ESTIMATE THECONCENTRATION OF SOME HEAVY METALS IN THE MUSCLES OF HAMRI FISH Barbus luteus (Heckel) COLLECTED IN THE EUPHRATES RIVER / MIDDLE OF IRAQ

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Abstract :

This study was conducted to estimate the concentration of some Heavy metals, (cadmium, lead, zinc, iron, manganese, selenium and nickel) in the muscles of three different categories in the weight and length of fish Hamri Barbus luteus (Heckel) collected from the Euphrates River from Saddat- Al- Hindiya Region dam , during October 2009 to September 2010 . and estimated the concentrations of Heavy metals in river water (dissolved and particulate phase) , And also study of some physical and chemical properties of water river temperature of the air and water, pH, Electrical Conductivity (E.C.) , Salinity, Speed of Flow, Dissolved Oxygen (D.O.), Biological Demand of Oxygen (B.O.D.) Total Suspended Substances, Total Dissolved Substances, Total Hardness and the Hardness of Calcium, Magnesium and plant nutrients (nitrate , nitrite and phosphate) , which were variety depending on the heterogeneity of months studied.

The results of the current study showed seasonal variations in the concentrations of Heavy metals in both water phases (dissolved and particulate phase) and in three category of fish muscles . It was found that , the concentrations of heavy metals in the third category was high compared to the first and second categories , results have found a direct correlation between the length and weight of the fish with the concentration of metals as of metals of concentration increase as well weight and height.

It was found that the concentrations of heavy metals studied in particulate phase were higher than water soluble phase in addition to the effect of some physical and chemical properties of water such as pH , EC , temperature , flow velocity , and salinity on the concentration of heavy metals studied.

Keywords // Heavy metals , Barbus luteus (Heckel) , dissolved phase , particulate phase , physical and chemical properties.

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تقدير تركيز بعض العناصر الثقيلة في عضلات سمكة الحمري Barbus luteus (Heckel) في نهر الفرات / وسط العراق

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الخلاصة :

أهتمت الدراسة تقدير تركيز بعض العناصر الثقيلة وهي (الكادميوم ، الرصاص ، الخارصين ، الحديد ، المنغنيز ، السيلينوم والنيكل) في عضلات ثلاثة فئات مختلفة في الوزن والطول من سمكة الحمري Barbus luteus (Heckel)) المجمعة من نهر الفرات من منطقة سدة الهندية (الموقع الأول) ، للفترة الممتدة من شهر تشرين الأول 2009 ولغاية أيلول 2010 ، وتضمنت الدراسة أيضاً قياس تركيز العناصر الثقيلة المدروسة في مياه النهر بالشكلين الذائب والدقائقي ، إضافة إلى دراسة بعض الخصائص الفيزيائية والكيميائية لمياه النهر وهي درجة حرارة الهواء والماء والاس الهيدروجيني والقاعدية الكلية والتوصيلية الكهربائية والملوحة وسرعة الجريان والأوكسجين الذائب والمتطلب الحياتي للأوكسجين والمواد العالقة الكلية والمواد الذائبة الكلية والعسرة الكلية وعسرة الكالسيوم والمغنيسيوم والمغذيات النباتية (النترات والنتريت والفوسفات) والتي تغايرت تبعاً لتغاير المواقع و الأشهر المدروسة .

أظهرت نتائج الدراسة الحالية تغايرات فصلية في تراكيز العناصر المدروسة في كلا الماء (الشكل الذائب والدقائقي) وفي عضلات الفئات الثلاثة للأسماك في الدراسة الحالية . ووجد أن تراكيز المعادن الثقيلة في الفئة الثالثة كانت عالية مقارنة بالفئتين الأولى والثانية ، وقد وجد من النتائج علاقة طردية بين طول ووزن السمكة مع تركيز العناصر إذ تزداد بزيادتهما .

وتبين من النتائج أن تراكيز العناصر الثقيلة المدروسة بالشكل الدقائقي للماء أعلى مقارنة بالشكل الذائب إضافة إلى تأثير بعض الخصائص الفيزيائية والكيميائية للماء مثل pH و E.C. ودرجة الحرارة وسرعة الجريان والملوحة على تركيز العناصر النزرة المدروسة .

كلمات مفتاحية // العناصر الثقيلة ، سمكة الحمري Barbus luteus (Heckel) ، الشكل الذائب ، الشكل الدقائقي ، الخصائص الفيزيائية والكيميائية .

Introduction:

Environmental pollution due to toxic heavy metals in air , soil and water is a major global problem . heavy metals cannot be degraded or destroyed ; hence they are persistent in all parts of the environment . The reduction amount of these metals from effluents to a permissible limit before discharging them into streams and rivers is very important for human health and environment (Srividya and Mohanty , 2009) Water pollution is thus a cosmopolitan problem that needs urgent attention and prevention . It resulted from many sources such as accidental spillage of chemical wastes , discharge of industrial or sewerage effluents , agricultural drainage , domestic wastewater and gasoline from fishery boots (Ali and Soltan, 1996 ; Handy, 1994 ; Osman, 2007) . Water pollution is one of the principal environmental and public health problem (Osman and Kloas, 2010) . The aquatic habitats are being contaminated with heavy metals due to industrialization and other anthropogenic activities (Muthupriya and

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Altaff, 2010) . Aquatic animals inhabiting polluted water bodies tend to accumulate many chemicals in high concentrations even when the ambient environmental contamination levels are low potentially hazardous situation for the entire food chain . Among several elements of the periodic table , there are (35) metals are associated with the community and occupational exposure . Out of these are described as heavy metals . these elements are generally released in small amounts into the environment by processes like weathering of rocks , volcanic eruptions etc. and their intake exposure is necessary in trace amounts for good health . But , presently , there is a steady increase in their concentration in all habitats owing to mining , electroplating , paints and dye , battery making industries etc. The release is rapid with the rapidly growing technology and heavy metal application in these industries (Sobha, et.al., 2007. (

The contamination of freshwater with a wide range of pollutants has become a matter of great concern over the last few decades (AL-Weher , 2008) . Heavy metals are natural trace components of the aquatic environment , but their levels have increased due to domestic , industrial , mining and agricultural activities (Leland, et.al., 1978 ; Mance, 1987 ; Kalay and Canli, 2000) . Aquatic organisms such as fish and shell fish accumulate metals to concentrations many times higher than present in water and sediment (Olaifa, et.al., 2004 ; Gumgum, et.al., 1994) . Discharge of heavy metals into river or any aquatic environment can change both aquatic species diversity and ecosystems , due to their toxicity and accumulative behavior (Heath , 1987. (

Fish has been the main supply of cheap and healthy protein to a large percentage of the world's population . In most Asian countries , fish is a main protein of the diet . It is particularly valuable for providing proteins of high quality comparable with those of meat , milk or eggs and is also a good source of omega-3 fatty acids ; calcium and phosphorus , iron , trace elements such as copper and a fair proportion of the B-vitamins (Tucker, 1997) . Beside good health benefits of fish , there were many reports on contamination of fish by chemical in the environment . The fish as a bioindicator species , plays an increasingly important role in the monitoring of water pollution because it responds with great sensitivity to changes in the aquatic environment . The sudden death of fish indicates heavy pollution , The effects of exposure to sub lethal levels pollutants can be measured in terms of biochemical , physiological or histological responses of the fish organism (Mondon , et.al.,2001) . Changes in age and species distribution in a stock fish population are general indicators of water pollution , but there are also responses specific to a single pollutant or a group of contaminants Biochemical markers are biochemical responses induced in the presence of a specific group of contaminants that have the same mechanism of toxic activity (Iroka and Drastichova , 2004. (

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The present study aims to estimate the concentration of seven heavy elements, namely, (Lead, Cadmium, Zinc, Iron, Manganese, Selenium and Nickel) in the muscles of Hamri Barbus luteus (Heckel) , divided into three different height and weight categories collected from the Euphrates River at Al- Hindiya dam uring from October , 2009 to September 2010, in addition to determine the concentration of these seven elements in the water of in dissolved and particulate phase and measure some physical and chemical properties of river water.

MATERIALS AND METHODS:

Hamri Barbus luteus (Heckel) fish belong to the Cyprinidae family , A species of economically important and widespread in Iraq , as it spread in most of the bodies , Internal water, especially the central areas (Al-Tamimi, 2004) , B. luteus and water samples were collected on a monthly basis from one location on the Euphrates River Al- Hindiya dam , as shown in Figure (1), the collected fish samples divided into three categories of height and weight, samples were collected from October 2009 to September 2010, water samples collected from the middle of the river using clean bottles of polyethylene washed with acid and distilled water that re-distilled for the purpose of examining some of the physical and chemical properties and measure the concentrations of some heavy metals in water

Temperature measured by using a normal mercury thermometer with (0.1) gradient and the range of (0-100) Celsius degree. The Electrical Conductivity (E.C.) has been measured directly using E.C. meter type HANNA the results has expressed as (µS / cm). The pH-meter used to measure the pH of river water after it has been calibrated by standard solutions . Dissolved Oxygen estimated by using azide modification of the Winkler method, and according to (APHA, 2003) the Biological Oxygen Demand (B.O.D.) values were measured in addition to total alkalinity, calcium hardness, Total Dissolved Solids, total suspended solids and sulfates. While the total hardness and magnesium hardness were measured according to (Lind, 1979) , the value of salinity calculated depending on the values of electrical conductivity (Mackereth, et.al., 1978). The amount of nitrite measured depending on the procedure described by (Parson, et.al., 1984), and the adopted method of (Wood and Armatrong, 1967) that described in (Parson, et.al., 1984) used to estimate the amount of active nitrates, while the amount of active phosphate has been calculated based on the procedure of (Murphy and Riely, 1962) cited in (Parson, et.al., 1984.)

Concentration of dissolved heavy metals in river water was calculated depending on the procedure described by (Riley and Taylor in 1968) . And the determined of heavy metals in particulate phase has followed the procedure of (Sturgeon, et.al., 1982) . Concentration of studied seven metals in samples all categories of fish studied which that collected and divided by height and weight was measured depending on the (ROPME, 1982) {digested after the muscle tissue

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separated from the bone and cut and mixed well and dried in oven at (70) C°, then the dry tissue grinded into very fine particles and sieved using a sieve with pores of (0.5) mm diameter, then (1) gram of sifted sample weighted and placed in tubes to digest and added to (10) ml of the mixture of concentrate nitric acid HNO3 and concentrate Perchloric acid HClO4 (4:1) and then placed in a shaker for the completion of the shaking process (4-6) hours, then the sample steamed at (70) C° for (2-3) hours and the contents of the digestive tube transferred to special Beakers made from Teflon. Using the heating plate the sample steamed at (70-80) C° to near drought, then the output dissolved by using (5) ml of nitric acid and the solution was taken and supplemented to (25) ml with diluted nitric acid (5%) concentration and preserved in dried clean and washed polyethylene bottles until examination} . The sample was measured using an Atomic Absorption spectrophotometer-Model (5000) and expressed in units (Micrograms /g.(

Statistical analysis:

All data were expressed as means ±SD . least significant difference (LSD) was used for mean separation . The significant level was set at the probability level of $P<0.05$.

RESULTS AND DISCUSSION:

The ranges of lengths and weights of Hamri B. luteus (Heckel) collected from Al- Hindiya dam located on the Euphrates River during from October 2009 to September 2010 were between (13.6 – 15.9) cm. and (28.6 – 39.1) g. respectively for the first category, and (15.8 – 20.1) cm. (53.9 – 67.8) g. respectively for the second category, the third category was between (18 - 23) cm. and (80.4 - 95) g. respectively.

The table (1) explained the monthly values for some physical and chemical properties of the water , While figure (2) explained the concentrations for heavy metals studied (Cadmium, Lead, Zinc, Iron, Manganese, Selenium and Nickel) as dissolved phase , and the figure (3) showed to the concentrations of heavy metals studied in the water as particulate phase , Figure (4) showed seasonal concentrations of the seven heavy metals in the muscles of the three categories of Hamri B. luteus (Heckel. (

The results of the current study found the annual rates of heavy metals concentrations in the waters of the river as dissolved phase were (6.15) µg / L for Cadmium, (1.608) µg / L of Lead, (18.6) µg / L of Zinc, (26.575) µg / L of Iron, (7.71) µg / L of Manganese, (0.475) µg / L for Selenium and (8.5) µg / L for Nickel. And the annual rates of its concentrations as particulate were (953.73), (134.6), (86.14), (63.73), (40.98), (11.03) and (1.143) µg / g dry weight, respectively. Heavy metals in the water as a particulate phase in the present study had higher concentrations compared with the dissolved phase and this is attributed to the process of adsorption, as these metals tend to linkage on the surfaces of some materials, especially particulate matter and organic mud that spreading in the

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water column (Elder, 1989 and Demina, et.al., 2009 .(

The current study found that concentration of metals in the particulate phase was higher than the concentration in dissolved phase , as the results of the study showed the presence of seasonal variations in the concentration of the metals studied in water dissolved phase and particulate phase

The results showed that the annual mean concentration of the studied heavy metals (Cd , Pb , Zn , Fe , Mn , Se , Ni) in the muscles of the first category, second and third of the Hamri B. luteus (Heckel) was (0.11475 , 0.14975 , 23.32 , 13.225 , 0.6945 , 1.575 , 3.485) and (0.18975 , 0.164 , 24.14 , 13.8375 , 0.806 , 1.6975 , 3.7075) and (0.291 , 0.16575 , 25.8275 , 14.365 , 0.926 , 1.75 , 4.0675) µg/ g dry weight, respectively, as well as found from the study is a direct correlation between Category longitudinal and weighted studied fish and concentration of elements, where we found that their concentrations in the third category of studied fish were higher compared to the first category and second category , with concentration increased of studied elements increase height and weight , and essential role in the accumulation of elements in the muscles. and this may be because the increase of concentration of the element by the increase of the size and length of fish (AL- Khafaji, 1996 and Blasco, et.al., 1998 .(

That the concentration of zinc , as is evident from the results was high compared to other elements and the reason is that this element is essential in maintaining the gonads as well as to protect the aquatic environment from the effects of cadmium toxic and this deliberately fish to absorb large amounts of this element (Hammoud, et. al., 2005.(

The results showed that fish are able to accumulate and retain heavy metals from their environment and it . Showed that accumulation of metals in tissues of fish is depended upon exposure concentration and duration as well as other factors such as salinity , temperature , hardness and metabolism of the animal (Pagenkopf, 1983 and Allen, 1995 . (

Since the toxic effects of metals have been recognized heavy metal levels in the tissues of aquatic animals are occasionally monitored . Because the heavy metal concentration in tissues reflects past exposure via water and / or food . It can demonstrate the current situation of the animals before toxicity affects the ecological balance of populations in the aquatic environment (Canli , et.al.,1998.(

The temperature in the aquatic environment may be considered as a limiting factor for life , as is the temperature the catalyst and specified for many of the life activities to aquatic organisms , especially fish and from which they can several select events such as migration , nutrition, reproduction and other (Al-Sayyab, 1988) , This is evident from the results was the highest concentration of the elements studied in the fish muscles in the summer and spring may be attributed to the increased accumulation of heavy elements in the hot season compared to cold season ,

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because of the increased metabolic activities in high temperature , The rise in temperature leads to a rise in the level of representation food and which is linked to a close relationship concentration of heavy elements , where the greater metabolic rate increased the concentration of elements within the body (Zayed ,et.al. 1994 and Hammoud,et.al.,2005 .(

In addition, the temperature working of the change in the effectiveness and activity enzymes which responsible for this process and affect the absorption rate of fish heavy elements (Raynal , et.al.,2005) . The study also demonstrated high concentrations of studied heavy metals has been ascribed to presence of some of the human activities various of heavily traffic for modes of transport to and subtraction continuous agricultural waste in the same location and to the possibility of transport of pollutants coming from upstream . In addition to the density of aquatic plants at this site, which allows to provide living adequate for the fish, which leads to increase weight and accumulation of elements in their tissues Salman, (2006.)

Figure (1) the study site on the Euphrates River / Iraq

Conclusions

-1 That the concentration of heavy metals in the waters of the Euphrates River as particulate phase was higher than the dissolved phase due to the adsorption of metals on the suspended matter in the water.

-2 There is a difference in the concentrations of heavy metals in the water, both in the dissolved and particulate phase in muscles fish Hamri B. luteus (Heckel). It was high in summer compared to winter.

-3 Third Category recorded longitudinal and weighted in a fish B. luteus concentrations of heavy metals higher compared to the first and the second reason is due to the difference in the speed of growth in addition to the length of the exposure period.

-4 Recorded a significant positive correlation between the concentrations of heavy metals in water (dissolved and particulate phase) and in fish muscle with temperature, while a significant correlation was found to reverse the concentration of these elements in the water with pH, salinity and electrical conductivity

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Table (1) Months differences in Physical – Chemical characteristic for Water Al-Euphrates river in Al- Hindiya dam

Month / Factors	2009			2010								
	October	November	December	January	February	March	April	May	June	July	August	September
Air temperature (c°)	23	14	12	11	20.5	19.5	26	36	36.5	38	39	34
Water temperature (c°)	24	16	15	10.5	12	17.5	20.8	28	32	34	36	31.5
pH	7.4	8.2	8.3	8.5	7.7	7.8	7.9	7.8	7.6	7.7	7.5	7.7
E.C. (µs /cm)	821	736	748	680	756	713	655	684	702	715	740	766
Salinity (‰)	0.525	0.471	0.478	0.435	0.483	0.456	0.419	0.437	0.449	0.457	0.473	0.490
Water flow (m/Sec.)	0.45	0.15	0.17	0.12	0.18	0.18	0.15	0.17	0.21	0.20	0.18	0.18
D.O. (mg/L)	7	4.8	7.8	5.2	70.9	8.6	7.3	6.8	6.5	6.7	6.1	6.8
B.O.D. (mg/L)	3.6	2.6	1.3	1.6	0.4	0.4	0.6	0.9	1.2	1.19	1.7	2.5
T.S.S. (mg/L)	0.041	0.025	0.032	0.065	57.3	59.2	61.3	42.03	50.9	51.7	30.6	0.56
T.D.S. (mg/L)	219	705	519	571	679	675	420	561.4	679	875	706	316
Total alkalinity (mg CaCo3 / L)	175	160	132	174	173	158	171	183	167.5	138	131	159
Total Hardness (mg CaCo3 / L)	600	584	524	540	586	579	516	588	569	544	521	530
Ca (mg CaCo3 / L)	136.88	246.89	145.2	187.5	265	290	168.3	200.4	180.3	151.6	156.2	123
Mg (mg MgCo3 / L)	112.53	81.91	92.04	85.65	78.003	70.22	84.4	94.18	94.4	95.3	88.6	98.9
Nitrite (µg/L)	1.96	1.65	1.23	0.95	0.75	1.88	0.9	1.05	0.78	0.46	0.61	0.95
Nitrate (µg/L)	13.63	9.51	8.41	8.91	6.21	13.06	55.9	64.07	58.3	42.08	46.2	36.1
Active Phosphate (µg/L)	4.88	3.79	2.56	3.26	2.76	5.83	3.7	6.03	2.7	0.77	1.35	2.92

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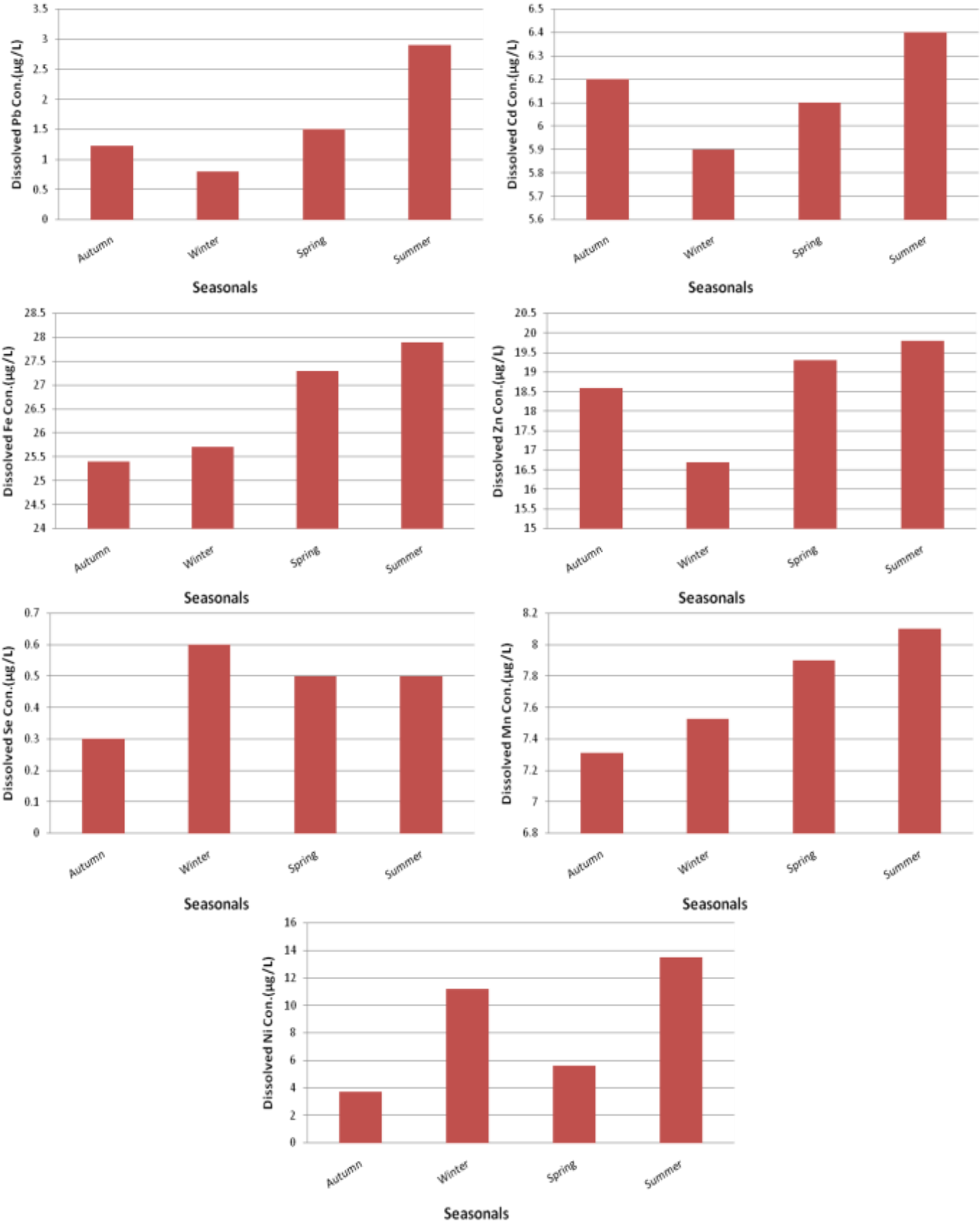

Figure (2) Seasonal Concentration For Dissolved heavy elements (Cd , Pb , Zn , Fe , Mn , Se and Ni) for Water Al-Euphrates river in Al- Hindiya dam

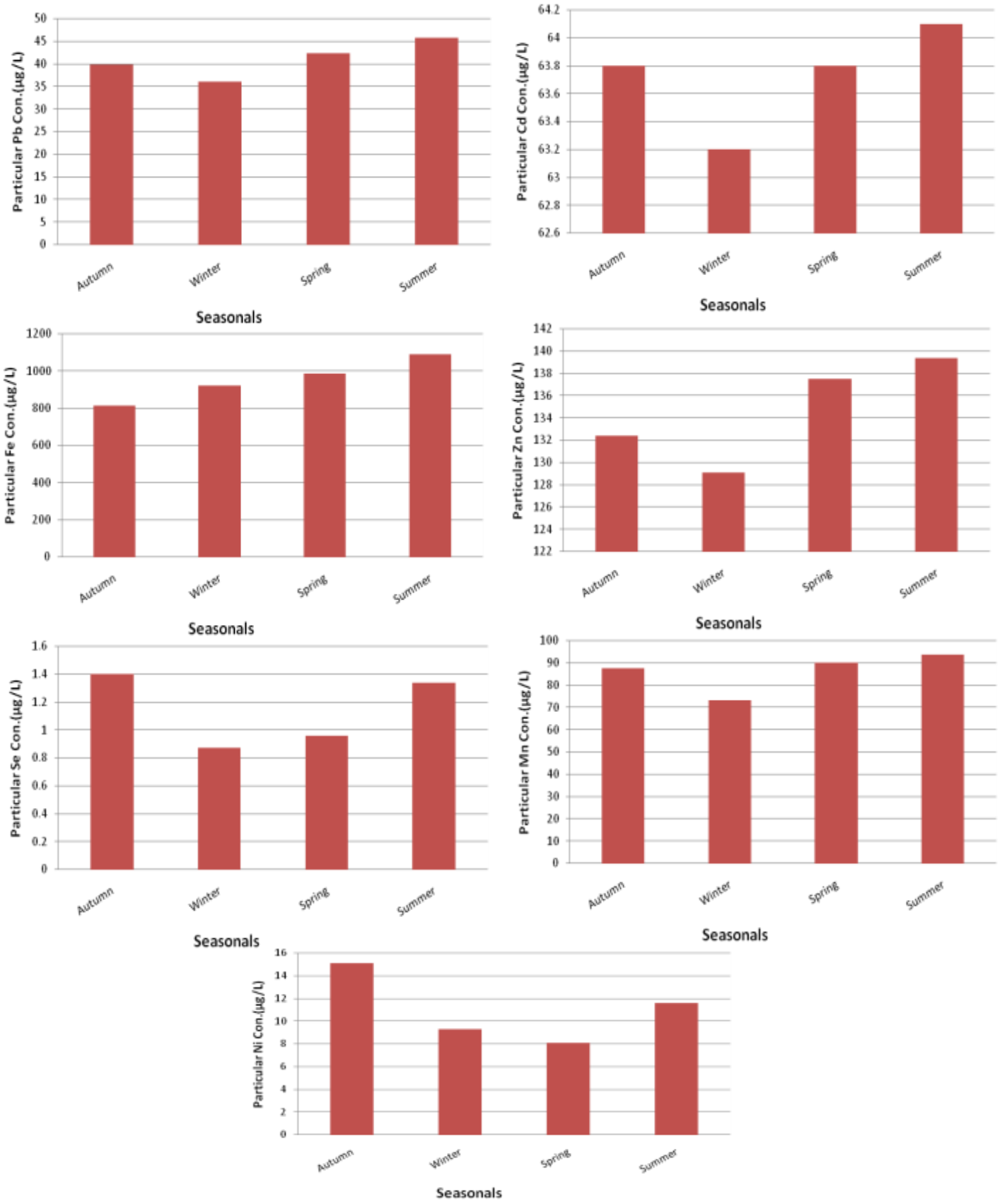

Figure (3) Seasonal Concentration For Particular heavy elements (Cd , Pb , Zn , Fe , Mn , Se and Ni) for Water Al-Euphrates river in Al- Hindiya dam

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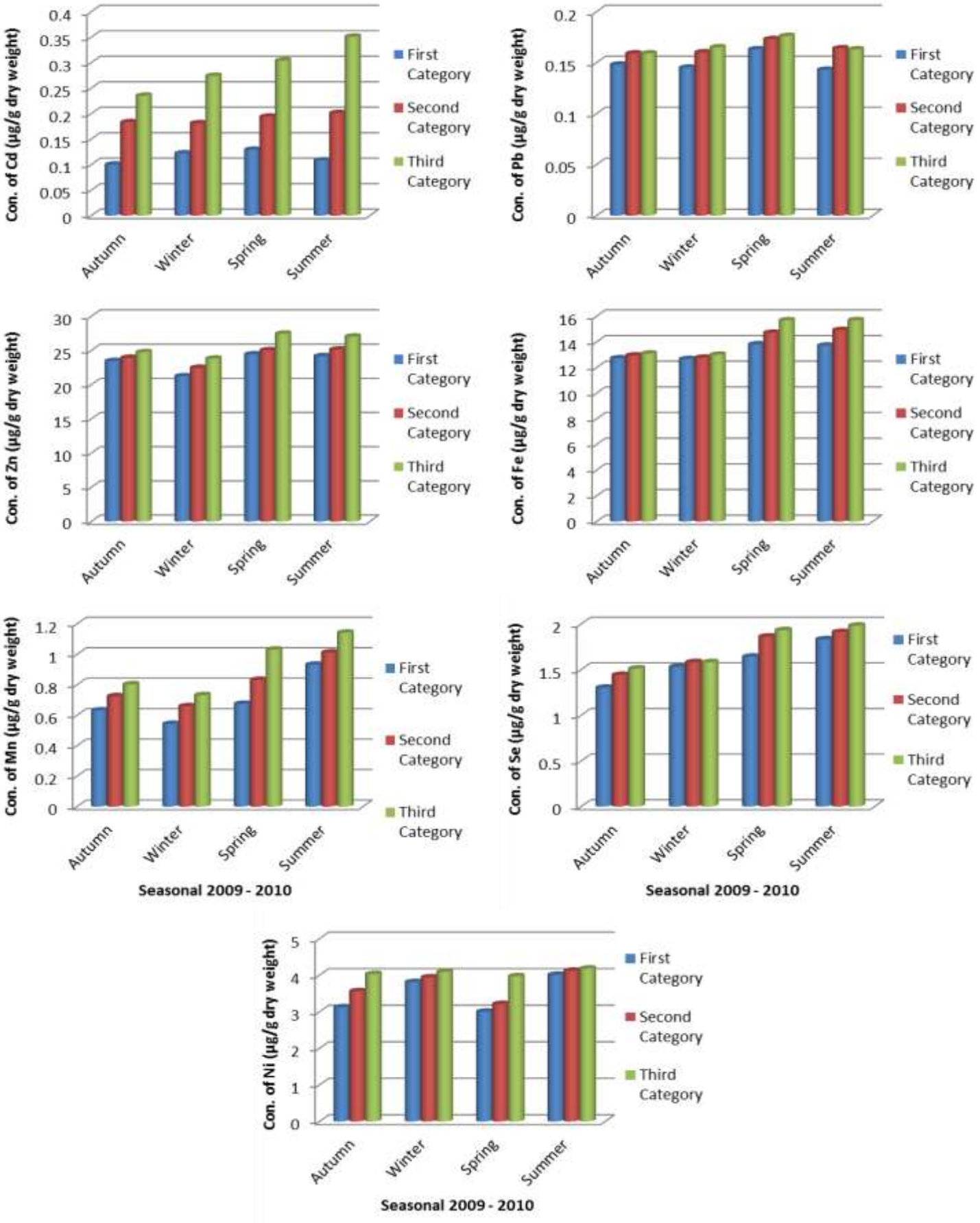

Figure (4) Seasonal Concentration (Cd , Pb , Zn , Fe , Mn , Se and Ni) in the Three categories muscles for fish Hamri *B. luteus* (Heckel)

REFERENCES :

Ali, M. and Spltan, M., (1996) . The Impact of three Industrial Effluents on Submerged Aquatic Plants in the River Nile , Egypt , *Hydrobiologia* , 340 (1-3) : 77 – 83 .

AL- Khafaji, B.Y. (1996). Trace metals in water, sediments, and fishes from Shatt Al-Arab estuary north-west Arabian Gulf. *Ph. D. Thesis, Coll. Of Education, Basrah University.*

Allen, P. (1995). Chronic accumulation of cadmium in the edible tissues of *Oreochromis aureus* (Steinduchner) : Modification by mercury and lead . *Arch. Environ. Contam. Toxicol.* 29 : 8 – 14 .

Al-Sayyab, A.A. (1988). Environment and lifestyle streaming Asian *Silurus triostegus* H in Hor ass _ Southern Iraq. *Master Thesis, Faculty of Agriculture _ University of Basra.*

Al- Tamimi, L. M. A. (2004) . Assessment environmental and community life fishes in the Euphrates River Near the power station Musayyib , *Ph. D. Thesis, Agriculture College , Basra University* . 147 P.

Al-Weher , S. M., (2008) . Levels of Heavy Metals Cd , Cu and Zn in three Fish Species Collected from the North Jordan Valley , Jordan . *Jordan Journal of Biological Science* , 1 (1) : 41 – 46 .

APHA (American public Helth Association). (2003). Standard methods for examination of water and wastwater, *20th, Ed. Washington DC,USA.*

Blasco , J. , Rubio , J.A. , Forja , J. , Gómez-parra , A. and Establier , R. (1998). Heavy Metals in some Fishes of the Mugilidae Family from Salt Ponds of Cádiz Bay , Sw Spain. *Ecotoxicology and Environmental Restoration* , 1(2) : 71 – 77 .

Canli , M., Ay, ö. And Kalay, M. (1998). Levels of Heavy Metals (Cd , Pb , Cu , Cr and Ni) in Tissue of *Cyprinus carpio , Barbus capito* and *Chondrostoma regium* from the Seyhen River , Turkey . *Tr. J. of Zoology*., 22 : 149 – 157 .

Demina , L.L. ; Galkin , S.V. and Shumilin , E.N. (2009). Bioaccumulation of some trace elements in the biota of hydrothermal fields of the Guaymas Basin (Gulf of California). *Boletin De LA Sociaeded Geologica Mexicana* , 61(1) : 31– 45 .

Elder, J.F. (1989). Metal biogeochemistry in surface water system , a review of principles and concepts , US. *Geological survy circular , 1013 , 43pp.*

Gumgum B, Unlu E, and Tez Z. Gulsun Z. (1994) . Heavy metal pollution in water , sediment and fish from the Tigris river in Turkey . *Chemosphere* . 29 : 111 – 116 .

Hammoud, V., Okda, M. and Saad, A. (2005) . Fact concentrations of some heavy metals in tissue of

ISSN 2072-3875

different thickness Alsrgos *Diplodus sargus* in the Syrian coastal waters. *Basil al-Assad Journal of Engineering Science*, (21): 37-45.

Handy , R. (1994) . Intermittent Exposure to Aquatic Pollution Assessment , Toxicity and Sublethal Responses in Fish and Invertebrates . *Comparative Biochemistry and Physiology C-Pharmacology Toxicology & Endocrinology* , 107 (2) : 171 – 184 .

Heath, A. G. (1987) . Water Pollution and Fish Physiology . CRC press , Florida , USA , 245 .

Iroka, Z. and Drastichova, J. (2004) . Biochemical Markers of Aquatic Environment Contamination Cytochrome P450 in Fish . A Review , Acta. Vte. Brno. , 73 : 123 – 132 .

Kalay, M. and Canli, M. (2000) . Elimination of essential (Cu , Zn) and nonessential (Cd , Pb) metals from tissue of a freshwater fish *Tilapia zillii* following and uptake protocol . *Tukr. J. Zool.* , 24 : 429 – 436 .

Leland, H. V., Luoma, S. N. and Wilkes, D. J. (1978) . Heavy metals and related trace elements . *J. Wat. Poll. Control Fed.* , 50 : 1469 – 1514 .

Lind, G. T. (1979). Handbook of common methods in Limnology, *2 nd ed., London.*

Mackereth, F.J.H, Heron, J. and Talling, J.T. (1978). Water analysis some revised method for liminologist, *Sci. publ. fresh water, Biol. Ass. (England) 36: 1-120.*

Mance, G. (1987) . Pollution threat of heavy metals in aquatic environment . Elsevier . London .

Mondon, J. A.; Duda, S. and Nowak, B. F. (2001) . Histological , growth and 7-thoxyresorufin O-deethylase (EROD) activity responses of greenback flounder *Rhombosolea tapirina* to contaminated marine sediment and diet . *Aquat. Toxical.*, 54 : 231 – 247 .

Murphy, J. and Riley, J.R. (1962). A modificational signal solution method for determination of phosphate in natural water. *Chem. Acta., 27: 31-36.*

Muthupriya, P. and Altaff, K. (2010). Influence of heavy metals on the reproductive performance of the estuarine copepod , Apocyclops rogi (Lindberg , 1940) . *Assian. J. Microbial. Biotech. Env. Sc.*, 12(1) : 23 – 27 .

Olaifa, F. E. ; Olaifia, A. K. ; Adelaja, A. A. and Owolabi, A. G. (2004) . Heavy metals contamination of *Clarias garpinus* from a lake and fish farm in Ibadan , Nigeria . *Afric. J. of Biomed. Res.*, 7 : 145 – 148 .

Osman, A. (2007) . Embryo-Toxic Effects of Lead Nitrate of the African Catfish *Clarias gariepinus* (Burchell , 1922) , PhD , Humboldt-University , Berlin .

Osman, A. G. M. and Kloas, W. (2010) . Water Quality and Heavy Metals Monitoring in Water , Sediments and Tissues of the African Catfish *Clarias gariepinus* (Burchell ,

ISSN 2072-3875

1922) from the River Nile , Egypt . *Journal of Environmental Protection* ,1 : 389 – 400 .

Pagenkopf, G.K. (1983) . Gill surface interaction model for trace metal toxicity to fish. Role of complexation, pH, water hardness . *Environ. Sci. Technol.,* 17(6) : 342 – 347 .

Parson, T.R.; Mait, Y. & Laui, C.M. (1984). A Manual of chemical and biological methods for sea water analysis. *Pergamine press, Oxford.*

Raynal , N.J. , Hontela , A. and Jumarie , C. (2005). Cadmium uptake in isolated adrenocortical cells of rainbow trout and yellow perch. *Comparative Biochemistry and Physiology Part C* 140 , 374 – 392 .

Riley, J.P. & Taylor, D.T. (1968). Chelating resins for the concentration of trace elements from sea water and their analytical use in conjuction with atomic absorption specrtophotometry. *Anal. Chim. Acta.*, 40: 479-485.

R.O.P.M.E. (1982). Manual of oceanographic observation and pollution analysis Methods . *ROPME/P.O. Box. 16388 , 13124 Safa , Kuwait.*

Salman, J. M. (2006). An environmental study of the pollution potential in the Euphrates River between the Indian and the Kufa - Iraq, *PhD thesis, Faculty of Science*, University of Babylon .

Sobha, K.; Poornima, A. ; Harini, P. and Veeraiah, K. (2007) . A study on biochemical changes in the freshwater fish , *Catla catla* (Hamiltion) exposed to the heavy metal toxicant cadmium chloride . Kathmandu University , *Journal of Science , Engineering and Technology* , 1(IV) : 1 – 11 .

Srividya, K. and Mhanty, K. (2009) . Biosorption of hexavalent chromium from aqueous solutions by *Catla catla* scales : Equilibrium and Kinetics studies . *Chemical engineering Journal* , 155 : 666 – 673 .

Sturgeon, R.E.; Desaulincrs, J.A.; Berman, S.S. & Russell, D.S. (1982). Determination of trace metals in estuarine sediment by graphite fernace atomic absorption spectrophotometry. *Anal. Chem. Acta*., 134: 288-291.

Tucker, B. W. (1997) . Overview of current seafood nutritional issues : Formation of potentially toxic products . In F. Shahidi, Y. Jones and Kitts, D. D. (Eds.) , Seafood safety , processing and biotechnology . *Technomic Publishing* Co. Inc. 5 – 10 .

Wood, E.D.; Armstrong, F.A. & Richards, F.A. (1967). Determination of nitrate in sea water by cadmium-copper education to nitrate. *J. Mar. Biol. Ass.*, 47: 23-31.

Zayed , M.A. , Eldrin , F.A.N. and Rabie , K.A. (1994). Comparative Study of seasonal variation in metal concentrations in river Nile sediment , fish and water by atomic absorption spectrophotometry . *Microchemical Journal* . 49 : 27 - 35.

ISSN 2072-3875