Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.20138

63 (2017) 96–102
February

Assessment of zinc, cadmium, nickel, lead and chromium concentrations in water, sediments and different tissues of *Cyprinus carpio*, from Kalpani stream Mardan Khyber Pukhtunkhwa, Pakistan

Naila Gulfam[a], Muhammad Zahoor[b,*], Farhat Ali Khan[c]

[a]*Jinnah College for Women, University of Peshawar, Pakistan, email: nailazoo@yahoo.com*
[b]*Department of Chemistry, University of Malakand, Chakdara, Dir (Lower), Pakistan, Tel. +923416062388; email: mohammadzahoorus@yahoo.com*
[c]*Independent, email: farhatkhan2k9@yahoo.com*

Received 7 April 2016; Accepted 7 August 2016

ABSTRACT

In this study the accumulation of trace metals like zinc (Zn), cadmium (Cd), nickel (Ni), lead (Pb) and chromium (Cr) were determined in water, sediments and different tissues of common carp, *Cyprinus carpio* collected from Kalpani Stream Mardan. The accumulation of zinc was highest in gills (7.343 μg/g)> intestine (4.833 μg/g)> liver (3.339 μg/g)> skin (2.068 μg/g)> sediments (1.745 μg/g)> muscles (1.738 μg/g) while in water, it was below detectable level. Similarly cadmium accumulation was highest in intestine (0.02 μg/g)> water (0.0189 μg/ml)> skin (0.01 μg/g)> sediments (0.010 μg/g)> gills (0.009 μg/g)> liver (0.0002 μg/g) while in muscles it was below the level of detection. Likewise the nickel concentration was in the order of sediments (3.325 μg/g)> intestine (0.099 μg/g)> skin (0.035 μg/g)> gills (0.008 μg/g)> muscles (0.0025 μg/g), while in water and liver it was below detectable level. The accumulation of lead was highest in sediments (0.045 μg/g)> skin (0.015 μg/g)> muscles (0.0016 μg/g) while in water, intestine, liver and gills it was below the level of detection. Similarly chromium accumulation was highest in sediments (0.803 μg/g)> gills (0.419 μg/g)> skin (0.398 μg/g)> intestine (0.261 μg/g)> muscle (0.057 μg/g)> liver (0.025 μg/g) while in water it was below the detectable level. Comparing the values of Zn, Cd, Ni, Pb and Cr determined during our studies with that of FAO 1989, WHO 2004 and U.S Recommended daily dietary Allowance (RDA 1989) for metals supplied by a 100 g of fish muscle shows that, our observed values did not exceed the set values.

Keywords: Heavy metals; Water; Sediments; Common carp

1. Introduction

Heavy metals have gained much consideration among the non-degradable noxious substance owing to their poor consequences on water inhabiting fauna and flora [1]. Heavy metals are the most toxic substances because of their varied effects. Those metals which are highly soluble in water are easily absorbed into the biotic components of an ecosystem. Fishes are infamous for their capability to accumulate heavy metals in their tissues. The metals occur most probably as cationic complexes and concentrate in the internal organs of fish. Metals with higher concentration are known to cause harmful effects on blood and organs in fish. They form metal compound when react with enzymes, DNA, RNA and cellular proteins [2].

Kalpani Stream is considered as the life line of part of Nowshera and Mardan Districts. The origin of this Stream is at a height of about 1,520 feet in Malakand Agency. It flows from North to South, and has a running length of about 110 km from its origin [3].

* Corresponding author.

The entire fish species of Kalpani Stream belong to South Asian sub region of the Oriental Region however, *Hetero pneustusfossilis,* species of *Puntius* and *Chana punctatus* are from Indus River. Various efforts have been made by researchers to explain the different fish species of Kalpani. The different fish species of Kalpani and its offshoots have been observed and studied at different places and times by different researchers [4]. Kalpani Stream facilitates diverse services to the local people of Mardan, for example waste disposal, irrigation, relief from intense heat of summer, fishing, waste bin, disposal of industrial waste, soil formation, ground water renewal, boating, primary productivity, reprocessing of nutrients, climatic parameters, water decontamination and a multitude of others.

Cyprinus carpio is considered as one of the ancient and important cultural fish species for food. Its culture first began in China and later on was introduced in European countries, from where its domesticated farms were introduced in several other countries. Being the most important fresh water fish, it is also considered as prized food in Europe, Asia and Middle East countries [5,6]. Carps are omnivores; they voraciously feed upon the bottom dwellers such as larvae of insects, mollusks, water insects, worms and zooplankton. Carps can gain a body weight of about 0.6 to 1.0 kg within a single growing season. According to the FAO statistics of 2004, production of farmed Common carp was 13% (3,387,918 tones) of the total world aquaculture Production [7].

Keeping in view the importance of *Cyprinus carpio* with special reference to its source of foods to the local communities, the present study was aimed to investigate the heavy metals contents in different organs of *Cyprinus carpio* and the environment where it grow.

2. Materials and methods

2.1. Sample collection

Water, sediments and fish samples (Common carp) were collected from Kalpani Stream Mardan and were transported to PCSIR lab. Water samples were preserved by adding few ml of HNO_3 to it while sediment samples were dried in oven at 110°C and grounded in glass mortar. Similarly fish samples were washed with distilled water and morphometric measurements were taken. After morphometric measurement fish were dissected for various tissues such as muscles, intestine, skin, liver and gills. A known weights of these tissue samples were taken in sterilized polythene bags and stored in freezer at –20°C for further analysis.

2.2. Sample preparation

The water samples were taken in separate beakers along with a mixture of 15 mL of concentrated HNO_3 and 5 mL of $HClO_4$. The beakers were covered with Pyrex glass cover and placed on hot plate for boiling. The samples were allowed to evaporate until 2–3 ml volume was left which indicate that digestion has been completed. After digestion samples were cooled, filtered, and were diluted to 100 ml distilled water by proper rinsing of the digestion beakers [8].The oven-dried samples of sediments were passed through a 2 mm sieve. The *aqua regia* method involving15 mL of conc. HNO_3 and 5 mL of $HClO_4$ was used as the standard method to digest the sample. 2 g of oven dried and mortar grounded sample was placed in a beaker by adding 15 ml of conc. HNO_3 and 5 mL of $HClO_4$. The beaker is then placed on hot plate and mixture is heated at 80°C–90°C in a fume hood until the dark color disappears. The dense white fume from the beaker after brown fumes is the indication of completion of the digestion process [8].

Tissue samples were digested according to the methods presented by Van Loon [9] and Duefreez and Steyn [10]. A slight modification was made in the procedure [11] instead of putting 10ml nitric acid (55%) and 5 ml per chloric acid (70%) at the time of digestion, 5 ml nitric acid (55%) and 1 ml per chloric acid (70%) were added to each flask and the flask were then kept for overnight. Next day a second dose of 5 ml nitric acid (55%) and 4 ml per chloric acid (70%) was added to each flask. The flask were kept on hot plate, covered with Pyrex glass cover and allowed to digest at 200°C to 250°C until a clear transparent solution was observed. Initially dark brown fumes appeared followed by white fumes. The dense white fumes from the flask, after brown fumes was an intimation of completion of the digestion process. By this method digestion was accomplished in about 30 min instead of 3–4 h as described by Van Loon 1980. After digestion, samples were cooled, filtered through (Watman 42) filter paper and diluted to 100 ml with distilled water by proper rinsing of the digestion beakers. Samples were stored in properly washed glass bottles until the metal concentration could be determined.

2.3. Analysis of heavy metals

All the solvents and chemicals used in this study were analytical grade (99% pure). Atomic Absorption Spectrophotometer (Spectra AA 2000) was used for determination of heavy metals concentration (Zn^{2+}, Cd^{2+}, Ni^{2+}, Cr^{3+} and Pb^{2+}) in water, sediments and tissue samples of each fish. A range of analytical standards for each metal was prepared from E Merck stock solution. Standard curves were prepared and the optical densities were calibrated against the standard curves to know the concentration of heavy metals present. Data was analyzed and presented as mean± standard error of the mean.

3. Results

The results showed the bio concentration of zinc, cadmium, nickel, lead and chromium in water, sediments and different tissues of common carp including muscle, intestine, gills, liver and skin. The concentration of zinc, cadmium and nickel accumulation (ppm) in water, sediments and different tissues of common carp are presented in Tables 1–6. Zinc concentration in sediments was 1.906–1.493 with a mean value of 1.745 (μg/g). Similarly in muscles and intestine its value ranged from 2.206 to 1.333 and 6.283 to 2.443 μg/g (wet weight) with mean values of 1.738 and 4.833 (μg/g), respectively. Thus the order of zinc accumulation was (gills > intestine> liver> skin> sediments> muscles), while in water the value of lead was below detectable level.

The cadmium accumulation in water ranged between 0.023 and 0.016 μg/ml, with a mean value of 0.0189 μg/ml. Similarly in sediments its value ranged between 0.013 and 0.006, with a mean value of 0.010 μg/g. In intestine, skin, liver

Table 1
Assessment of zinc accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration of zinc (μg/g)				Mean	Mean ± SEM
	Sample 1	Sample 2	Sample 3	Sample 4		
Water	BDL	BDL	BDL	BDL	BDL	BDL
Sediments	1.7833	1.493	1.906	1.8	1.745	1.745 ± 0.15322
Common carp organs						
Muscle	1.333	1.533	2.206	1.883	1.738	1.738 ± 0.333952
Intestine	6.283	5.8633	4.746	2.443	4.833	4.833 ± 1.490276
Skin	1.31	1.31	2.926	2.726	2.068	2.068 ± 0.761291
Liver	4.616	2.763	2.293	3.686	3.339	3.339 ± 0.89121
Gills	6.73	6.406	7.236	9.003	7.343	7.343 ± 1.002595

BDL, Below detection level; SEM, Standard error mean.

Table 2
Assessment of cadmium accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration of cadmium (μg/g)				Mean	Mean ± SEM
	Sample 1	Sample 2	Sample 3	Sample 4		
Water	0.023	0.02	0.016	0.0166	0.0189	0.0189 ± 0.00281
Sediments	0.006	0.01	0.013	0.013	0.010	0.010 ± 0.00287
Common carp organs						
Muscle	BDL	BDL	BDL	BDL	BDL	BDL
Intestine	0.02	0.02	0.02	0.02	0.02	0.02 ± 0
Skin	0.01	0.01	0.01	0.01	0.01	0.01 ± 0
Liver	0.0033	BDL	BDL	BDL	0.0002	0.0002 ± 0.00142
Gills	0.01	0.006	0.01	0.01	0.009	0.009 ± 0.00173

BDL, Below detection level; SEM, Standard error mean.

Table 3
Assessment of nickel accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration of nickel (μg/g)				Mean	Mean ± SEM
	Sample 1	Sample 2	Sample 3	Sample 4		
Water	BDL	BDL	BDL	BDL	BDL	BDL
Sediments	3.3633	2.92	3.27	3.75	3.325	3.325 ± 0.295
Common carp organs						
Muscle	0.01	BDL	BDL	BDL	0.0025	0.0025 ± 0.00433
Intestine	0.1566	0.1266	0.09	0.026	0.099	0.099 ± 0.048701
Skin	BDL	0.06	0.063	0.02	0.035	0.035 ± 0.02672
Liver	BDL	BDL	BDL	BDL	BDL	BDL
Gills	BDL	BDL	0.033	BDL	0.008	0.008 ± 0.014289

BDL, Below detection level; SEM, Standard error mean.

and gills the mean values were 0.02, 0.01, 0.0002, 0.009 μg/g (wet weight), respectively. Thus the pattern of accumulation was as follows: intestine> water> skin> sediments> gills> while in muscles its value was below the detectable level. Similarly nickel accumulation in sediments ranged between 3.75 and 2.921 with a mean value of 0.010 μg/g. In muscles, intestine, skin, and gills the mean values were 0.0025, 0.099, 0.035 and 0.008 μg/g (wet weight), respectively. Thus the pattern of accumulation was as follows: sediments> intestine> skin> gills> muscles while in water and liver its values were below the detectable level.

Lead concentration in sediments was 0.045 ± 0.02593 with a mean value of 0.045 (μg/g). Similarly in muscles and skin its value ranged as 0.0016 ± 0.00165 and 0.015 ± 0.02598 μg/g (dry weight) with mean values of 0.0016 and 0.015 (μg/g), respectively. Thus the order of lead accumulation was (sediments> skin> muscle). While in water, intestine, liver and gills the value of lead was below detectable level.

Table 4
Analysis of lead accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration of lead (μg/g)				Mean	Mean ± SEM
	Sample 1	Sample 2	Sample 3	Sample 4		
Water	BDL	BDL	BDL	BDL	_	_
Sediments	0.036	0.026	0.03	0.09	0.045	0.045 ± 0.02593
Common carp organs						
Muscle	BDL	BDL	0.0033	0.0033	0.0016	0.0016 ± 0.00165
Intestine	BDL	BDL	BDL	BDL	_	_
Skin	0	0	0	0.06	0.015	0.015 ± 0.02598
Liver	BDL	BDL	BDL	BDL	_	_
Gills	BDL	BDL	BDL	BDL	_	_

BDL, Below detection level; SEM, Standard error mean.

Table 5
Analysis of chromium accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration of chromium (μg/g)				Mean	Mean ± SEM
	Sample 1	Sample 2	Sample 3	Sample 4		
Water	BDL	BDL	BDL	BDL	_	_
Sediments	0.8266	0.653	0.64	1.096	0.803	0.803 ± 0.18403
Common carp organs						
Muscle	0.07	0.056	0.09	0.013	0.057	0.057 ± 0.028261
Intestine	0.206	0.35	0.32	0.17	0.261	0.261 ± 0.075344
Skin	0.60	0.4433	0.446	0.106	0.398	0.398 ± 0.18056
Liver	BDL	0.09	BDL	BDL	0.025	0.025 ± 0.0389
Gills	0.313	0.513	0.4366	0.413	0.419	0.419 ± 0.071445

BDL, Below detection level; SEM, Standard error mean.

The chromium accumulation in sediments ranged between 1.096 and 0.64 μg/g, with a mean value of 0.803 μg/g. In muscles, intestine, skin, liver and gills the mean values were 0.05, 0.261, 0.389, 0.025 and 0.413 μg/g (dry weight), respectively. Thus the pattern of accumulation was as follows (sediments>gills>skin>intestine>muscle>liver).

Comparing the values of zinc, cadmium, nickel, lead and chromium concentration in different tissues of fish, it was noted that Zinc showed much accumulation affinity to different tissues of common carp (muscle, intestine, skin, liver and gills) as compared to cadmium, nickel, lead and chromium. Likewise the total accumulation of these five metals showed the following order: gills> sediments> intestine> liver> muscle> skin> water (Table 6).

4. Discussion

Fish can accumulate zinc from the surrounding water as well as from their diet. Even though zinc is one of necessary element but at high concentrations, it can be lethal to fish. It may cause growth retardation, mortality and reproductive impairment. Zinc is capable of interacting with other elements and producing additive or opposite effects. Zinc get entered in to the fish body through different pathways, including skin or general body surface, gills and alimentary canal or gut by consumption of contaminated food [12].

In the present study highest Zn concentration is shown by gills which may be due to close contact of blood and water. Therefore, gills are the main site for absorption of Zn from ambient water. The concentration of Zinc observed in this study were in close agreement to that of study conducted by Ishaq et al. [13] who reported 7.05 ppm of Zn in the gills of fish *Clarias gariepinus* collected from Nigeria River. Similarly Olaifa [14] has recorded 0.66 and 0.729 ppm of Zn in the muscle of *Clarias gariepinus* collected from Eleiyele Lake and Zartech pond in Ibandan, Nigeria respectively, which is low as compared to our recorded value (1.738) μg/g wet weight. The skin of fish is in direct contact with water so metal accumulation in skin occurs due to adsorption which is followed by absorption through several mechanisms. Yousafzai [15] has also reported 1436.7± 92.19 μg/g (wet weight) of Zn in the skin of *Tor putitora* netted from River Kabul. Similarly, Ruelas and Osuna [16] have also reported 388 ppm (wet weight) of Zn in the liver of fish species *Eschrichtius robustu.*

Cadmium is a non-biodegradable and non-essential, element which is considered to be a major pollutant that causes adverse effects on the aquatic eco-system [17]. In fish the highest Cd concentration occurs in metabolically active tissues while the lowest concentration occurs in muscles [1].

It is well-known fact that total heavy metal accumulation does not occurs in fishes because these are regulated to certain extent by fish metabolism and after that extent

Table 6
Comparison of Zinc, Cadmium, Nickel, Lead and Chromium accumulation in water, sediments and different tissues of common carp collected from Kalpani Stream Mardan

Source	Concentration (μg/g)					Mean	Mean ± SEM
	Metals	Sample 1	Sample 2	Sample 3	Sample 4		
Water	Zn	BDL	BDL	BDL	BDL	–	–
	Cd	0.023	0.02	0.016	0.0166	0.0189	0.0189 ± 0.00281
	Ni	BDL	BDL	BDL	BDL	–	–
	Pb	BDL	BDL	BDL	BDL	–	–
	Cr	BDL	BDL	BDL	BDL	–	–
Sediments	Zn	1.7833	1.493	1.906	1.8	1.745	1.745 ± 0.15322
	Cd	0.006	0.01	0.013	0.013	0.010	0.010 ± 0.00287
	Ni	3.3633	2.92	3.27	3.75	3.325	3.325 ± 0.2954
	Pb	0.036	0.026	0.03	0.09	0.045	0.045 ± 0.02593
	Cr	0.8266	0.653	0.64	1.096	0.803	0.803 ± 0.18403
Common carp organs							
Muscle	Zn	1.333	1.533	2.206	1.883	1.738	1.738 ± 0.333952
	Cd	BDL	BDL	BDL	BDL	BDL	BDL
	Ni	0.01	BDL	BDL	BDL	0.0025	0.0025 ± 0.00433
	Pb	BDL	BDL	0.0033	0.0033	0.0016	0.0016 ± 0.00165
	Cr	0.07	0.056	0.09	0.013	0.057	0.057 ± 0.028261
Intestine	Zn	6.283	5.8633	4.746	2.443	4.833	4.833 ± 1.490276
	Cd	0.02	0.02	0.02	0.02	0.02	0.02 ± 0
	Ni	0.1566	0.1266	0.09	0.026	0.099	0.099 ± 0.048701
	Pb	BDL	BDL	BDL	BDL	–	–
	Cr	0.206	0.35	0.32	0.17	0.261	0.261 ± 0.075344
Skin	Zn	1.31	1.31	2.926	2.726	2.068	2.068 ± 0.761291
	Cd	0.01	0.01	0.01	0.01	0.01	0.01 ± 0
	Ni	BDL	0.06	0.063	0.02	0.035	0.035 ± 0.02672
	Pb	0	0	0	0.06	0.015	0.015 ± 0.02598
	Cr	0.60	0.4433	0.446	0.106	0.398	0.398 ± 0.18056
Liver	Zn	4.616	2.763	2.293	3.686	3.339	3.339 ± 0.89121
	Cd	0.0033	BDL	BDL	BDL	0.0002	0.0002 ± 0.00142
	Ni	BDL	BDL	BDL	BDL	BDL	BDL
	Pb	0	0	0	0.06	0.015	0.015 ± 0.02598
	Cr	BDL	0.09	BDL	BDL	0.025	0.025 ± 0.0389
Gills	Zn	6.73	6.406	7.236	9.003	7.343	7.343 ± 1.002595
	Cd	0.01	0.006	0.01	0.01	0.009	0.009 ± 0.00173
	Ni	BDL	BDL	0.033	BDL	0.008	0.008 ± 0.014289
	Pb	BDL	BDL	BDL	BDL	–	–
	Cr	0.313	0.513	0.4366	0.413	0.419	0.419 ± 0.071445

BDL, Below detection level; SEM, Standard error mean.

bioaccumulation occurs. Thus in a particular tissue the ability of heavy metals concentration depends upon the total heavy metal uptake in that particular tissue. This metal regulation is due to the induction of low molecular weight metal-binding proteins, such as metallothionein which are closely related to heavy metal exposure and metals taken up from the environment can be detoxified by binding on these proteins [18,19].

Therefore, tissue like liver, which is a major producer of metal-binding proteins, show high concentrations of most heavy metals detoxification [20] which eventually result in clearance of heavy metal ions from the body. Furthermore, the physiological differences and the position of each tissue in the fish can also influence the accumulation of a particular metal [21]. In other words, the amount of a metal accumulated is influenced by various environmental, biological and genetic factors, leading to the differences in metal accumulation between different individuals, species, age, tissues, seasons and sites [18].

Fish seems less vulnerable to nickel. However, the highest nickel concentrations were detected in the gills of *Cyprinus carpio* [22]. Wallagoattu. Javed and Usmani [23]

have recorded 34.09 ± 1.45 ppm (dry. wt) of Ni in the muscle of fish, *Chana punctatus.* The mean value of nickel concentration observed in the muscle of Common carp collected from Southern District of Tamilnadu, India was 0.633 ± 0.015 μg/g (dry. weight) [22].

Highest nickel concentration was recorded in the intestine of Lake white fish, *Coregonus clupeaformis*, while in the present study nickel was below the detectable level. Javed and Usmani [23] have recorded 46.6 ± 2.89 ppm (dry.wt) of Ni in the liver of fish, *Chana punctatus*. Nickel concentration of 9.55 ± 3.18 ppm (dry.wt) was observed in the liver of fish, *Labeo umbratus* collected from Witland Dam Mpumalanga [24]. The mean value of nickel concentration observed in the liver of Common carp collected from Southern district of Tamilnadu, India was 0.973 ± 0.021ug/g (dry.wt) [22]. Yilmaz [25] has recorded nickel concentration of 2.72 and 0.02 ppm (wet.wt) in the skin of *Mugil cephalus and Trachur mediterraneus* respectively collected from Iskenderm Bay Turkey, which is close to the observed values during this study.

Nickel concentration of 11.64 ± 3.14 ppm (dry. wt) was observed in the gills of fish, *Labeo umbratus* collected from Witland Dam Mpumalanga. Javed and Usmani [13] have recorded 14.0 ± 1.63 ppm (dry. wt.) of Ni in the gills of fish, *Chana punctatus*. The mean value of nickel concentration observed in the gills of Common carp collected from Southern District of Tamilnadu India was 1.043 ± 0.021 μg/g (dry. wt.) [22].

Generally chromium does not accumulate in fish and hence low Cr concentrations were reported even from the industrialized areas of the world [26]. Previously [27] have recorded 3.48 ± 0.60 ppm (wet weight) of chromium in the skin of fish, *Catla catla* collected from Lahore Siphon (upstream). In the present study, among the fish tissues skin revealed highest chromium concentration which is due large surface area for exposure to the surrounding water. It is well-known fact that total heavy metal accumulation does not occurs in fishes because these are regulated to certain extent by fish metabolism and after that extent bioaccumulation occurs. Thus in a particular tissue the ability of heavy metals concentration depends upon the total heavy metal uptake in that particular tissue. This metal regulation is due to the induction of low molecular weight metal-binding proteins, such as metallothionein which are closely related to heavy metal exposure and metals taken up from the environment can be detoxified by binding on these proteins [18]. Therefore, tissue like liver, which is a major producer of metal-binding proteins, show high concentrations of most heavy metals detoxification [19] which eventually result in clearance of heavy metal ions from the body. Furthermore, the physiological differences and the position of each tissue in the fish can also influence the accumulation of a particular metal. In other words, the amount of a metal accumulated is influenced by various environmental, biological and genetic factors, leading to the differences in metal accumulation between different Individuals, species, age, tissues, seasons and sites [18].

5. Conclusion

In this study the accumulation of some heavy metals were determined in water, sediments and different tissues of common carp, *Cyprinus carpio* collected from Kalpani Stream Mardan. The concentration zinc was in the order; gills> intestine> liver> skin> sediments> muscles while in water it was below detection limit. For cadmium the order was; intestine> water> skin> sediments> gills> liver. In muscles its concentration was below the detectable limit. The nickel concentration was in the order of sediments> intestine> skin> gills> muscles. In water and liver it was below detectable level. Lead concentration was highest in sediments > skin> muscles while in water, intestine, liver and gills it was below the level of detection, while chromium amount was highest in sediments> gills> skin> intestine> muscle> liver while in water it was below the detectable level. In conclusion among water, sediments and fish, the highest metals concentration was recorded in sediments, followed by fish and water. The upper limits of U.S RDA1989 (U.S Recommended Dietary Allowance) for Zn, Cd, Ni, Pb and Cr are 2,600, 14, 10, 200 and 300 μg, respectively. By comparing the values our study to that of U.S RDA 1989 for metals supplied by a 100 g of fish muscle did not exceed the set values. Therefore, the common carp fish of Kalpani Stream Mardan river is suitable for human consumption and fulfill all hygienic limits determined for these elements. By using such studies we can easily identify the metals concentrations in edible fishes residing in water bodies in different parts of the world. This study will open a new research area for marine researcher.

References

[1] N. Dirilgen, Accumulation of heavy metals in fresh water organisms, Assessment of toxic interactions, Fish. Technol., 212 (2001) 1–13.
[2] A. Akahori, T. Gabryelak, Z. Jozwiak, R. Gondko, Zinc-induced damage to carp (*Cyprinus carpio*) erythrocyte *in vitro*, Int. J. Biochem. Mol. Biol., 47 (1999) 89–98.
[3] M.C. Acreman, M.P. Farquharson, M.C. Cartney, C. Sullivan, K. Campbell, Managed Flood Releases from Reservoirs. Issues and Guidance, Report to Department for International Development and the World Commission on Dams, Wallingford, United Kingdom, Centre, 2000.
[4] J. Mcclelland, Indian Cyprinidae. Asiatic Researches, Calcutta, Vol. 19, 1839, pp. 217–468.
[5] S. Eddy, J.C. Underhill, Northern Fishes with Special Reference to the Upper Mississippi Valley, 3rd ed., University of Minnesota Press, 1974.
[6] E.K. Balon, The oldest domesticated fishes, and the consequences of an epigenetic dichotomy in fish culture, J. Ichthyol. Aquat. Biol., 11 (2006) 47–86.
[7] E.K. Balon, Oldest domesticated fishes, and the consequences of an epigenetic dichotomy in fish culture, J. Ichthyol. Aquat. Biol., 11 (2006) 47–86.
[8] A.P.H.A. (American Public Health Association). Standard Methods for the Examination of Water and Waste Water, APHA, Washington DC, 16th ed., 1999.
[9] J.C. Vanloon, Analytical Atomic Absorption Spectroscopy, Selected Methods, Academic press, New York, United State of America, 1980, p. 337.

[10] H. Due Freez, G.J. Steyn, A preliminary investigation of concentration selected methods in the tissues and organ of the tiger fish (*Hydrocynus vittatus*) from the Oil fants River, Kruger National Park, South Africa, Water Sci. Technol., 18 (1992) 130–136.
[11] A.M. Yousafzai, A.R. Shakoori, Bioaccumulation of chromium, nickel, lead, copper and zinc in the Tor putitora as an indicator of presence of heavy metals load in River Kabul, Zool. Soc. Pak., 4 (2006) 341–347.
[12] J.R. Jenning, P.S. Rainbow, Studies on the uptake of cadmium by the crab, Carcinusmaenas in the laboratory. I. Accumulation from seawater and a food source, Marine Biol., 50 (1979) 131–139.
[13] S. Ishaq, I. Eneji, R. Sha, P.A. Annune, Accumulation of Heavy Metals in Fish (*Tilapia zilli* and *Clarias gariepinus*) Organs from River Benue, North Central Nigeria Department of Chemistry and Centre for Agrochemical Technology, University of Agriculture P. M. B. Makurdi, Benue State, Nigeria, 2011.
[14] F.E. Olaifa, Heavy metal contamination of *Clariasgariepinus* from a Lake and Fish farm in Ibadan, Nigeria, Afr. J. Biomed. Res., 7 (2004) 145–148.
[15] A.M. Yousafzai, Toxicological Effects of Industrial Effluents dumped in River Kabul on Mahaseer, Tor Putitora at AmanGarh Industrial Area, Nowshera, Peshawar, Pakistan, Ph. D. Thesis, Department of Zoology University of Punjab, Pakistan, 2004.
[16] I.J. Ruela, P.O. Suna, Distribution of Cd, Cu, Fe, Mn, Pb and Zn in selected tissues of juvenile hales standard in the ES Gulf of California (Mexico), Environ. Int., 28 (2002) 325–329.
[17] V. Filipovic, B. Raspor, Metallothionein and metal levels in cytosol of liver, kidney and brain in relation to growth parameters of *Mullus surmuletus* and *Liza aurata* from the Eastern Adriatic Sea, Water Res., 37 (2003) 3253–3262.
[18] C.J. Schmitt, W.G. Brumbaugh, National contaminant bio monitoring program: of arsenic, cadmium, copper, lead, mercury, alumenium and zinc in U.S. freshwater fish, Arch. Environ. Cont. Toxicol., 19 (1990) 731–47.
[19] P.H, Kotze, H. Preez, J.V. Vuren, Bioaccumulation of Cu and Zn in *Oreochromus mossambicus* and *Clarias garipinus* from the Olifants River Mpumalanya, South Africa, Water Sci. Technol., 25 (1999) 99–110.
[20] D.W. Thomas, Metals and their Compounds in the Environment, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany, 1991, pp. 1309–1342.
[21] A.G. Heath, Water Pollution and Fish Physiology, Chemical Rubber Company (CRC) Press, New York, 1990, p. 254.
[22] R. Vinodhini, M. Narayanan, Bioaccumulation of heavy metals in organs of fresh water fish Cyprinus carpi, Int. J. Environ. Sci. Technol., 2 (2008) 179–182.
[23] M. Javed, N. Usmani, Accumulation of Heavy Metals in Fishes, A Human Health Concern Aquatic Toxicology Research Laboratory, Department of Zoology, Aligarh Muslim University, Aligarh, India, Vol. 2, 2011, 0976–4402.
[24] G.J. Nussey, H.V. Vurenand, H.H. Preez, Bioaccumulation of chromium, manganese, nickel and lead in the tissues of the moggel, *Labeo umbratus* (Cyprinidae), 26 (2006) 378–381.
[25] A.B. Yilmaz, Level of heavy metals Fe, Cu, Ni, Pb and Zn in tissues of *Mugail cephalus* Trachurus Bay Turkey, Environ. Res., 92 (2003) 277–281.
[26] J.W. Moore, S. Ramamoorthy, Heavy Metals in Natural Waters Applied Monitoring and Impact Assessment, Springer-Verlag, New York, 1839, p. 268.
[27] A. Rauf, M. Javed, M. Ubaidullah, Heavy metal levels in three major carps (*Catla catla*, Laboe rohta and Cirrhina mrigala) from River Ravi Pakistan, Fisheries Research Farms, Department of Zoology and Fisheries University of Agriculture, Faisalabad, Pak. Vet. J., 1 (2009) 24–26.