Research Article

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Monitoring Bioaccumulation of heavy metals in Kattan (*Luciobarbus xanthopterus*) and Xashni *(Planiliza abu)* from different geographical localities in Salah al Dain Province

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Abstract

The fish consider a good bio-montiring for aquatic environment pollution , so the goal of this study was to assess e the heavy metals Copper (Cu), Cadmium (Cd), Lead (Pb), Zinc (Zn) concentrations in the gills, liver and muscles of Kattan (*Luciobarbus xanthopterus*) and Xashni *(Planiliza abu)* and to assess potential human health risks. Fish were collected from Tigris, Al Uzym rivers and Tharthar Lake. Atomic Absorption has been used for esstemation the heavy metals in the gills, liver and musclesand determined the human health risk(Estimated Daily Intake, Hazard Quotient, and Maximum Allowable Fish Consumption of these metals). The occurrence of metal generally ranked in the orde Cu> Zn> Cd> Pb. The ranked order concentration in tissue for Cu and Cd was liver> gill >Muscle, for Pb was gill > liver >Muscle, while Zn, was Muscle > liver > gill, According to the locations, the ranked order for Cd and Pb was Tharthar> Al Uzym>Tigris, Zn was Tigris >Al Uzym>Tharthar. In the fish species, the ranked order concentration for Cu and Pb was Kattan > Xashni, while the concenrtaion of Cd and Zn showed no significant differences between the two species also the result suggested that fish meat has no health risks. This study conclusion that heavy metals bioaccumulation concentrated in variable ranked order according to the fish spp., types of tissue and location habitate also no significant impacts effects on people health.

Key words: Heavy metals, *Luciobarbus xanthopterus*, *Planiliza abu*, Human health risks.

Introduction

Fish is an important source of protein, essential polyunsaturated fatty acids, essential amino acids, mineral nutrients, vitamins, and fat which are represented the nutritional components for human daily live so the fish consumption has been rapidly increase (1,2). Contamination of the atmosphere with heavy metals is now considered to be one of the most significant problems in the world owing to their toxicity, bioaccumulation, and bio amplifications in the developed way of life (3). Heavy metals are called metallic components, compared to water, have a generally high density and are frequently alluded to as trace elements due to their presence in the environmental matrices in trace (10 mg/kg) or ultra-trace (1μg/kg) amounts. The major source of environmental pollution from toxic metals and minerals can arise from human activities such as industrial development, mining, milling, combustion of fossil fuels, and agrochemicals that release a variety of hazardous heavy metals , such as or including rsenic, mercury, cadmium, copper, nickel, cobalt, zinc, and cuppers into agricultural soils and water bodies (4;5). Even though heavy metals cannot be degraded, they are stored, assimilated, or introduced into water, sediment, and aquatic animals (6). The other heavy metal sources are naturally derived from soil and rock erosion, solid waste runoff, and volcanic activity (7). Contamination of foods by heavy metals may occur through the natural source or by human activity sources such as industrial activities (8) or chemical fertilizers and pesticides used in agricultur Basically, heavy metals are divided into two categories, which are essential metals as copper is due to its important role in biological systems , the dose-response curve for essential metals is U-shaped because these metals have adverse health in both deficiency and excessive amount intake (9). and non-essential metals such as lead, mercury, and cadmium are toxic and harmful to organisms, even in a small amount, over a long period of time (10). Heavy metals can enter the marine environment, and Food chains of human and animal from a number of sources (11). The main reason for the elevated metal concentrations in polluted fish tissues in comparison to the corresponding reference concentrations could be due to high levels and continuous metal discharges into this site, which increases metal uptake from water and leads to their bioaccumulation in various fish tissues (40). Ahmed (13) study suggested the calculation of the estimated daily intake (EDI) of heavy metals through fish consumption, for this reason fish are often used as indicators of heavy metals contamination in the aquatic ecosystem. The aims of this study was to assessment bioaccumulation of the (Cu, Cd, Pb, Zn) concentrations in the gills, liver and muscles of two fish species in different geographical localities in Salah al-Din governorate

Materials and Methods:

Sample collection:

Fishs: About (90) for both Kattan fish average weight 2400±400g and average length 45 ± 3 cm and for Xashni fish average weight 238±8g and average length 23 ± 3cm were collected from three different aquatic sites, Tigris River (Tikrit city border), Tharthar Lake, and Al Uzym River (Figure 1), study carried out in the Spring 2021. The expermintal fish were identify according to the FishBase database (14) and the data provided by the fishermen. The fish were then packaged separately in labeled boxes, The samples gills , liver and muscle were be collected from two fish species and have been kept in the sterile bag and transferred to store in- 15 °C and then transported to the laboratory of High education in the collage of Agricultural Engineering Sciences, university of Sulaimani. Specimens, were taken from common muscle (dorsal(we can say shoulder) muscle above the lateral line and under the dorsal fin).

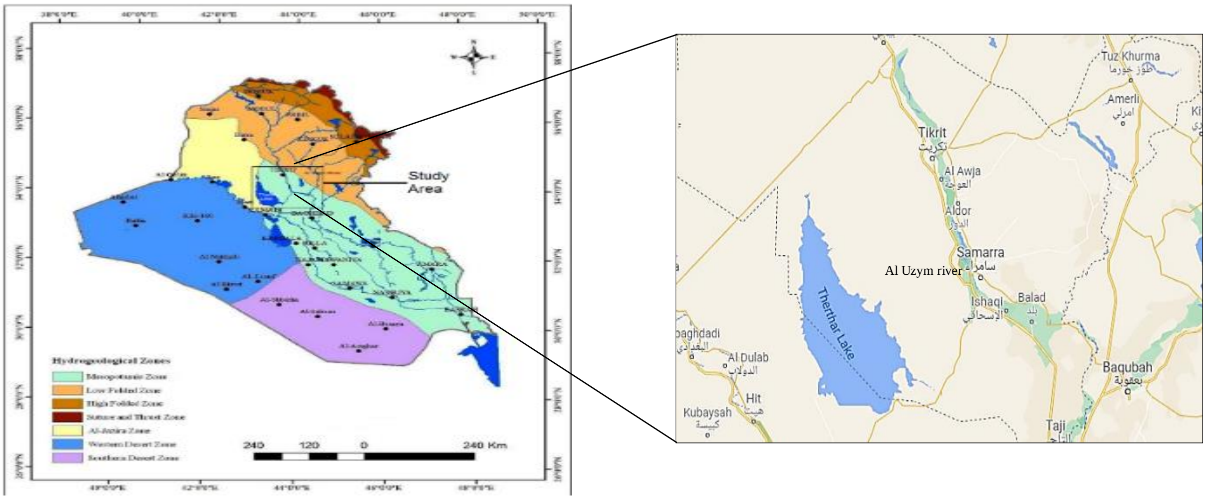


Figure 1: Studied aquatic sites

Estimation of heavy elements (15):

Heavy metal concentration were estimated in the samples by using Atomic Absorption after incineration of samples at 600 ºC by muffle furnace. 1 gm weight of ash was taken and put in a 100ml beaker, then nitric acid (15-20ml) was added to form a 1:1(V/W) suspension, covered by a watch glass. The mixture was heated on water bath until ash was solubilized, and left to cool at room temperature. Then samples were transferred quantitatively to a volumetric flask (100 ml volume) and completed with distilled water, and thus became a model ripe for estimation by an atomic absorption spectrometer. Standard solutions: intermediate standards were diluted with 1% nitric acid in a volumetric flask, stored in plastic bottles.

Human Health Risk Assessment

Based on data from an Iraqi Ministry of Agriculture survey on fish intake, the study calculated the possible human health risk by using the following parameters.

Estimated Daily Intake (16)

The estimated daily intake (EDI) (µg/kg body weight/day) was calculated with the following parameters:

EDI =Cm.DI/BW

where Cm is the average of heavy metal concentrations in the fish muscle tissue (µg/g), DI is the fish intake consumed per day (14.2 g/day), and BW is the mean of body weight of the person (70 kg).

Hazard Quotient (16)

To characterize the possible risk, the hazard quotient (HQ) was utilized, which is defined as the connection between a heavy metal's EDI and its reference dosage:

$$HQ = EDI/RfD$$

There is no risk if $HQ < 1$; however, if $HQ > 1$, then there is a potential risk associated with the heavy metal.

Maximum Allowable Fish Consumption (16)

The maximum permissible fish consumption rate (CRlim, in g/day) of contaminated fish with a non-carcinogenic effect was calculated using the equation below:

$$CRlim = RfD.BW/Cm$$

Statistical Analyses

XL Stat for Windows was used to do a one-way analysis of variance (ANOVA) on the data in this investigation. Duncan's multiple range tests were used to calculate the differences between the means. The significance level was set at ($P \leq 0.05$), and the data were presented as mean±standard error (17).

Results:

Copper concentration:

ch were 0.072 and 0.068 ppm in Xashni and Kattan, respectively. However, the descending order of tissue concentration was liver, gill >Muscle (0.078, 0.074, and 0.059 ppm, respectively) (table 2).

According to the findings, the highest concentration of Copper (1.410 ppm) was found in the Gill of Kattan from Al Uzym, while the lowest concentration was found in the Muscle of Xashni from the Tigris river (0.437 ppm). Concentration among locations, the descending order of Copper concentration was Al Uzym>Tharthar>Tigris (1.102, 0.767, and 0.633 ppm, respectively). According to concentration in species, the descending order was Kattan > Xashni, which was 0.905 and 0.763 ppm, respectively. The descending order of tissue concentration was liver> gill >muscle (0.960, 0.862, and 0.680 ppm, respectively) (Table 1).

Cadmium Concentration:

The highest concentration of Cadmium was found in the Liver of a Xashni from the Al Uzym site (0.091 ppm), while the lowest concentration was found in the Muscle of a Xashni from the Tharthar river (0.053 ppm) (0.053 ppm).Concentration among locations, the descending order of Cadmium concentration was Tharthar > Al Uzym >Tigris, (0.076, 0.072, and 0.062 ppm, respectively). Regarding the concentration in species, no significant differences were observed in cadmium concentration between two species, which were 0.072 and 0.068 ppm in Xashni and Kattan, respectively. However, the descending order of tissue concentration was liver, gill >Muscle (0.078, 0.074, and 0.059 ppm, respectively) (table 2).

Table 1: Bioaccumulation of copper in the tissues of two species of fish three studied aquatic sites (mean±se)

Location	Fish species	Type of tissue			Average means of Location	Average means of fish species
		Muscle	Liver	Gill		
Tigris	Xashni	0.437 ±0.030 j	0.654 ±0.070 hi	0.556 ±0.074 ij	0.633 ± 0.033 c	Xashni
	Kattan	0.626 ± 0.032 hi	0.798 ± 0.052 defg	0.724 ± 0.008 fgh		0.763 ± 0.047 b
Tharthar	Xashni	0.693 ± 0.031 gh	0.755 ± 0.009 efgh	0.845 ± 0.023 def	0.767 ± 0.031 b	Kattan
	Kattan	0.538 ± 0.032 ij	0.853 ± 0.025 def	0.915 ± 0.005 cd		0.905 ± 0.054 a
Al Uzym	Xashni	0.757 ± 0.022 efgh	0.861 ± 0.017 de	1.306 ± 0.042 ab	1.102 ± 0.060 a	
	Kattan	1.027 ± 0.011 c	1.253 ± 0.048 b	1.410 ± 0.081 a		
		Muscle	Liver	Gill		
Average of Tissue		0.680 ± 0.046 c	0.960 ±0.048 a	0.862 ± 0.076 b		

The averages of the cells with identical letters (same color) are not statistically different (P≤0.05).

Table 2: Bioaccumulation of cadmium in the tissues of two species of fish three studied aquatic sites (mean±se).

Location	Fish species	Type of tissue: Muscle	Liver	Gill	Average means of Location	Average means of fish species
Tigris	Xashni	0.054 ±0.001 b	0.084 ±0.002 ab	0.061 ±0.023 ab	0.062 ± 0.005 b	Xashni 0.072 ± 0.004 a
	Kattan	0.058 ± 0.003 ab	0.064 ± 0.018 ab	0.053 ± 0.018 b		
Tharthar	Xashni	0.053 ± 0.002 b	0.082 ± 0.009 ab	0.086 ± 0.008 ab	0.076 ± 0.004 a	Kattan 0.068 ± 0.004 a
	Kattan	0.074 ± 0.003 ab	0.077 ± 0.010 ab	0.085 ± 0.004 ab		
Al Uzym	Xashni	0.055 ± 0.002 b	0.091 ± 0.001 a	0.081 ±0.009 ab	0.072 ± 0.004 ab	
	Kattan	0.060 ± 0.005 ab	0.070 ± 0.015 ab	0.076 ± 0.011 ab		
		Muscle	liver	gill		
Average of Tissue		0.059 ± 0.002 b	0.078 ±0.004 a	0.074 ± 0.006 a		

The averages of the cells with identical letters (same color) are not statistically different (P≤0.05).

Lead Concentration:

The highest concentration of Lead was found in the liver of Kattan fish from the Al Uzym location (0.115 ppm), while the lowest value was found in the Muscle of Xashni from the Tigris river (0.043 ppm). The Concentration of Lead among locations was ordered descending and it was Tharthar, Al Uzym>Tigris (0.078, 0.078, and 0.061 ppm, respectively). Regarding the concentration in species, the descending order was Kattan > Xashni, which was 0.079 and 0.065 ppm, respectively. The descending order of tissue concentration was gill, liver >muscle (0.080, 0.079, and 0.057 ppm, respectively) (table,3).

Table 3: Bioaccumulation of lead in the tissues of two species of fish three studied aquatic sites (mean±se).

Location	Fish species	Type of tissue Muscle	 Liver	 Gill	Average means of Location	Average means of fish species
Tigris	Xashni	0.043 ±0.003 ef	0.033 ±0.006 f	0.075± 0.003 b-d	0.061 ± 0.005 b	Xashni
	Kattan	0.051 ± 0.005 d-f	0.092 ± 0.000 a-c	0.070± 0.004 b-d		0.065 ± 0.004 b
Tharthar	Xashni	0.066 ± 0.003 cde	0.093± 0.002 ab	0.085 ± 0.004 bc	0.078 ± 0.003 a	Kattan
	Kattan	0.056 ± 0.003 d-f	0.077 ± 0.001 b-d	0.089 ± 0.001 bc		0.079 ± 0.005 a
Al Uzym	Xashni	0.056 ± 0.003 d-f	0.069 ± 0.004 b-d	0.068 ± 0.001 b-e	0.078 ± 0.006 a	
	Kattan	0.071± 0.001 b-d	0.115± 0.031 a	0.088 ± 0.002 bc		
		Muscle	liver	gill		
Average of Tissue		0.057 ± 0.002 b	0.079 ± 0.002 a	0.080 ± 0.008 a		

The averages of the cells with identical letters (same color) are not statistically different (P≤0.05).

Zinc Concentration:

The maximum concentration of Zinc was found in Muscle of Kattan from the Tigris river (1.059 ppm), while the minimum value was found in Gill of Kattan from Tharthar lake (0.122 ppm). Concentration among locations, the descending order of Zinc concentration was Tigris >Al Uzym>Tharthar (0.713, 0.517, and 0.422 ppm, respectively). Regading concentration in species, no significant differences were found in Zinc concentration between the two species, which was 0.583 and 0.555 ppm in Xashni and Kattan, respectively. The descending order of tissue concentration was muscle>liver >gill, it was 0.860, 0.510, and 0.336 ppm, respectively (table 4).

Table 4: Bioaccumulation of zinc in the tissues of two species of fish three studied aquatic sites (mean±se).

Location / Fish species		Type of tissue: Muscle	Liver	Gill	Average means of Location	Average means of fish species
Tigris	Xashni	0.808± 0.058 a-c	0.743 ±0.045 a-d	0.519 ±0.070 c-g	0.713 ± 0.064 a	Xashni
	Kattan	1.059 ±0.015 a	0.680 ± 0.287 b-e	0.470 ± 0.040 d-g		0.583 ± 0.060 a
Tharthar	Xashni	0.966 ± 0.024 ab	0.341 ± 0.030 f-h	0.224 ± 0.018 gh	0.422± 0.067 c	Kattan
	Kattan	0.540 ± 0.014 c-g	0.342 ± 0.029 f-h	0.122 ± 0.006 h		0.555 ± 0.062 a
Al Uzym	Xashni	1.056 ± 0.022 a	0.314 ± 0.008 f-h	0.274 ± 0.042 gh	0.571 ± 0.078 b	
	Kattan	0.734 ± 0.017 b-e	0.642 ± 0.268 c-f	0.409 ± 0.090 e-h		
		Muscle	liver	gill		
Average of Tissue		0.860± 0.047 a	0.510 ± 0.071 b	0.336 ± 0.039 c		

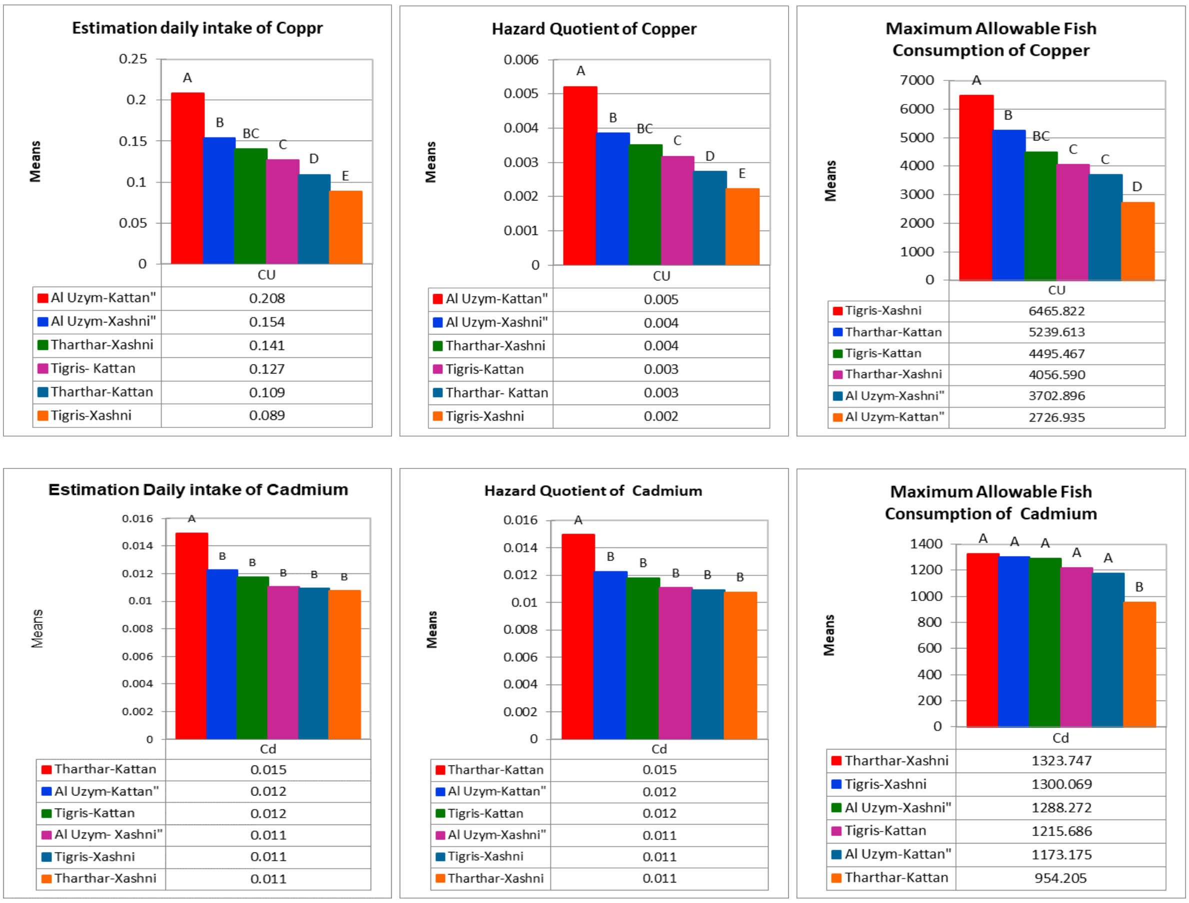
The averages of the cells with identical letters (same color) are not statistically different (P≤0.05).

Health Risk Assessment:

The Health Risk of metals in our study was presented in figure 2, the range of estimated daily intake of copper consumption was 0.089-0.208 µg/day/person. Cadmium consumption range was 0.011-0.015 µg/day/person. Lead consumption range was 0.009-0.014 µg/day/person, and Zinc consumption range was 0.109-0.215 µg/day/person.

The hazard quotient (HQ) results of different metals were shown in figure 2. For copper, the highest HQ was recorded in Kattan muscle from Al Uzym that was 0.005, while the lowest HQ was recorded in Xashni muscle from Tigris river. The highest HQ for Cadmium was recorded in Kattan muscle from Tharthar lake that was 0.015, whereas the lowest HQ was recorded in Xashni muscle from Tharthar lake, which was 0.011. The highest HQ for Lead was recorded in Kattan muscle from Al Uzym river, which was 0.004, while the lowest HQ of Lead was recorded in the Xashni muscle from the Tigris river and it was 0.002. The highest Zinc HQ was recorded in the Xashni muscle from Tigris river that was 0.00035, while the lowest HQ was recorded in the Kattan muscle from Tharthar lake, which was 0.00008.

The Maximum Allowable Fish Consumption (CR_{lim}) for elements in this study is presented in figure 2, The Copper risk was the highest when the consumption of Kattan muscle from Al Uzym river was (2726.935 g/day)., The risk of Cadmium was the highest when the consumption of Kattan muscle from Tharthar lake was (954.205 g/day). As for Lead, the risk is the highest when the consumption of Kattan muscle from the Al Uzym river was (3931.427 g/day). Finally, the Zinc risk is the highest when the consumption of Kattan muscle from Tigris River was (19835.782 g/day).



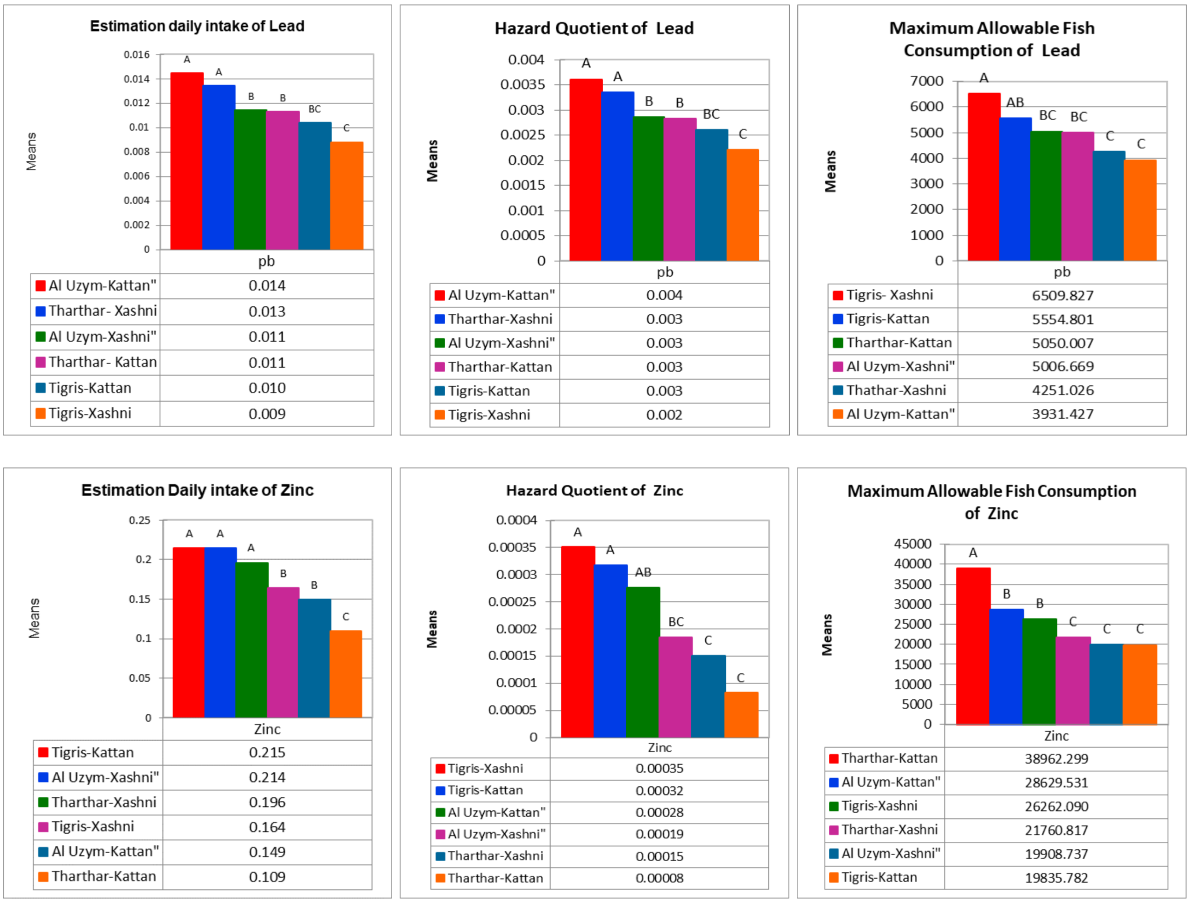


Figure 2: The Health Risk of metals

Discussion:

The results in tables 1, 2, 3 and 4 showed that the descending order of four metals were Cu> Zn> Cd> Pb, and this is in agreement with the results of Al-Taee and Yasser (18) that found the order were Pb> Zn > Cu > Mn > Cd. Most metal concentrations are influenced by habitat, dietary patterns, metal accumulation capacity, and organism type (19). Moreover, physiological mechanisms and metabolic activities may have a part in the variances. The interspecies discrepancies were likely attributable to eating patterns and environments, with carnivorous and benthivorous fish have comparatively higher quantities of heavy metals in their muscles (20). Also, our findings contradicted those of Yesser *et al.*, (21) who discovered that the ranking order of mean heavy metal concentrations in fish muscles from Basrah, was Zn (8.75-25.8) > Cu (1.73-11.93 ppm) > Pb (0.0-3.19 ppm) > Cd (0.23-3.00 ppm). Our study concentration order agrees with the results of Khidhir (22) that study the concentration of Cd and Pb in five fish species in Sulaimani province/ Iraq, and descending concentration order was Cd >Pb.

The maximum and minimum level of copper were (1.410 ppm) and (0.437 ppm) respectively. This concentration was lower than the concentration found by Al-Mayahi (23) who found the Cu concertation in *Cyprinus carpio* from Euphrates and Tigris river were 425.05, 192.25 ppm respectively, this variation between this two study may result from variable in the aquatic environment (Tigris and Euphrates), season, fish species also fish age, physiological status, fish weight and fish feeding habitats. The concentration of Cu concentrations in all location, tissue and 2 fish species were within FAO limits (Cu 30 mg/kg fresh weight) (24),copper is necessary for optimal health, but excessive amounts can cause problems like liver and kidney damage (25).

The range of cadmium in our study was 0.053 -0.091 ppm (table 2), this average is greater than results of Al-Taee and Yasser (18), that did not detected Cd in fish sample, and also our result were greater than the lowest and highest Cd levels recorded in fish species in Bangladesh, which were 0.015 and 0.019 ppm in *Clarias gariepinus* and *Puntius sarana*, respectively (26). The level of cadmium found in all fish species was higher than the European Union and Governmental's threshold of 0.05 ppm (27) and this maight be as a result of increased contamination of Iraqi water with Cd in last year as results of increase industrial activity (28) . Cadmium is a very hazardous metal that can cause serious poisoning even at very low concentrations of less than 1 ppm. Cadmium is of even greater concern because of its harmful effects on plants, animal, and humans (29).

The range of lead concentration (table 3) was 0.043 -0.115 ppm, and this is lower than the range of lead level of Khidhir (22) results, that found the Pb concentration range was 0.306 to 0.364 ppm in five fresh species from Sulaimani province. Our results of lead concentration was less than maximum legislative value of lead as described by the Commission Regulation (EC) N0. 18812006 and Bangladesh Gazette S. R. O. No. 233-Act (26), is 0.30 ppm as wet weight basis.

The maximum and minimum level of Zinc were (1.059 and 0.122 ppm) respectively. This concentration was lower than the concentration found by Yesser et al. (21) that found zinc levels in fish from freshwater ecosystems of Basrah, that found zinc concentration was (8.75-25.80 ppm). The ratios of zinc concentrations in this study were within the levels that mentioned by Yilmaz and Doğan (30), or the Food and Agriculture Organization (FAO) limits (30-100 mg/kg Zn). When compared to those found in unpolluted aquatic habitats, high amounts of zinc are harmful to aquatic organisms (31).

The concentration of four metals was accumulated more in Kattan species than Xashni species and this may be due to that Kattan species is omnivorous, fed mainly on aquatic insects, macrophytes, detritus, crustacean, and diatoms (32). Whereas, Xashni is an omnivore with a tendency to herbivory (33). Variations in heavy metal concentrations between two species can be attributable to a range of factors; including size (body weight and length), gender, age, fish species' growing rates, tissue types tested, and physiological circumstances (34). According to another study, even in the same fish species, differing metal concentrations can be caused by geographical location and capture season (35).

The descending accumulation of four metals in fish tissues was liver> gill> muscle except for Zn. Heavy metal analysis in the liver and gills is frequently recommended as a water pollution environmental indicator (23). The quantities of heavy metals in the gills are closely related to those in the surrounding environment, which could indicate heavy metal contamination in the water (36).

Fish muscle was chosen since it's considered consuming parts by people (37). In this study, the level of metals accumulation was the lowest in Muscle. This was also mentioned by Ronagh *et al*. (38) as they found that the lowest level of heavy metals accumulation occur in fish muscle. The ability of the fish muscle to accumulate heavy metals was previously thought to be minimal in contrast to other tissues (12), differences in metal concentrations in various tissues may result from their different capability to induce metal binding proteins such as metallothioneins (MTs) (**39**). Ion exchange allows the fish gill to accumulate more dissolved heavy metals in the water (40).

The concentration of most heavy metals in different locations was the highest in Al Uzym and Tharthar location (Tables 1, 2, 3, 4) and this may be due to Iraqi aquatic environment that is seriously contaminated with heavy metals (41; 42).

Figure 2 shows that the EDI of the tested fish samples was lower than the recommended values. This demonstrated that there was no harm to people's health from consuming the examined heavy metals through the ingestion of the selected fish samples (21), since the EDI values were below the JECFA's tolerable intake reference levels (43).

HQ values of heavy metals in the present study were followed the descending order of Cd >Pb>Cu > Zn (Figure 2), and all HQ results were belowone. This revealed that consuming individual heavy metal through the intake of fish would not pose any significant health hazards (44).

Results of the maximum allowable fish consumption rate (CRlim) were higher for all evaluated metals (Figure 2). Cadmium was recorded the highest consumption risk (954.205 g/day), followed by Copper (2726.935 g/day), and then Lead (3931.427 g/day), and finally Zinc (19835.782 g/day). Pinzón-Bedoya et al. (45) found similar results when assessing potential health concerns related with heavy metal intake in fish caught from Colombia's largest estuary.

Conclusion:

The descending order of four metals were Cu> Zn> Cd> Pb, and the concentration of 4 metals was accumulated more in tissues of Kattan species than Xashni species, The descending accumulation of four metals in fish tissues were liver> gill> muscle except for Zn. The concentration of most heavy metals in different locations was the highest in Al Uzym and Tharthar location. HQ values for the study of heavy metals suggested that people would not experience significant health risks. Estimated daily results were below the tolerable intake reference levels. Therefore, consumption of the fish meat has no health risks to people.

Conflict of Interest: Author declare ther is no conflict of interest.

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رصد التراكم الحيوي للمعادن الثقيلة في اسماك الكطان *Luciobarbus xanthopterus* والخشني *Planiliza abu* من مواقع جغرافية مختلفة في محافظة صلاح الدين

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الخلاصة:تعتبر الأسماك دليل حيوي جيد لتلوث البيئة المائية ، لذلك كان الهدف من هذه الدراسة هو تقييم تراكيز النحاس (Cu) والكادميوم (Cd) والرصاص (Pb) والزنك (Zn) في الخياشيم والكبد والعضلات في اسماك القطان (*Luciobarbus xanthopterus*) والخشني (*Planiliza abu*) ، ولتقييم المخاطر المحتملة على صحة الإنسان من المعادن الموجودة في عضلات الأسماك. تم جمع عينات من ثلاث مناطق تشمل نهر دجلة وبحيرة الثرثار ونهر العظيم. تم تقدير العناصر الكيميائية في العينات باستخدام الامتصاص الذري بعد ترميد العينات عند 600 درجة مئوية بواسطة فرن الترميد. تم استخدام المقدار اليومي المقدر ، وحاصل المخاطر ، والحد الأقصى المسموح به من استهلاك الأسماك من هذه المعادن كمؤشرات للمخاطر المحتملة على صحة الإنسان. كان ترتيب التركيز التنازلي لأربعة معادن هو النحاس< الزنك< الكادميوم< الرصاص. كان الترتيب التنازلي لتركيز النحاس والكادميوم في أنسجة و هو الكبد<الخياشيم< العضلات ، أما بالنسبة للرصاص فكان الخياشيم< الكبد< العضلات ، وبالنسبة للزنك كان الترتيب العضلات< الكبد< الخياشيم. وفقًا للمواقع ، كان ترتيب التركيز التنازلي للنحاس هو العظيم< الثرثار< دجلة ، وبالنسبة للكادميوم والرصاص كان الترتيب الثرثار< العظيم< دجلة ، وبالنسبة للزنك كان الترتيب دجلة< العظيم< الثرثار. وفقًا لأنواع الأسماك ، كان ترتيب التركيز التنازلي للنحاس والرصاص هو القطان< الخشني. في حين أن تركيز الكادميوم والزنك أظهر عدم وجود فروق ذات دلالة إحصائية بين النوعين. أظهرت نتائج مؤشرات المخاطر المحتملة على صحة الإنسان أن استهلاك لحوم الأسماك ليس له مخاطر صحية على المستهلكين.

الكلمات االمفتاحية: المعادن الثقيلة، *Luciobarbus xanthopterus*، *Planiliza abu* ، المخاطر على صحة الإنسان.