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A study of heavy metals concentration in water, sediments and *Cyprinus carpio, Abramis brama, Carassius carassius* species from Anzali Wetland

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Abstract

In the present study, some heavy metals (Pb, Cd, Zn,Cr and Cu) were determined in water, sediment and some tissues of *Cyprinus carpio*, *Abramis brama, Carassius carassius* from Anzali wetland. Heavy metal levels in water, sediment and fish samples were analyzed by atomic absorption spectrophotometer. Also we studied condition factor for species. In this study *Carassius carassius* had best condition factor across caught species. the analysis of heavy metals in sediments and water indicated that among the heavy metals tested, Zn was maximum , followed by Cu, Pb,Cr and Cd. Heavy metal concentrations were found to decrease in sequence of the fish samples, in the muscle as Zn > Cu> Pb > Cr > Cd . The bioaccumulation factors obtained for the various heavy metals and were all less than 1.00 implying no bio-accumulation. Cu and Zn with the highest bioaccumulation factors was the most bio-accumulated and bio-magnified of all the metals studied.

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Introduction

Among environmental pollutants , metals are of particular concern, due to their potential toxic effect in aquatic ecosystems (Censi *et al*., 2006). Fish accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately reach concentrations hundreds or thousands of times above those measured in the water, sediment and food (Goodwin *et al*., 2003; Labonne *et al* ., 2001).

Metals can enter into the food web through direct consumption of water or organisms, or through uptake processes, and be potentially accumulated in edible fish , there is a growing concern that metals accumulated in fish muscle tissues may represent a higher health risk than a health benefit, especially for populations with high fish consumption rates (Paquin, 2003). Even at low aqueous concentrations, the metals can damage the nervous system (Johnson and Atchison, 2009) and disrupt the immune system (Mishra , 2009). Metals are non-biodegradable and are considered as major environmental pollutants causing cytotoxic, mutagenic and carcinogenic effects in animals (More *et al*., 2003). For the normal metabolism of the fish , the essential metals must be taken up from water, food or sediment (Canlı and Atlı, 2003). These essential metals can also produce toxic effects when the metal intake is excessively elevated (Tüzen, 2003).

Fish are often at the top of aquatic food chain and may concentrate large amounts of some metals from the water and sediment (Mansour and Sidky, 2002). Factors such as high population growth accompanied by intensive urbanization, increase in industrial activities and higher exploitation of natural resources including cultivable land have caused pollution increase. Reports from literature suggest that these toxicants are responsible of hazardous effects on human health (Paquin *et al*, 2003; Johnson and Atchison, 2009; Mansour and Sidky, 2002). Fish have been the most popular choice as test organisms because they are presumably the best-understood organisms in the aquatic environment (Buikema *et al*., 1982). In this study we determined the levels of contamination of Cd, Cr, Cu, Zn and Pb on some fish species that are of commercial importance (*Cyprinus carpio*, *Abramis brama, Carassius carassius*) in anzali wetland.

Materials and methods

Determination of Condition factor

A total of 34 specimens, comprising three different fish Species, the collected species were *Cyprinus carpio*, *Abramis brama* and *Carassius carassius* were captured using fish traps. The condition factor (k) of The experimental fish was estimated from the relationship:

$K = 100\ W/L^3$ (1)

Where

K= condition factor

W= weight of fish

L= length of fish (cm)

Determination of heavy metal in Media and fish

Sampling for our study was done during spring, 2012.In this study, surface water and sediment samples were taken from four sampling sites at Anzali wetland. Also fish samples were caught from the same localities.

Surface sediment was collected using a Peterson grab sampler. The samples packed in polyethylene bags and stored below – 20°C prior to analysis. After transportation of sediment and water samples to laboratory and digestion process heavy metals concentrations of Cd, Zn, Cu, Pb and Cr were determined with a Shimadzu AA/680 atomic absorption spectrophotometer . Concentrations of metals were calculated on a dry weight basis and expressed as µg/g for sediment and mg/l for water.

The samples of fish were collected from different parts in wetland randomly and kept in the laboratory deep freezer (-18°C). For the determination of Zn,Cu,Cd, Pb and Cr concentrations, tissue samples were subjected to wet acid digestion and then heavy metals concentrations were determined with a Shimadzu AA/680 atomic absorption

spectrophotometer. Concentrations of metals tissues were calculated on a dry weight basis and expressed as µg/g. Data obtained in this study were analyzed using Excel 2007. The least significant differences test was used to measure the difference of the metal levels.

Determination Bio-accumulation Factors of Heavy Metals

The bio-accumulation factors of the heavy metals obtained in fish samples were as recorded below, using equation:

BSAF = C organism /C sediment (2)

Where,

BSAF =bio-accumulation factor of sediment

C organism = Concentration of metal in the organism (µg/g)

C sediment = Concentration of metal in sediment (µg/g)

Results

Table 1 shows the concentrations of metals in Water that average was as follows: Cd(0.048) < Cr(0.055) < Pb(0.057)<Cu(1.24) <Zn (1.32), respectively. There was a higher concentration of copper in Sheyjan(1.99 mg/l) . The mean concentration varied from 0.027 to 0.078 for Cr, 0.89-1.99 for Zn, 0.036 to 0.065 for Cd, 0.87 to 1.99 for Cu, and 0.038 to 0.072 for Pb mg/l different samples. Also table 2 shows the concentrations of metals in sediment of Anzali wetland. the concentrations of metals in sediment that average was as follows: Cd(1. 46) < Cr(6.12) < Pb(12.14)<Cu(18.12)<Zn(78.08) , respectively .There was a higher concentration of Zn in Abkenar and Sheyjan (83.47, 83.41µg/g). Also There was the lowest concentration of Cd (0.84µg/g) in Abkenar. The lowest concentration of metals (except Zn) was found at station Abkenar and the highest concentration of metals in Sheyjan where runoff and urban sewage are discharged. The mean concentration varied from 3.68 to 9.11 for Cr, 68.51-83.47 for Zn, 0.84 to 2.47 for Cd, 14.23 to 23.51 for Cu and 10.06 to 14.18 for Pb µg/g dry wight in different sampels. The presence of Cd, Cu, Cr, Pb and Zn in sediments is mostly due to anthropogenic sources in the region. Runoff and sanitary waste derived from urban and industrial developments are among the contamination sources that directly impact sediments. The negative impact of release of significant levels of metals from the sediment into the water column needs to be evaluated in terms of bioaccumulation and toxicity, particularly with native species of this wetland. Table 3 is showing the lists studied fish species, mean of the length and weight ranges with standard deviation. The fish samples ranged in length from 145 to 305 mm, and in net weight from 45 to 336 g. the highest length related to *Cyprinus carpio* (240.3±56.95) and the lowest to *Abramis brama* (229.25±36.74) and highest weight related to *Carassius carassius***(**226.33±13.66) in this study**.** In studies of population dynamics high condition factor values indicates favorable environmental conditions (such as: habitat and prey availability) and low values indicate less favorable environmental conditions (Blackwell *et al*., 2000). Condition factor (K) is used by several authors to compare condition of fish species. In the present study *Carassius carassius* (1.75±0.06) had best performance across caught species.

Table 1. Concentrations of heavy metals (m g/l) in water of Anzali wetland.

Sampel	Pb	Cd	Zn	Cu	Cr
Abkenar	0.038	0.036	0.89	0.92	0.027
Siyahkeshim	0.061	0.049	1.43	0.87	0.066
Hendekhale	0.058	0.043	1.77	1.21	0.049
Shyjan	0.072	0.065	1.21	1.99	0.078
Mean	0.057	0.048	1.32	1.24	0.055
SD	0.01	0.01	0.37	0.51	0.02
Range	0.038-0.072	0.036-0.065	0.89-1.77	0.87-1.99	0.027-0.078

The results of table 4 indicated that the metal concentrations were different among fish muscle tissues. The mean concentration varied from 0.65 to 1.05 for Cr, 9.64-23.54 for Zn, 0.12 to 0.24 for Cd, 2.68 to 7.34 for Cu and 0.76 to 2.12 for Pb µg/g drywight in different species. Cadmium tended to be the least concentrated in the all fish as compared to other elements measured. In all studied fishes concentrations of Zn were high (Fig 1). The higher metal concentrations were found in the *Cyprinus carpio*(18.31±3.04) .The sequence of order of the heavy metals measured in the fish samples observed from the Anzali Wetland was as follows: Cd < Cr < Pb<Cu<Zn, respectively.

Table 2. Concentrations of heavy metals in sediments of Anzali wetland (µ g/g).

Sampel	Pb	Cd	Zn	Cu	Cr
Abkenar	10.06	0.84	83.47	14.23	3.68
Siyahkeshim	12.38	1.08	76.83	15.7	6.91
Hendekhale	11.97	1.58	68.51	19.05	4.95
Shyjan	14.18	2.35	83.41	23.51	9.11
Mean	12.14	1.46	78.08	18.12	6.12
SD	1.69	0.66	7.08	4.11	0.27
Range	10.06-14.18	0.84-2.47	68.51-83.47	14.23-23.51	3.68-9.11

Discussion

Metal accumulation in fish depends on pollution, and may differ for various fish species living in the same water body (Jezierska and Witeska, 2001). Generally, the higher metal concentration in the environment, the more may be taken up and accumulated by fish. Relationship between metal concentrations in fish and in the water and sediment was observed in both, field and Laboratory studies (Moiseenko *et al*., 1995; Linde *et al*., 1996). Various species of fish from the same water body may accumulate different amounts of metals. Interspecies differences in metal accumulation May be related to living and feeding habits (Canil & Atli ,2003).

Table 3. Average fish length and weight ± standard deviation of fish species collected in Anzali Wetland (µg/g drywight).

Fish	Weight(g)		Length(mm)		Condition factor	
	Mean	Range	Mean	Range	Mean	Range
Cyprinus carpio	214.9±118.90	45-336	240.3±56.95	145-305	1.32±0.16	0.99-1.54
Abramis brama	179.87±99.98	63-302	229.25±36.74	147-270	1.34±0.23	1.02-1.60
Carassius carassius	226.33±13.66	206-237	234.5±3.88	230-240	1.75±0.06	1.69-1.85

Ahmed *et al*. (2009) investigated the heavy metal concentration in fish from the Shitalakhya River, Bangladesh and found variation of Cr, Cd, Pb ranged from 8.12-9.07 µg/g, 1.09-1.21 µg/g and 9.16-13.09 µg/g respectively, it was for our study Cr, Cd, Pb ranged from 0.65-0.95 µg/g, 0.12-0.24,0.76-2.12 that were higher than our results. Ashraf (2006) studied samples of canned tuna fish and found the concentration of Pb, Cr and Cd ranged between 0.14 and 0.82, 0.10 and 0.57, 0.08 and 0.66 µg/g respectively, which are lower than present findings. Kalay and canil (1999) found that muscle tissues in *Mugil cephalus* and *Mullus barbatus* collected from Northeast Mediterranean Sea contained cadmium, chromium, lead at 1.17–0.96, 1.53–1.30, 6.79–6.24 µg/g species, respectively . In this study, we found lower concentrations of metals than Kalay and canil . Ebrahimpour *et al* (2011) reported cadmium, chromium and lead in the muscle tissues of *Carassius gibelio* collected from the Anzali wetland, Iran at concentrations of 0.25 µg/g, 0.7 µg/g and 1.2 µg/g, respectively. In our study, Cr & Pb was observed at

higher concentrations(except in *Carassius carassius*) and Cd was observed at lower concentrations than the Ebrahimpour *et al.* study for all species.Karadede and Unlu (2007) reported the average Cu content as 3.05 µg/g d.w., and Zn content as 8.76 µg/g d.w. that were lower than our findings.

Table 4. The mean of heavy metals ± standard error of fish species collected in Anzali Wetland.

Contaminnt		*Cyprinus carpio*	*Abramis brama*	*Carassius carassius*
Cr	Mean±SD	0.83±0.11	0.88±0.09	0.88±0.13
	Range	0.65-0.96	0.79-1.02	0.72-1.05
Zn	Mean±SD	18.31±3.04	16.71±0.5	10.48±0.76
	Range	11.98-23.54	16.00-17.30	9.64-11.5
Cu	Mean±SD	5.24±1.42	5.42±1.81	3.09±0.27
	Range	3.09-7.03	2.68-7.34	2.78-3.43
Pb	Mean±SD	1.56±0.44	1.27±0.38	0.89±0.11
	Range	1.06-2.12	0.95-1.87	0.76-1.03
Cd	Mean±SD	0.16±0.04	0.19±0.02	0.17±0.03
	Range	0.12-0.23	0.16-0.24	0.13-0.22

Table 5. Correlation between heavy metal concentrations in muscle tissue (µg/g drywight) and length (mm), body weight (g) and condition factor of different fish in Anzali wetland.

Fish	Parameter	Cd	Cr	Pb	Zn	Cu
Cyprinus carpio	K	-0.38	-0.37	-0.12	-0.41	0.05
	L	0.28	0.54	-0.10	0.95	0.94
	W	0.23	0.52	-0.03	0.51	0.94
Abramis brama	K	0.71	0.77	0.75	0.50	0.48
	L	0.76	0.78	0.85	0.11	0.98
	W	0.88	0.98	0.96	0.30	0.93
Carassius carassius	K	0.17	-0.66	0.10	0.71	0.95
	L	0.96	0.73	0.98	0.53	0.20
	W	0.88	0.17	0.85	0.009	0.76

(significance level $p < 0.05$)K:condition facor L:length W: weight.

The relationship between size and weight of fish and metal accumulation is subject to variable opinions from different authorities. In this study concentration of metals Cr,Zn,Cu, Cd and Pb was varied as size, weight and Condition factor of fish (Table 5).

copper and lead in *Abramis brama* and cadmium and lead in *Carassius carassius* with total lengths. .Also metal concentrations were regressed with fish weight statistically significant strong positive correlations were observed for lead, cadmium in *Carassius carassius* and copper in *Cyprinus carpio*.

A l-Yousuf *et al.* (2000) found that the concentration of Cd in *Lethrinus lentjan* a positive correlation with fish length and weight . In this study we found positive relation between metal concent rations and fish size for species (except Pb in *Cyprinus carpio*) .Widianarko *et al.*, 2000 investigated the relationship between metal (Pb) concent rations and fish (Poecilia reticulat a) size, and found that there was a significant decline in lead concent rations with the increase in size. Some research have shown negative relationships between fish size and the metal concentrations found in fish (Canli and Atli, 2003; Farkas and Specziár, 2003). Metal accumulation in fish has been found to reach a steady state after a certain age (Douben, 1989).Negative relationships between fish length and metal concentrations (for Pb) were also reported by Canli and Atli (2003). Farkas *et al.*, 2003 in their study on Abramis brama reported a negative size-related correlation for cadmium,

copper, lead and zinc in the muscle and positive correlation for Pb that is disagree with our study. Moderate positive relationships between condition factor and zink concentration were found in *Abramis brama* (r=0.50). For cadmium and chromium, postive associations of cadmium concentration related to the condition factor were found in *Abramis brama* (r=0.71 and r=0.77 respectivly). Significant negative relationships were also found between the condition factor and chromium level in *Carassius carassius* (r=−0.66) and positive relationships were found the ondition factor and copper and zink levels in *Carassius carassius*(r=0.95, r=0.71 respectivly).

Table 6. Comparison of mean heavy metal concentrations in different fish from different areas of t he world as well as maximum allowable concentrations of several heavy metals in seafood f or human consumption(µg/g wet weight).

Geographical area/Standard s	Species	Cd	Cu	Pb	Zn	Cr	References
WHO[1]		0.2	10	-	1000	-	Madany*et al* . , 1996
NHMR[2]		0.05	10	1.5	150	-	Darmono & Denton, 1990
New Zealand		10	30	2.0	40	-	Nauen, 1983
Anzali wetland	*Cyprinus carpio*	0.03	1.04	0.31	3.36	-	Present s tudy
Anzali wetland	*Abramis brama*	0.04	1.08	0.25	3.34	-	Anz ali wetland
Anzali wetland	*Carassius carassius*	0.03	0.61	0.17	2.09	-	Anzali wetland
Mulbar Australia	Pagrus auratus	0.001	0.18	0.02	4.80	-	Mulbar Australia
Diyala rive,	Barbus	0.15	1.61	3.49	29.30	-	Diyala
Iragh	grypus						rive, Iragh
Fish Farming Lake	Mugil	0.93	5.16	7.30	7.20	-	Fish Farming Lake

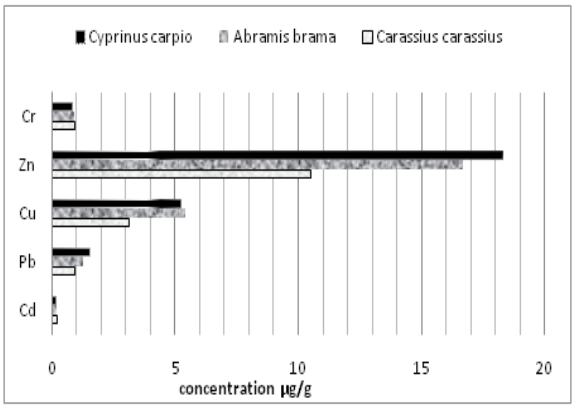
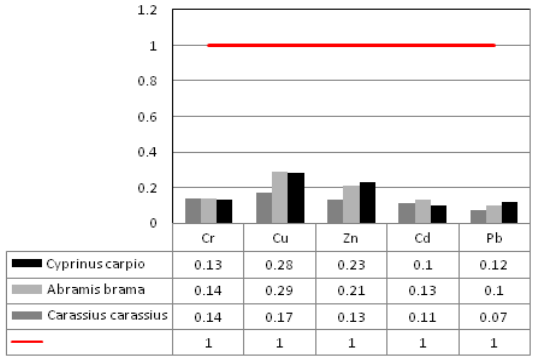


Fig. 1. Concentration of heavy metals in different fish species(µg/g dry weight.

In this study, metal concentrations were regressed with fish total lengths statistically significant strong positive correlations ($p<0.05$) were observed for the bioaccumulation factors of heavy metals in the tissues from fish sampels are presented in Fig 2.

For all zink and copper in *Cyprinus carpio* , metals, a BAF value of less than 1.00 is usually expected.

The accumulation factor for Cu at *Abramis brama* is the highest recorded in our study while Lead accumulation factor is lowest at *Carassius carassius* species. Although, fish muscle was reported have lowest metal concentrations compare to bone, gill and liver, this study focus metals in fish muscle since, people eat fish muscle and not others Various.



	Cr	Cu	Zn	Cd	Pb
Cyprinus carpio	0.13	0.28	0.23	0.1	0.12
Abramis brama	0.14	0.29	0.21	0.13	0.1
Carassius carassius	0.14	0.17	0.13	0.11	0.07
	1	1	1	1	1

Fig. 2. Compration of Bioaccumulation factors for samples collected at Anzali wetland. Conclussion.

In this study, the levels of metals including Cd, Cr,Zn,Cu and Pb of three species were determined in Anzali Wetland, Among the metals analyzed, Zn was

the one with the highest concentration, while Cd had the lowest level. The concentrations of metals determined in this study did not exceed the standards recommended by the WHO and. Hence, at the present, it seems that consumption of the species do not present any danger for human health.Biota–sediment accumulation factors (BSAF) are frequently used to predict Contaminant bioaccumulation in risk assessments. Development of these parameters is often hindered by uncertainty regarding the spatial scale of contaminant transfer from sediments to biota. In our study bioaccumulation factors of sediment was lower than 1 for species. Patterns of elements accumulation in t he studied species were com parable to What has been reported by m any other researchers for other fish species. Future efforts should focus on health risks posed by metal contamination in the other biological factor along the Anzali Wetland.

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