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Accumulation of some heavy metals in *Tenualosa ilisha* (Hamilton, 1822) collected from Shatt Al-Arab River

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Abstract - In the present study, the concentrations of various heavy metals including copper, nickel, lead, cadmium, iron and manganese were investigated in several organs (muscles of head, muscles of trunks, muscles of tails, liver, gills, gonads and intestine) of *Tenualosa ilisha* (Hamilton, 1822) which was collected from Shatt Al-Arab river during the period between February 2013 and September 2013. Heavy metal concentrations were measured by using Flame Atomic Absorption Spectrophotometer. The results of the heavy metals during study period showed that the highest concentration was 41.910 µg/g (dry weight) for iron between February and March, whereas the least concentration was 0.036 µg/g (dry weight) for lead between June and July. Also, they showed that the highest concentration was 27.470 µg/g (dry weight) for iron in liver, whereas the least concentration was 0.003 µg/g (dry weight) for lead in muscles of tails.

Key words: *Tenualosa ilisha*, Biological accumulation, Environmental pollution, Heavy metals and Shatt Al-Arab River.

Introduction

Fish are regarded an important food source for human being and a principle element in many natural food webs, they also one of the valuable protein sources as they contain vitamins and soluble fats (Al-Taee, 1987). Fish protein was regarded better for health than those of fleshes and fowls. Fish chemical composition consists of protein 15-24 %, carbohydrate 1-3 %, fat 0.1-22 %, inorganic materials 0.8-2 % and water 66-84 % (Al-Najjar, 2014), each of these compounds is important for growth and intelligence of human being.

Heavy metals are usually present in nature, they are necessary for life but they can be toxic through accumulation in the living organisms on the contrary with most of organic pollutants. The most dangerous organic materials that can accumulate and enlarge (Al-Saad and Al-Najjar, 2011).

The metals are classified into four groups; (1) the metals that needed in large quantities these include calcium, magnesium, sodium, potassium, phosphorus, sulphur, iron, copper and zinc; (2) trace metals that are needed in large quantities include manganese, chrome, selenium, boron, bromine, silicon, iodide, vanadium, molybdenum, lithium, cobalt and germanium and others (UNEP/GPA, 2006a); (3) trace metals that are needed in small quantities include fluorine, arsenic, rubidium, tin, nerbium, strontium, gold, silver and nickel; (4) the toxic metals include beryllium, mercury, lead, cadmium, aluminum, antimony, bismuth, barium, uranium and others.

These groups of metals little bit intersect because of evaluation of the metals is required by human beings (UNEP/GPA, 2006b). Some of the metals may be needed in small quantities. It was noted that the required metals in minute quantities usually toxic if they are in large quantities such as iron, copper, manganese, selenium, vanadium even if calcium and sodium.

This present study was carried out to investigate the concentration of many heavy metals in fish tissues of commercial important and to evaluate the risks the fish face and to provide the information that concern the concentrations of copper, nickel, lead, cadmium, iron and manganese in several tissues of fish body.

Materials and Methods

Forty samples of *Tenualosa ilisha* fish were collected from Al-Qurma (Khalid Bridge) during February 2013 to September 2013. Fish length and weight measurements were taken and the length average was recorded as 230 mm and weight average was recorded as 275 g.

ROPME method (1982) was used to digest fish samples of muscles from head, trunk and tail and in addition to the tissues of liver, gills, ovaries and intestine, 0.5 g of each dried and grinded sample was taken and put in glass test tube then 3 ml of (1:1) Concentrated Perchloric acid ($HClO_4$) and Nitric acid (HNO_3) were added to the mixture. The test tubes were put in water bath at 70 °C for 30 minutes then transferred to hot plate for completion the digestion until the mixture became clear, then it was filtered or separated by centrifuge in order to discard the undigested fibers.

Filtrate volume was completed by deionized water to 25 ml. The samples were preserved in tightly closed plastic vials until their analysis by Flame Atomic Absorption Spectrophotometer. The results were expressed as µg/g (dry weight). Analysis of variance (ANOVA) was performed to assess whether trace element concentrations varied significantly between seasons and organs. Revised least significant differences test (R.L.S.D.) and probabilities ($p<0.05$) were considered statistically significant. All statistical calculations were performed with SPSS program.

Results

Results of concentration heavy metals in various tissues during the period from February to September 2013 were listed in Tables (1-6).

The highest value for copper was 8.560 µg/g (dry weight) that recorded in liver during the period between June and July, whereas the least concentration (below the detection level) was recorded during the period between February and March in the muscles of tail (Table 1). Table (2) showed that the highest value for nickel was 9.200 µg/g (dry weight) that recorded in liver during the period between April and May, whereas the least concentration (below the detection level) was recorded during the period between June and July in the muscles of head and gills. Table (3) obtained that the highest concentration for lead was 0.710 µg/g (dry weight) in the liver during the period between August and Septmber. The least concentrations for it were recorded in different tissues during the period between April and September; they were below the level of Flame Atomic Absorption Spectrophotometer detection. The highest value for cadmium was 8.600 µg/g (dry weight) that recorded in intestine during the period between April and May, whereas the least concentration was 0.070 µg/g (dry weight) that recorded in gonads during the period between

June and July (Table 4). Table (5) obtained that the highest concentration for Iron was 80.960 µg/g (dry weight) in gonads during the period between February and March, whereas the least concentration was 10.961 µg/g (dry weight) that recorded in gills during the period August and September. Table (6) showed that the highest value for manganese was 5.500 µg/g (dry weight) that recorded in liver during the period between April and May, whereas the least concentration was 0.010 µg/g (dry weight) that recorded in intestine during the period between February and March. The results showed a significant difference at ($P<0.05$) probability level between studied parts, especially, between the liver and intestine on the one hand and between other tissues on the other hand.

Table 1. Concentration of Copper µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	0.312	0.210	0.291	0.357
Muscles of Trunks	0.234	0.423	0.212	0.285
Muscles of Tails	ND	0.545	0.234	0.195
Liver	4.560	3.670	8.560	0.350
Gills	0.178	0.489	0.478	0.660
Gonads	0.191	0.311	5.900	0.161
Intestine	0.823	0.723	0.620	0.426

ND: Not Detected

Table 2. Concentration of Nickel µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	0.245	0.845	ND	0.263
Muscles of Trunks	0.267	0.367	1.020	0.212
Muscles of Tails	0.289	0.589	0.922	0.334
Liver	3.120	9.200	0.932	0.410
Gills	0.334	0.123	ND	0.156
Gonads	0.256	0.622	0.242	0.287
Intestine	0.178	0.323	0.352	0.691

ND: Not Detected

Table 3. Concentration of Lead µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	0.019	0.014	ND	0.111
Muscles of Trunks	0.011	ND	ND	ND
Muscles of Tails	0.012	ND	0.010	0.110
Liver	0.113	0.750	0.101	0.710
Gills	0.024	0.101	0.101	ND
Gonads	0.015	ND	0.040	0.100
Intestine	0.086	0.036	ND	0.312

ND: Not Detected

Table 4. Concentration of Cadmium µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	3.700	3.010	0.300	0.370
Muscles of Trunks	3.300	3.060	0.204	0.330
Muscles of Tails	0.178	2.010	0.401	0.370
Liver	4.300	4.030	0.403	0.450
Gills	0.691	2.090	0.209	0.420
Gonads	3.100	2.050	0.070	0.270
Intestine	1.200	8.600	0.209	0.160

Table 5. Concentration of Iron µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	50.400	16.700	20.010	15.040
Muscles of Trunks	20.120	11.610	18.080	12.010
Muscles of Tails	40.330	12.310	19.030	20.200
Liver	30.840	20.910	40.080	18.050
Gills	30.250	13.300	20.830	10.961
Gonads	80.960	11.050	25.050	12.060
Intestine	40.470	12.330	10.990	17.010

Table 6. Concentration of Manganese µg/g (dry weight) in different tissues during the period from February to September 2013.

Tissues	Feb.-March	April-May	June-July	Aug.-Sept.
Muscles of Head	1.010	0.412	0.051	1.010
Muscles of Trunks	0.028	0.202	0.022	0.213
Muscles of Tails	0.085	0.634	0.083	0.209
Liver	0.070	5.500	0.070	0.504
Gills	0.151	0.760	0.070	0.300
Gonads	0.039	0.170	0.155	0.101
Intestine	0.010	0.018	0.056	0.114

The results showed that the parts that accumulated the metals were as follows; liver, gonads, head, muscles, tail muscles, intestine, gills and trunk muscles. The sequence of metals in the body was as follows; iron, cadmium, manganese, copper, lead and nickel. All the results of this study were agreed with that recorded in different Iraqi fishes (Table 7) and within the permitted limits of heavy metals in fish (Table 8). Figure (1) shows the mean concentration of the heavy metals during study period. The highest concentration was 41.910 µg/g (dry weight) for iron during the period between February and March, whereas the least concentration was 0.036 µg/g (dry weight) for lead during the period between June and July. Figure (2) shows the mean concentrations of the heavy metals in tissues, that the highest concentration was 27.470 µg/g (dry weight) for iron in liver, whereas the least concentration was 0.003 µg/g (dry weight) for lead in muscles of tails.

Table 7. Concentrations of heavy metals µg/g (dry weight) in different Iraqi fish.

Species	Ni	Pb	Cd	Co	Cu	Fe	Mn	References
Acanthopagrus latus	44.85	-	ND	4.9	2.87	62.0	13.1	Al-Khafaji, 1996
Otolithes ruber	11.9	-	11.9	-	51.1	1.7	26.0	Al-Saad *et al.*, 1997
Liza subviridis	10.9	-	5.9	3.3	9.5	57.0	6.72	Al-Najare, 2012
Acanthopagrus latus	1.46	-	24.53	11.1	19.5	215.3	5.73	Al-Najare *et al.*, 2012
Tenualosa ilisha	1.866	0.011	6.894	-	1.15	61.82	0.465	Present Study

ND: Not Detected

Table 8. Permitted limits of heavy metals µg/g (dry weight) of fish.

References	Pb	Cd	Fe	Mn	Ni
FAO (2009)	3.1	3.9	50	7.9	17.8
MFR (1985) (Swami *et al.*, 2001)	4.0	1	55	4.5	20.0
FDA (2001) (Swami *et al.*, 2001)	1.7	4	40	-	80

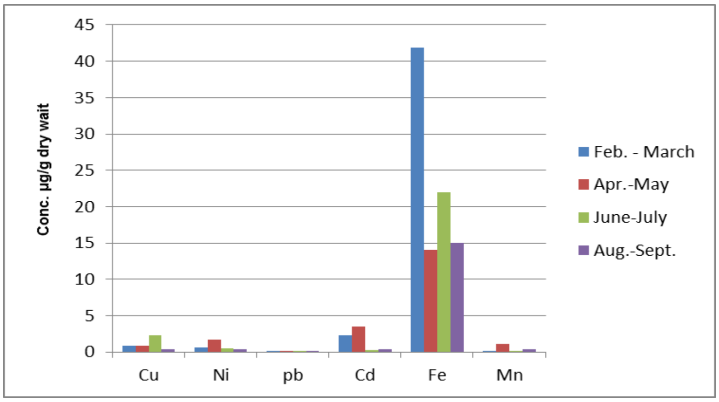

Figure 1. Mean concentrations of heavy metals during the period of study

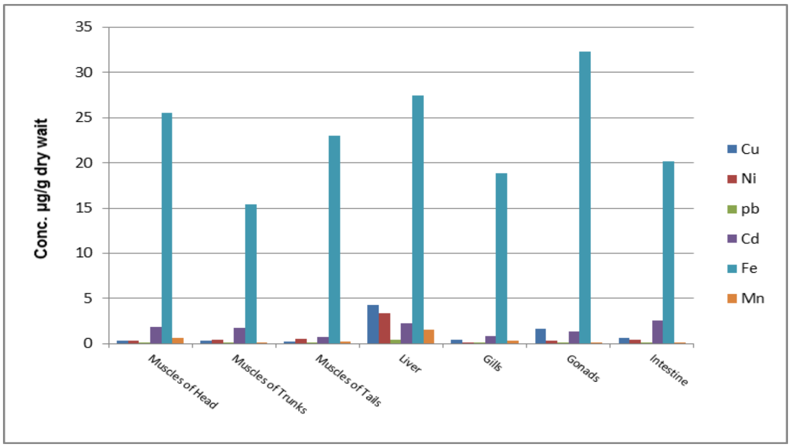

Figure 2. Mean concentrations of heavy metals in tissues.

Discussion

Tissue changes are regarded as sensitive indications of evaluation the changes that occur in the cells of gill, liver and gonad tissues. They point to the concentration of toxic material in tissues and environmental regime (Van den Broek *et. al.*, 2002). By looking through the results of present study, it was noted that there was un unstability of heavy metal concentrations of liver, gills and muscles, it was important here their concentration in muscles because this part was the important in use (the edible part). By comparing the results, it was found that the measured concentrations were much lower than it was reached to it (Irwandi and Farida, 2009). Heavy metals could be of importance and direct connection with the development, reproduction and growth of living organisms such as zinc, iron, copper, manganese and cobalt (Hantoush *et al.*, 2013). Heavy metals connect with many proteins and enzymes and they are necessary in using and liberating the energy. They play role in ionic and osmotic exchanges and in regulating body fluid inside cells (Al-Najjare *et al.*, 2012). There was a distinguished relationship between heavy metals accumulation and their centralization in body parts (Rauf *et al.*, 2001), they can pass through food web from one creature to another through many paths have the ability to accumulate in tissues of different creatures until they reach the peak of food pyramid (Al-Najjar, 2012).

Heavy metals accumulation in fish increases as their sizes increase (Davies *et al.*, 2006). The organisms have the ability to absorb water dissolved heavy metals via some body tissues such as gills and skin (Evans, 1987). However, fish are relatively situated at the top of the aquatic food chain; therefore, they normally can accumulate heavy metals from food, water and sediments (Yilmaz *et al.*, 2007). Heavy metal gatherings in water depend upon natural and unnatural factors (Weiner, 2000), some of them were environmental parameter such as temperature and hydrogen ion concentration (pH value) that affect the solubility of metals and their release in water medium. Hydrogen ion concentration is one of the factors that affect solubility of metals and increasing one unit in pH value will lead to decreasing the solubility of metal by a hundred time, heavy metals tend to precipitate in basic media and vice versa occurs when pH value decreases (Lindsay, 1979), this depends upon readiness of metal in the environment during separation, metal ions can combine with salts to form complexes that precipitate on the sediment. So, the precipitates are regarded the main store for releasing metals in to water and then to accumulate in the different tissues of organisms (Al-Najjar, 2009). The results demonstrated that the fish contain different levels of heavy metals in their tissues, this may be belongs to their concentration levels in the environment or it depends upon nutrition habits, age, size and length of fish.

Many studies pointed out that fish concentrate heavy metals in liver, kidneys and gills more than muscles, this agree with present study, whereas Yilmaz (2009) pointed to some fish hunted from one of the major lakes in Turkey, their heavy metal concentrations in some tissues were worriedly high such as cadmium, lead and zinc in muscles (the edible parts) and cadmium, lead and zinc concentrations were also high in liver and gills, these results were much higher than the ones of present study, the relatively high concentrations were gathered in fish liver, the values of the study recorded concentrations much less than the ones of southern Sri Lanka (Canli and Atli, 2003; Allinson *et al.*, 2002). Heavy metals are naturally found in the environment but in small concentrations (Ososkov and Kebbekus, 1997).

Researchers point out that pollution of aquatic system with heavy metal was a reflection of their high levels in the precipitates; this effect is connected with their distribution between liquid phase and solid phase of aquatic surface (Linnik and Zubenko, 2000). Heavy metal concentrations contrast between liquid and solid phases may belong to heavy metal concentration increases in the suspended solid materials of water column (Frenzel, 1996). Heavy metals are found in aquatic environment in several forms and they can be organic or inorganic complexes or suspended molecules or dissolved ions, these forms differ in their biological and toxic readiness (Tokalioglu *et al.*, 2000). The precipitates can be used as good evidence s on aquatic environment pollution with heavy metals, they represent the pollutants final receiver from water or organisms (Kwon and Lee, 2001).

The results showed that the metal concentrations were gradual. *T. ilisha* fish eat diatoms, algae, organic fragments, aquatic plants, copepods, phytoplankton, zooplankton (Mutlak, 2012). These planktons, diatoms and aquatic plants can absorb heavy metals, more several times concentrate them inside their bodies and finally these fish concentrate the heavy metals inside their different tissues, this was emphasized by a study of Al-Najjar *et al.* (2012). Results review denotes using these fish as important biological indications because of their closeness to water surface and type of nutrition. Increasing or decreasing the concentration of these metals than the necessary levels will lead to physiological damage occurrence that can lead to death of these organisms (Sirrkiss *et al.*, 1982). Some metals such cadmium, copper, zinc and iron connect with different parts of the cell since there is no law of selectivity for metal connections in the cell and it seems that the metals connect regardless the dose and its period (Al-Saad and Al-Najjar, 2011). This helps in evaluating environmental situation of aquatic surface.

The results of present study differed in arranging heavy metals storing parts from those of Mohamed *et al.* (2009) that concern heavy metal concentration seasonal changes in *Mugil cephalus*. It was noted in the results of present study unstability of heavy metals in precipitates except minor differences during winter because of amounts of rains and the liberated water quantities from above, i.e., the rains, because of metal liberation from the precipitates during rain season and floads and their mixing with precipitate molecules during dryness season (Obasohan *et al.*, 2007). The results of present study agree with the ones of Mucha *et al.* (2005), in the estuary of Douro river in Portugal, it revealed a relationship between alluvium and mud increase and heavy metal concentration in precipitates. This also agrees with the study that was carried out on one of the branches of Ravi river in Pakistan. It found the annual averages for copper, cadmium, nickel, manganese, zinc, lead, iron and chrome in rain season were higher than those of dryness season (Fufeyin, 1994). The present study was agreed with what Abida *et al.* (2009) mentioned about arrangement of storing tissues i.e., kidney, liver, gills, muscles. Heavy metals in this study were below the permitted level approved by Food and Agriculture Organization (FAO) and World Health Organization (WHO), (FAO/WHO, 1984) and Malazia Food Register (MFR) (MFR, 1985).

Conclusion

1- *Tenualosa ilisha* can accumulate heavy metals in their tissues.
2- Heavy metals accumulate with high level in fat tissues.
3- The least concentrations of heavy metals were in fish muscles.
4- The highest concentrations of heavy metals were in liver.

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تراكم بعض العناصر الثقيلة في أسماك الصبور *Tenualosa ilisha* المصطادة من نهر شط العرب

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مركز علوم البحار، جامعة البصرة، البصرة، العراق

المستخلص - درست تراكيز العناصر الثقيلة (النحاس، نيكل، رصاص، الكادميوم، الحديد، منغنيز) في عدة أجزاء من جسم أسماك الصبور *Tenualosa ilisha* (عضلات الرأس، عضلات الجذع، عضلات الذنب، الكبد، الغلاصم، المناسل والأمعاء) المصطادة من نهر شط العرب للفترة من شهر شباط ولغاية شهر أيلول 2013. قيست تركيز العناصر الثقيلة بواسطة جهاز مطياف الامتصاص الذري Flame Atomic Absorption Spectrophotometer. أظهرت النتائج أن أعلى تراكيز العناصر الثقيلة التي سجلت خلال فترة الدراسة كانت قد سجلها عنصر الحديد 41.910 مايكروغرام/غم (وزن جاف) خلال شهري شباط وآذار وأدناها قد سجلها عنصر الرصاص 0.036 مايكروغرام/غم (وزن جاف) خلال شهري حزيران وتموز. أما أعلى تركيز للعناصر الثقيلة في الأنسجة فكان لعنصر الحديد 27.470 مايكروغرام/غم (وزن جاف) والذي سجل في الكبد في حين أدنى تركيز كان لعنصر الرصاص 0.003 مايكروغرام/غم (وزن جاف) في عضلات الذنب.

الكلمات المفتاحية: أسماك الصبور، التراكم الحيوي، التلوث البيئي، العناصر الثقيلة، نهر شط العرب، *Tenualosa ilisha*.