling and sample preparation

Sediment and fish samples were collected from three stations Eskel Abad, Dehpabid and Bidaster in the city of Khash(South East of Iran) in spring 2013. A total of 45 fish samples from three sampling sites were analyzed with a mean weight. Fish samples were transported to the laboratory in box with ice. All fish samples were kept at -30°C until analysis. Each fish was properly cleaned by rinsing with distilled water to remove debris planktons and other external adherent. The fishes dissected to separate organs (gill, muscle, gonads and fin) to investigate heavy metals. Next, the extracted parts were put in the oven for 48 hours in 80˚c to be dried and Powdered completely . To digest the fish samples, 1gr of each powdered fish sample was mixed in 10 ml pure concentrated nitric acid (65%) and hydrochloric acid by the proportion 4:1 to digest. Then they were put in the water bath for the next 2 hours in 140˚c to be digested. After this, the samples were diluted using double distilled water to the volume of 50 ml and then they were filtered using Whatman 42 micron filter paper (Abdul-Wahab and Jupp., 2009). To determine the amount of heavy metals in fish samples (gill, muscle, gonads and fin) 3 repetitions were picked.

Sediment samples from a depth of 15 cm were collected using steel shovel at every station (3 repetitions) and returned to the laboratory in polyethylene bags. The sediments were kept in oven for 3 days at 80˚c to dry off. Once sediment samples dried they were powdered and passed through 63 µm sieve. The samples packed in polyethylene bags and stored to analysis. The sediment samples were weighed 1g and the same procedure, digested fish samples, was carried out for dried sediment samples. Heavy metal concentrations were measured using atomic absorption spectrometry Konic (FAAS) model Novaa 300 in gram in dry weight gram.

Statistical analysis

The statistical analysis was performed by SPSS software (version 14). Data were tested for normality using Kolmogorov–Smirnov test. After making sure of data normality, the concentration differences of each metal for every tissue (gill, gonads, fin and muscle) and the sediments was measured using the One Way ANOVA and to separate the groups, the Tukey-test was used. And, Microsoft Excel was used to draw the charts. $P < 0.05$ was counted as being significant.

RESULTS AND DISCUSSION

Heavy metals in sediment:

Table 2 shows the sediment quality constituents of study areas, and other global published values in different sites. The results showed the metals concentrations in bottom sediment varied widely and decreased in the sequence of Zn > Cu >Ni > Pb. The data indicated that Zn was maximally accumulated in the sediment whereas Pb got the least concentration. Metals exhibited a similar pattern of concentration as its abundance in water. The presence of Cu, Ni, Pb and Zn in sediments of sampling sites is mostly due to anthropogenic sources as there are no sources of natural inputs in the region. Urban and industrial developments are among the contamination sources that directly impact sediments in these regions. Sediments act as the most important reservoir or sink of metals and other pollutants in the aquatic environment (Gupta et al., 2009). Heavy metal contamination in sediment can affect the water quality and bioaccumulation of metals in aquatic organisms, resulting in potential long-term implication on human health and ecosystem (Fernandes et al., 2007).

Table 2.Comparison of metal concentrations in sediment samples from this study and other study areas (concentration unit is in μg g-1 dry weight)

Locality	Zn	Cu	Ni	Pb	Refereces
Dehpabid River	223.5	167.5	23.8	9.00	
Bidaster River	215.4	158.2	30.1	4.03	Present study
Eskel Abad River	210.5	160.9	15.2	4.03	
Gediz River, Turkey	160	140	-	128	Uzunoğlu, (1999)
Lake Tanganyika	28.36	20.81	-	14.0	Chale, (2002)
PECf	459	111	135	158	NOAA , 2009
Avsar Dam Lake St	-	29.98	29.99	2.44	Öztürk et al, 2009
Lake Geneva	-	727	87	620	Pote et al, 2008
Lake Texoma	-	38	17	10	An and Kampbell, 2003

Heavy metals in fish tissues:

The mean concentrations of heavy metals in different Gara fish tissues and research conducted are presented in Table 3. samples decreased in the sequence for the gill as Zn > Cu > Ni > Pb; muscle as Zn > Cu > Pb >Ni ; gonad as Zn > Cu > Ni> Pb and fin as Zn >Cu > Ni > Pb.

In this study, it is obvious that Zn has the highest concentration, while Ni and Pb have the lowest concentration of all measured metals in fish organs. The results showed the concentrations of metals in muscle tissue of all stations, there were significant differences, so that the Zn had the highest concentration and Ni the lowest concentration.
The highest concentrations Zn in fish muscle was observed at station Bidaster, but the concentration Zn was not significantly different stations Eskel Abad and Dehpabid. There was the lowest concentrations Cu and Pb in muscle tissue at the station Dehpabid. Although the highest concentrations Cu and Pb achieved in stations Eskel Abad and Bidaster but there was no significant difference. Ni concentration in muscle tissue showed no significant differences between the 3 stations surveyed.

In the present Research, the order of metals corresponded with the results Khosravi *et al* (2011) found in muscle tissue of Esox luciusn. According to the study, the concentrations Zn in gonad tissue was significantly different at the stations Bidaster and Dehpabid and a trend of increasing concentrations was from Ni and Pb to the Cu and Zn.The study of heavy metals in the Trachurus mediterraneus species concluded by Yilmaz (2003), the amount Zn was obtained in muscle 38.23 mg/kg and gonad 56 mg/kg , the data obtained in our study was far less than that of Yilmaz′s study.

By evaluating the results, we found that concentrations Zn in gill tissue had significant differences at the stations Dehpabid and Bidaster and we have seen increasing trend metal concentrations from Pb and Ni to the Cu and Zn.
In gill Zn followed by Cu showed higher concentrations and Pb and Ni the lowest. This could be explained by the fact that Zn and Cu are essential elements in the bodies of living organisms and have an important role in different physiological processes. The concentration level in the gills could also be attributed to the fact that water always passes through mouth and gill when the water is filtered, this is correlated with the findings of food and agricultural

organization (Adeniyi and Yusuf., 2007; (Bryan.,1971 ; Sreenivasa *et al*., 2003). Ray et al (1990) with the evaluation of concentrations Ni, Cu, Pb in the gills and muscle tissue of Clarris batrachus found some similar results.

The major total body part of loads accumulated at various metals concentrations in the water and at different exposure times are found in kidney, liver and gills (Al-Mohanna, 1994; Kock *et al.,* 1998; Giguere *et al.,* 2004). Metal concentration in the gills could be due to complexing of the elements with mucus, which is impossible to remove completely from between the lamellae, before tissue analysis preparation. Thus, high concentrations of various metals can be observed (Heath, 1987).

Results showed significant differences in Zn in fin tissue at the stations Bidaster and Dehpabid and there was a sequence of increasing metal concentrations from Pb and Ni to the , Cu and Zn. Results of many research indicated that metals exhibit various affinity to fin organ (Marzouk, 1994).

Alam *et al.* (2002) have reported the concentrations of elements in the muscle, gill, and gonads of cultured and wild carps caught in Lake Kasumigaura, Japan. The heavy metal levels in Gara fish were lower than what Alam et al. have reported.

This may be due to the difference of feeding habits of the where the carps caught fish is mainly omnivorous feeding on fish, insect larvae, mollusks, planktonic organisms and water weeds which accumulate large amounts of heavy metals. Results of many research indicated that metals exhibit various affinity to fin organ (Marzouk, 1994).

Table 3. Comparison of metal concentrations in the tissues of Gara fish and other studies (concentration unit is in µg g-1 dry weight)

Element	Muscle	Fin	Gill	gonad	Species	References
Zn	4.1	3.9	4.3	4.4		
Cu	3.7	1.2	1.2	1.2		Dehpabid River
Ni	0.1	0.2	0.2	0.2		
Pb	0.2	0.1	0.1	0.1		
Zn	4.4	3.7	3.7	3.8		
Cu	4.3	1.2	1.2	1.6	*Gara*	Bidaster River
Ni	0.3	0.2	0.2	0.2		
Pb	0.9	0.1	0.1	0.1		
Zn	4.3	-	-	-		Eskel abad River
Cu	4.2	-	-	-		
Ni	0.4	-	-	-		
Pb	0.9	-	-	-		
Ni	0.63	-	1.04	-	*Cyprinus carpio*	Vindohini and Narayanan, 2008
	0.24	-	0.26	-	*Hipophthalmichthys molitrix*	Pakzad, 2013
Pb	0.039	-	0.14	-	*Tilapia*	Abdel-Baki et al, 2011
	0.15	-	0.36	-	*Silver bream*	Staniskiene et al, 2006
	0.09	-	0.07	-	*Hipophthalmichthys molitrix*	Pakzad, 2013
Cu	1.08	-	2.06	-	*Tilapia*	Abdel-Baki et al, 2011
	41.01	-	53.80	-	*Hipophthalmichthys molitrix*	Pakzad, 2013
Zn	14.82	-	47.39	-	*Silver bream*	Staniskiene et al, 2006
	38.23	-	-	56	*Trachurus mediterraneus*	Yilmaz, 2003

Table 4. Comparison of metal concentrations in muscle tissue with existing standards (concentration unit is in µg g-1 dry weight)

Standards	Zn	Pb	Ni	Cu	References
WHO	30	0.4	0.38	10	European Commission, 2000 Pourang et al, 2004
FDA	35	5	1	-	Pourang et al, 2004
NHMRC	150	1.5	-	10	Pourang et al, 2004
UK MAFF	50	2	-	20	Pourang et al, 2004
Dehpabid River	4.1	0.2	0.1	3.7	
Eskel abad River	4.3	0.9	0.4	4.2	Present study
Bidaster River	4.4	0.9	0.3	4.3	

CONCLUSION

In this study the effect of stress ratio (K_0) on the boundary conditions is investigated and could be used as initial parameter for modeling of tunnels. Overall, the rocks with strain-softening behaviour have the effect of localization of deformation and causes instability problems for underground openings. The following conclusions could be noted:
- Numerical analysis of K_0 in the tunnels shows that for all boundary conditions, with decreasing the values of K_0, the displacement around tunnels has increased.
- In modeling of tunnels, the shape of the external boundary is important and the external boundaries circle, hull and box to cause maximum displacement around tunnels, respectively.
- In the rocks with strain-softening behaviour, by increasing the values of GSI, the displacement around tunnels has strongly decreased for all boundary conditions.

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