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The concentrations of heavy metals (copper, nickel, lead, cadmium, iron, manganese) in *Tenualosa ilisha* (Hamilton, 1822) hunted from Iraqi Marine Water

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Abstract

The concentrations of heavy metals (copper, nickel, lead, cadmium, iron, manganese) in several parts of body (gonads, gills liver, intestine, and muscles of head, trunk and tail) of *Tenualosa ilisha* (Hamilton, 1822) hunted from Iraqi Marine Water. Metal concentrations were measured by Flame Atomic Absorption Spectrophotometer. The results showed that the highest values were recorded for iron (105.049) µg/g (dry weight), the least concentration was for lead (0.643) µg/g (dry weight). Cadmium, nickel, manganese and Copper recorded (1.069, 1.098, 1.089 and 1.069) µg/g respectively. results showed that fish body parts that accumulated the metals were as follows; liver, gonads, gills, intestine, head muscles, tail muscles, trunk muscles, whereas the sequence of metals in fish body was as follows; iron, copper, manganese, nickel, cadmium, lead.

Keywords; *Tenualosa ilisha* ; biological accumulation ; environmental pollution ; heavy metals ; Iraqi Maine Water.

Introduction

Heavy metals today have a great ecological significance due to their toxicity and accumulative behavior (Purves, 1985). They are non-biodegradable and undergo a globaleco-biological cycle in which natural waters are the main pathways (1). Heavy metals in water are particularly dangerous for fish juveniles and may considerably reduce fish density, or even cause extinction of entire fish population in polluted reservoirs. The data of many authors indicate that heavy metals reduce survival and growth of fish larvae (2). They also cause behavioral anomalies, such as impaired locomotors performance resulting in increased susceptibility to predators (3), or structural damages, mainly vertebral deformities, Overexposure to heavy metal contaminants can lead to overproduction of tumorsand consequently systemic damage to the organism (4). The lethal and sub-lethal concentration, cadmium has accumulative polluting effect and could cause serious disturbances in fish metabolism such as abnormal behavior, locomotors anomalies or anorexia (5; 6; 7). Cadmium may also affect the blood cells (8). Heavy metals such as cadmium, chromium, Nickel and lead might alter the properties of hemoglobin by decreasing their affinity towards oxygen binding capacity rendering the erythrocytes more fragile and permeable, which probably results in cell swelling deformation and damage (9). Particle of nickel may cause some morphological transformations in numerous cellular systems and chromosomal aberrations (10). Among the aquatic fauna, fish is the most susceptible to heavy metal toxicants (11) and so, are more vulnerable to metal contamination than any other aquatic fauna. Heavy metal concentrations in organism can be changed during the seasons of year (12). Entering of heavy metals in to organisms largely depends upon water temperature (when metabolisms increases), connects positively or negatively with both temperature and salinity (13) ,these metals accumulate in certain tissues and organs but their concentrations differ from one organ to another .Benthic - feeding fish can accumulate heavy metals in their tissues in concentrations higher than the ones of a water column nutrition or surface water nutrition because the sediments contain big quantities of those metals. This study was carried out to investigate the concentrations of many heavy metals in fish tissues of commercial importance and to evaluate the risks the fish expose to, to provide information about copper, nickel, lead, cadmium, iron, manganese concentrations in several tissues of fish body.

Materials and methods

Thirty five samples of *Tenualosa ilisha* fish were caught in Iraqi marine waters. Lengths and weights of the fish were taken, their length and weight averages were (295) mm and (310) g respectively. The Method was explains in (14) used to digest fish samples of muscles from head, trunk and tail.

heavy metals. After collecting and preparing samples, 0.5 g of each dried and grinded sample was taken and put in glass test tube then 3ml of (1:1) Concentrated Perchloric acid ($HClO4$) and Nitric acid ($HNO3$) mixture .The test tubes were put in water bath at 70 C^0 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 they were measured by Flame Atomic Absorption Spectrophotometer.

Statistical program SPSS was used to analyze the data statistically. Significance differences among averages were tested by using Revised Least Significant Difference (RLSD) at 0.05 significant level.

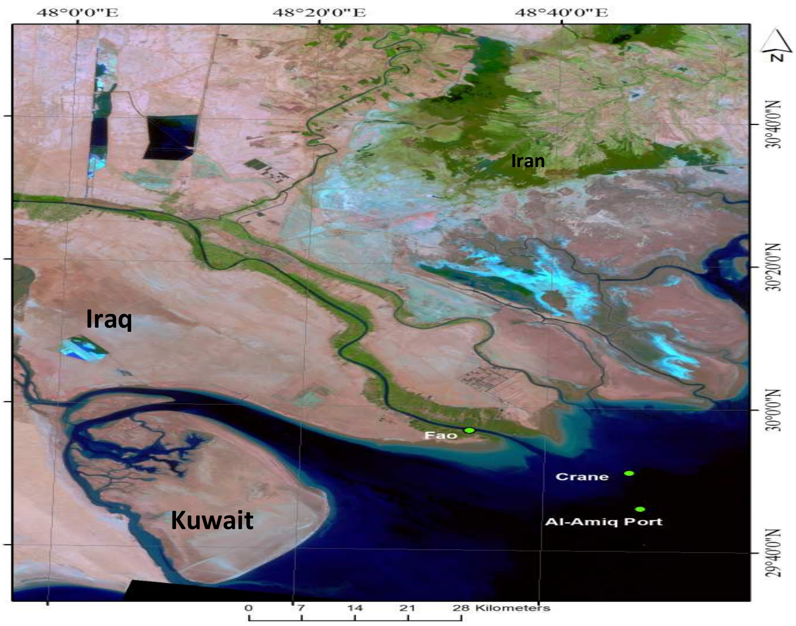
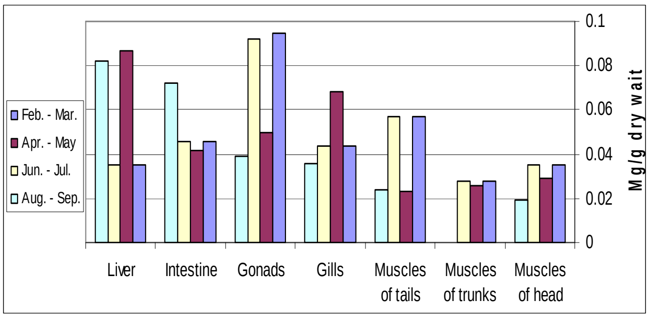


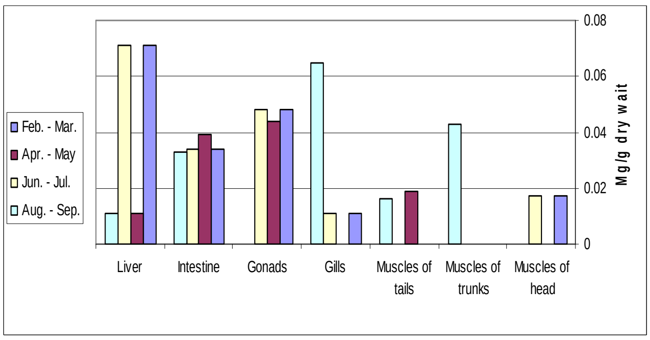
Plate. 1 study area

Results

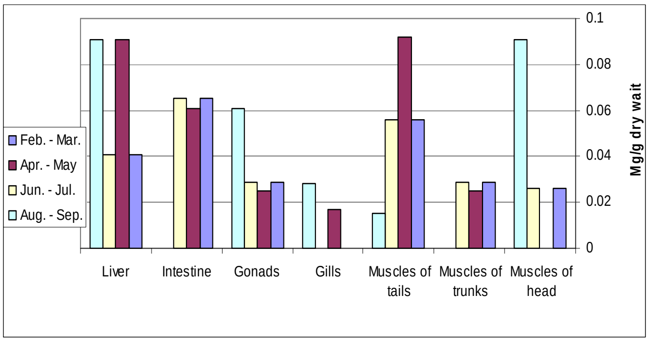
Figure (1) illustrated the highest values for copper concentration was (0.095) µg/g (dry weight) during February and March, while the least concentrations were below level of Flame Atomic Absorption Spectrophotometer detection during August and September in the muscles of trunk, there were significant differences, at ($P<0.05$) probability level in metal concentrations in different tissues, they were between the liver and intestine and between other tissues, there were significant differences at same level of probability between August and September and between other months of study. Figure (2) showed that the highest values of nickel concentration was (0.092) µg/g (dry weight) during April and May in the muscles of tail, whereas the least concentrations were below level of Flame Atomic Absorption Spectrophotometer detection in gills and intestine. The results showed significant differences at ($P<0.05$) probability level for nickel concentrations in different tissues, they were between gills and muscles of trunk on the one hand and between other tissues on the other hand, they also showed significant differences at same level of probability between (April and May) and other months of study. Figure (3) showed the highest recorded concentration for lead (0.065) µg/g (dry weight) during February and March, the least recorded concentration for the same metal was below level of Flame Atomic Absorption Spectrophotometer detection, the results showed significant differences, at ($P<0.05$) probability level between (gonads, intestine, liver) and other tissues, Also there were significant differences, at ($P<0.05$) probability level between (April, May) and other months of study. Figure (4) showed the least recorded concentration for cadmium(0.016) µg/g (dry weight) in intestine during most of the months of study, where as the highest recorded concentration (0.087) µg/g (dry weight) during February and March ,It was found a significant differences between gonads on the one hand and other organs on the other hand. The results did not show significant differences, at ($P<0.05$) probability level among the months study. Figure (5) illustrated the highest concentration for iron was (7.53) µg/g (dry weight) during June and July, whereas least concentration for iron was (1.151) µg/g (dry weight) in gills during August and September, there were significant differences in metal concentrations in different tissues, there was significant difference between (liver, gonads, muscles of tail) and other tissues, the results also did not show significant differences at the same level of probability among the months of study. Figure (6) showed the highest concentration for manganese was (0.081) µg/g (dry weight) during April and May in the muscles of tail, whereas the least concentrations were below level of Flame Atomic Absorption Spectrophotometer detection in the muscles of trunk during August and September, the results also showed significant differences, at ($P<0.05$) probability level in manganese concentrations in different tissues, there were significant differences between (liver, gills, muscles of tail) and between muscles of tail and other tissues, there was significant differences, at ($P<0.05$) probability level (April, May) and other months of study. Figure (7) illustrated that the total concentration of the metals during the period of study, it revealed that the highest concentration was for iron (105,049) µg/g (dry weight) and the least concentration for lead (0.643) µg/g (dry weight). Figure (8) showed the total concentration of the metals during the period of study. Figure (9) showed the total concentration of the metals in the tissues during the period of study by part per million (ppm). Figure (10) illustrated the heavy metal concentrations in sediments during the period of study, the least concentrations were for lead, nickel, iron, cobalt, copper during, they were (25.11, 39.2, 396.2, 188.7, 40.12) µg/g (dry weight) respectively. Table (1) shows the permitted limits of heavy metals in fish µg/g (dry weight), Table (2) shows concentration of heavy metals in different Iraqi fish, Table (3) environmental factors during of study



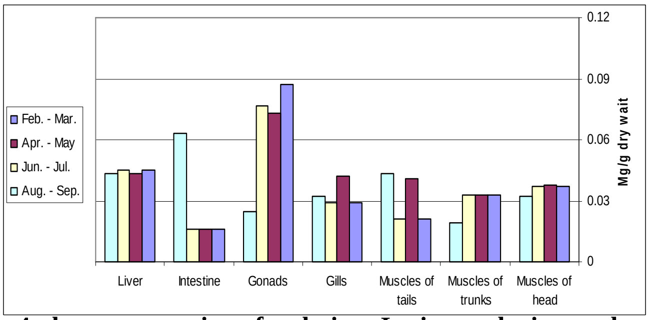
Figuer 1 the consentration of copper In tissues during study period



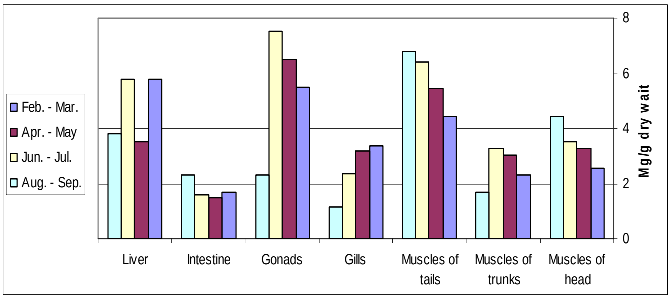
Figuer 2 the consentration of nickel In tissues during stady period



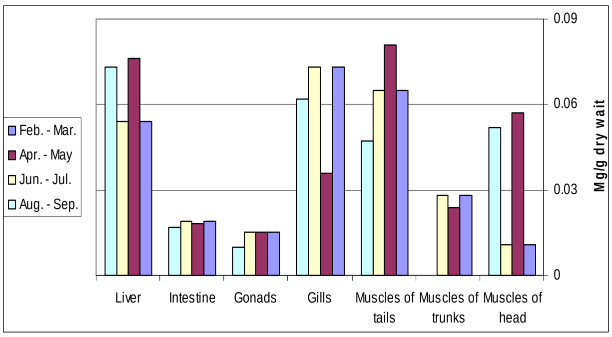
Figuer 3 the consentration of lead In tissues during stady period



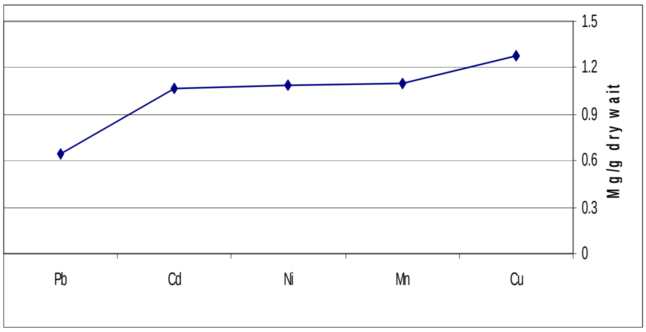
Figuer 4 the consentration of cadmium In tissues during stady period



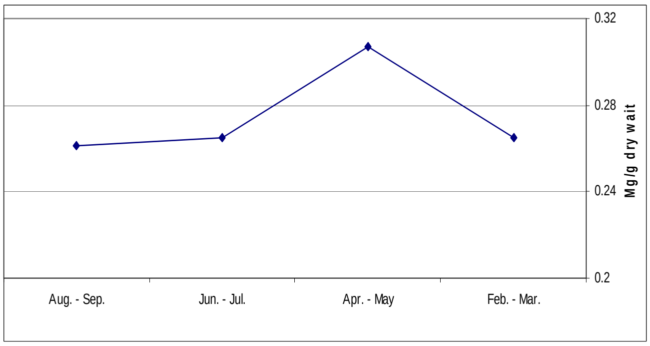
Figuer 5 the consentration of iron In tissues during during stady period



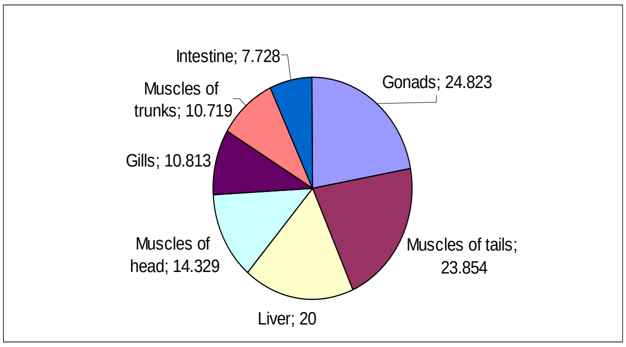
Figuer 6 the consentration of manganese In tissues during stady period



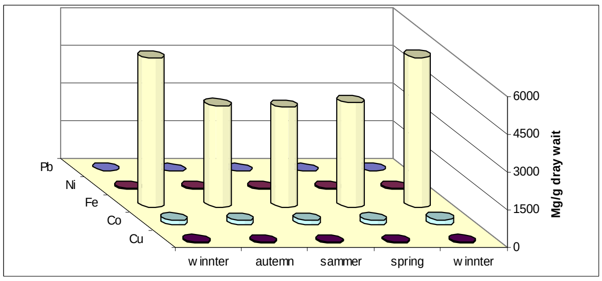
Figuer 7 the consentration of heavy metals during stady period



Figuer 8 the consentration of heavy metals during months of stady



Figuer 9 the total consentration of heavy metals In tissues during stady period



Figuer 10 the consentration of heavy metals in sediment during of stady

Table 1 permitted limits of heavy metals in fish µg/g (dry weight) according to (references)

Refrains	pb	Cd	Fe	Mn	Ni	Cu	Zn
15	3	3.9	50	8	18	–	–
16, 17	4	1	55	4.5	20	–	–
18, 17	2	4	40	—	80	–	–
19	5	8.3	–	–	–	5	–

Table 2 concentration of heavy metals in different Iraqi fish

Refrains	Ni	Pb	Cd	Cu	Fe	Mn	type
20	1.9	0.0 11	6.89	1.2	62	0.6	*T. ilisha*
21	12	–	11.9	51	1.7	26	*Otolithes ruber*
22	45	_	ND	2.9	62	13	*Acanthopag rus latus*
23	4	_	ND	—	44	1.4	*T. ilisha*
24	1		24.5	20	215	5.7	*A. latus*
25	13	5.3	—	29	949	—	*chirocentrus dorab*
The study	0.80		3.8	12		1.3	*T.ilisha*

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Table 3 environmental factors during of stady

Month	temperature	salinity	PH	Dissolved Oxygen mg / L
February	16	19.6	7.8	11.70
March	17.7	12.9	7.9	11.60
April	20	9.6	8.1	10.90
May	28.3	8.2	8.0	10.50
Jun	27	17.6	8.1	10.50
July	28.5	26.2	7.6	10.27
August	29.1	21.7	7.5	9.67
September	18.8	23.5	7.3	9.90

Discussion

Today humanity is facing the highest level of pollution with heavy metals and other pollutants up to the limit is higher many times than it was before pollution. Pollutants and heavy metals are found in the aquatic environment in many forms, they can be found as organic and inorganic complexes or suspended molecules or dissolved ions and these forms differ with respect their bioavailability toxicities (26). Heavy metals are naturally found in the environment but in very low concentrations (27). The determination of heavy metals ions in aquatic system was useful in controlling the pollution specially these metals were undegradable thus they differed from hydrocarbonic pollutants of varied chemical composition that lost some of their toxic characteristics with changing their chemical composition, so it is difficult to remove easily the heavy metals from the environment by natural processes in comparison with most of organic pollutants, but the ions of these metals can combine with salts to form complexes that settle on the bottom (28). The accumulation of heavy metals in fish differed according to the method by which the metals were absorbed and fish sp and kind of metal (29). The results showed that the highest concentration during the period of study was for iron in all parts of the body, it was considered one of the important, essential and nontoxic metals in case of its increased concentration in the body (28), whereas the quantity of heavy metals in muscles were less than other parts of the body because muscles fat scarcity, this agreed with a study of (30), it was found that metal concentrations in muscles of four fish species of Arabian Gulf were less than their concentrations in other parts of the body ,this follows the kind of nutrition or metal concentrations in the environment ,but metal concentrations were high in tail muscles (red muscles) this agreed with a study of (31) on *Mugil sp.*, when he measured the concentrations of cadmium, copper, zinc, lead and chrome, the concentrations of these metals in fish red muscles were higher than those of fish white muscles, his results were higher than the ones of present study, this could belong to muscle composition types and their ability to accumulate the heavy metals as well as their contents of fat, heavy metals settle and bioaccumulate in fat tissues, gonads, liver and muscles and could cause heavy damages to the organism (32). Some heavy metals such as copper and lead attract to fats so easily accumulate in fatty tissues of fish in spite of the ability of fish to transferee or discharge the heavy metal to the surrounding environment (33). The present study recorded an increase in heavy metal concentrations in fish gonads during the period of study because they contain big quantity of fat in their tissue composition and so became a center for accumulation of heavy metals during this period , they started accumulation heavy metals with small quantities then they reached the highest averages in reproduction season, this process can be regarded as a part of reproduction strategy to conserve sp ,some fish types their ovaries contain toxic compounds and by this way the fish protect their eggs from predation, bioaccumulation and enlargement mostly connected with high levels of toxic material pollution. The results showed that the least concentration in all tissues during all the period of study was for lead, it is very toxic, can be transferred via food chain to the main consumer, i.e the human being. Lead can affects every system and regime in the body and exposure to high level of lead can cause heavy damage in the brain kidneys and finally death (34), infection of vital part in food chain may lead to disorder in whole regime and it will weaken or may completely stop. Heavy metal concentrations in marine but high salinity reduce dissolving heavy metals in water, so raising of some heavy metal concentrations in fish tissues lead to deterioration of peroxidative protein that activate fat production in marine fish, work on regulation of metal level inside their bodies via nutrition and excretion (35), this explained that the heavy metals concentrations in marine fish tissues were less than those of fresh water fish tissues and this due to raising of salt ratios that combine with heavy metals and settled them down and reduce their toxicity and this what (36) showed in their study about the impact of salinity on toxicity of some heavy metals, they found as salty concentration (salinity) in water increased the concentration of free heavy metals ions decreased, by combining with salts and forming bottom settled complexes. This agree with the results of present study, few heavy metals were recorded and the reason could be attributed to different abilities to control heavy metal levels inside their bodies via nutrition and excretion. With respect heavy metals arrangement in muscles of this study differ from what (29) mentioned in their study, they arranged lead, cadmium, nickel, chrome, they recorded high concentrations for lead and cadmium in organs and this case calls to worry about the probabilities of human exposure to heavy metals by eating the hunted fish. The results of study showed that heavy metals were less than the permitted maximum level of food recommended by (37), besides that the heavy metals in fish tissues were much less than permitted level for human consumption explained by Food and Agriculture Organization (38). Calcium ions in water plays important role when helps sequencing the heavy metals in sediments and it was noted in connection with concentrations of these metals in water and sediments, this indicates the position and role of environmen tin accumulation of metals, i.e. the most important ground for forming fish nutrients, specially Bento phages and annelids of the bottom as asource of fish nutrition. Benthic fauna played important role as a link up of heavy metals absorption, infection of vital part in food chain may lead to disorder in whole regime and it will weaken or may completely stop (39). All fish have the ability to bioaccumulate sediment heavy metals with different levels. The differences that were found concerned with metal concentration in tissues can be explained on the basis of environmental circumstances that specially occurs in environmental regimes, these circumstances unite on the basis of nutrients as well as pollution level. Still there are many doubts with respect to the dangers of pollutants on health because the probable pollution of fish with heavy metals may be decisive for future utilization, it is important to proceed the research in order to get more knowledge in this topic, to devote environmental programs on the national and regional level in order to control the pollutants, affording the required financing to develop the environmental societies via the projects that aim at exploring connections between the pollutants and health through priority that was determined by studying two programs, they are the heavy metals and organic pollutants.

Conclusions

Heavy metals accumulate in different body tissues, they can highly concentrate in fatty tissues and their increase leads to damage or distortion of cell tissues so waters should be treated before discharging them in to the environment. Increasing fresh water level that pour in to the Gulf. Protecting fish nest areas and examining the fish before marketing. *T. ilisha* can accumulate heavy metals in their tissues; they can highly accumulate the metals. The least concentration of heavy metals were in muscles of fish, the highest concentrations were in ovaries. Concentrating and distributing of heavy metals in the Gulf will permit to researchers to evaluate probable dangers for birds and fish and even human beings, some peoples hunt fish in parts of the gulf. Heavy metals should be more concentrated in sediments near to its source, to determine special fields for high concentrations of heavy metals can help in determining the fields that can benefit from the increase of sacrificed efforts to control surface flow and effluents of pollutants in to the Gulf, high level of some heavy metals that were discovered in the sediments of Gulf, the concentrations of heavy metals were fluctuating and accompanied the variation in food chains. More studies can be done through ou different age groups of this fish sp and to carry out a detailed study concerned vital parts of food chain, to study different levels of heavy metals accumulation in soil, to carry out a study connects the impact of heavy metals on the organisms including human being, to follow up the environmental studies in the region and seashores, to study the pollutants during the high tide in order to know the quantity of pollutants that were brought with water.

References

[1] **Ukpebor JE, Ndiokwere CL, Ukpebor E.E.,** The use of heavy metals load as an indicator of the suitability of Ikpoba River for domestic and consumption purposes. *Chem. Tech. J.* No.2. Vol. 1: 108-115. 2005.

[2] **Holdway D.A.,** Uranium toxicity to two species of Australian tropical fish, *Sci. Total. Environ.* No.1. Vol.25: 137-158. 1992.

[3] **Weis J.S., Weis P.**, Swimming performance and predator avoidance by mummichog (*Fundulus heteroclitus*) larvae after embryonic or larval exposure to methylmercury-Can. *J. Fish. Aquat. Sci*. . No.2. Vol. 5: 2168-2173 p. 1995.

[4] **Cavaletto, M.,** Effect of hydrogen peroxide on antioxidant enzymes and Metallothionein level in the digestive gland of *Mytilus galloprovincialis, Comparative Biochemistry and Physiology,* No. (1): Vol. (31):447-455 pp. 2002.

[5] **Woo, P.T. K., Sin, Y. M., Wong, M. K.,** The effects of short-term acute cadmium exposure on blue tilapia, Oreochromis aureus. Environ. Biol. Fish. No.3. Vol.7: 67-74p. (1994).

[6] **Bryan, M. D., Atchison, G. J., Sandheinrich, M. B.** Effects of cadmium on the foraging behavior and growth of juvenile bluegill, Lepomis macrochirus. Can. *J.Fish. Aquat. Sci,* No. (2): Vol.5: 1630 – 1638pp. 1995.

[7] **Cicik, B., Engin, K.** The effect of cadmium on levels of glucose in serum and glycogen reserves in the liver and muscle tissues of *Cyprinus carpio* L. (1758)". *Turk. J. Vet. Anim. Sci,* No. (2): Vol. 9: 113-117pp. 2005.

[8] **Witeska, M.,** Changes in selected blood indices of common carp after acute exposure to cadmium. *Acta. Vet. Brno,* No. 6. Vol.7: 289-293p. 1998.

[9] Witeska, M., Kosciuk, B., Changes in common carp blood after short-term zinc exposure. Environ. Sci. Pollut. Res, 3: 15-24.Wood, J. M., (2003). *Biological cycle of toxic elements in the environment. Science,* No.3. Vol. 18: 1049-1052. 2003.

[10] Coen, N., Mothersill, C., Kadhim, M., Wright, E. G., Heavy metals of relevance to human health induce genomic instability. *The Journal of Pathology*, No. (3) Vol. 195, 293-299 pp. 2001.

[11] Nwaedozie, J.M., The determination of heavy metal pollution in some fish samples from River Kaduna. *J. Chem. Soc. Nigeria*, No. 2. Vol. 23: 21-23p. 1998.

[12] USGS., Daily Discharge CFS for Puyallup River, *USGS Water Resources*, http://nwis.waterdata.usgs.gov, accessed 3/26/05. 2005.

[13] Mance, G., Pollution threat of heavy metals in aquatic environments. New York : Elsevier. 1987.

[14] ROPME. Manual of Oceanographic Observation and Pollution Analyses Methods ROPME/P.O Box 16388. Blzusafa, Kuwait, 1982.

[15] FAO, Fisheries and Aquaculture Department., The State Of World Fisheries and Aquaculture 2008. Food and Agriculture Organization of the United Nations. Electronic Publishing Policy and Support Branch, Rome, 176 pp. 2009.

[16] MFR, Malaysian Food and Regulations., In Hamid Ibrahim، Nasser and Yap Thiam Huat. Malaysian law on food and drugs. Kuala Lumpur، Malaysia Law Publisher. 1985.

[17] Swami, K., Judd, C.D., Orsini, J., Yang, K.X. and Husain, L., "Microwave assisted digestion of atmospheric aerosol samples followed by inductively coupled plasma-mass spectrometry determination of trace elements," *Fresenius J. Anal. Chem.*, No.9. Vol. 36: 63-70. 2001.

[18] FDA. Fish and Fisheries Products Hazards and Controls Guidance, third ed.; Center for Food Safety and Applied Nutrition, US Food and Drug Administration. 2001.

[19] FAO/WHO. List of maximum levels recommended for contaminants by the Joint FAO/ WHO Codex Alimentarius Commission. Second Series. *CAC/FAL, Rome.* No.2. Vol. 3: 1–8p. 1984.

[20] Al-Najare, G. A. Seasonal variations of some heavy Metal's concentrations in some organs of Otolithes ruber collected from Iraqi Marine Waters, A scientific and refereed journal issued by university of thi-Qar. in pries. 2015.

[21] Al-Saad, H. T.; Mustafa, Y. Z. and Al-Imarah, F. J. Distribution of trace metals in tissues of fish from Shatt Al-Arab estuary. *Iraq. Mar. Me. so.*, No. (3): Vol.11: 15-25pp. 1997.

[22] Al-Khafaji, B. Y. Trace Metals in Waters, sediments and fishes from shatt Al-Arab estuary north-west Arabian Gulf. *Ph.D. Thesis*, College of Education-Univ. of Basrah, 131p. 1996.

[23] Al-Saad, H. T.; Abdul-Hassan, J. K., and Al-Sodani, A. M. Uptake–Release of pollutant by Tenualosa ilisha (Sbuor) fish collected from Southern- *Iraq. Mar.Meso.* No. (1): Vol. 23: 29-38pp. 2008.

[24] Al-Najare, G.A. Concentration of metals in the fish *Liza subviridis* from the Iraqi marine Estimation. *J. of King abdulaziz University, Marin Sciences*, No. (1): Vol.23: 129-146p. 2012.

[25] Al-Nagare, G. A. The Bioaccumulation of some heavy metals in fish *chirocentrus dorab* collected from Iraqi Marine Waters. *J. of King saud University,* No. 2. Vol. 26, in pries. 2014.

[26] Tokalioglu, S.; Kartal, S. and Elci, L., Speciation and determination of heavy metals in lake waters by atomic absorption spectrometry after sorption on amberlite XAD-16 Resin. *Analytical Sciences,* No.1., vol.16, 1169-1174p. 2000.

[27] Ososkov, V.K. and Kebbekus, B.B.. Preconcentration, speciation and determination of dissolved heavy metals in natural water, using ion exchange and graphite furnace atomic absorption spectrometry. *U.S. Environmental Protection Agency.* 1997.

[28] Al-Nagare, G. A. Seasonal changes to some of heavy metals in the muscles of three species of fish (Cyprindae) from Al-Hawizeh Marshe and south Hammar. MSc. Fisheries and Marine Resources Coll. of Agriculture, Basrah University. 2009.

[29] Abida B., HariKrishna S., and Irfanulla K. Analysis of Heavy metals in Water, Sediments and Fish samples of Madivala Lakes of Bangalore, Karnataka. *International Journal of Chem. Tech. Research,* No.2, Vol.1, 245-249 pp, 2009.

[30] Agah, H., Leermakers, M., Elskens, M., Fatemi, M.R. and Baeyens, W. Total Mercury and Methyl Mercury Concentrations in Fish from the Persian Gulf and the Caspian Sea. Water, Air and Soil Pollution, No.18. Vol,1: 95-105pp. 2007.

[31] Joyeux, J. C.; Filho, E. A. and Jesus, H. C. Trace Metals Contamination in Estuarine Fishes from Vitória Bay, *Brazilian Archives of Biology and Technology an International Journal,* No.(5), Vol.47: 765-774p. 2004.

[32] Ackman, R.G.; Haras, H. and Zhou, S. Salamon lipid storage site and their roles in contamination with water soluble. Petroleum materials. *Jou. Food lipids,* No.3: Vol.1, 161-170 pp, 1996.

[33] EPA,Environmental Protection Agency. Assessing human health risks from chemically contaminated fish and shellfish: a guidance manual. EPA-503/8-89-002, Appendix F. US Environmental Protection Agency, Cincinnati, Ohio. 1998.

[34] Adeyemi, O. Osubor C. C. and Adeyemi, O., Toxicological evaluation of the effect of *Clarias gariepinus* (African catfish) cultivated in water contaminated with phthalate, benzene and cyclohexane on liver of albino rats, *African Journal of Food Science.* No.1. Vol 4, 026-031pp, 2010.

[35] Metwally, M.A.A. and Fouad, I.M., Biochemical Changes Induced by Heavy Metal Pollution in Marine Fishes at Khomse Coast, Libya. *ISSN Global Veterinaria* No. 2, Vol. 6: 308-311. 2008.

[36] Hantoush, A.A., Younis, K.H., Al-Najare G.A. and H.T. Al-Saad., Bioaccumulation of some heavy metals in the tissues of *Liza abu* captured from Al-Hawizeh Marsh. *Basrah j. of Agri. Sci.* No. (1). Vol. 26: 289-296p. 2013.

[37] FAO, Food and agriculture organization. Review of pollution in the African aquatic environment. CI F A technical paper, No. 25: 118pp. 1994.

[38] FAO, Food and agriculture organization. Report on a Regional Study and Workshop on the Environmental Assessment and Management of Aquaculture Development. Food and Agriculture

Organization of the United Nations. 1995. http://www.fao.org/docrep/field/003/ac279e/ac279e00.htm.14 January 2009.

[39] Al-Najare, G.A., Hantoush, A.A., Al-Shammary, A.C. and Al-Saad, H.T. Bioaccumulation of heavy metals in *Acanthopagrus latus* collected from Iraqi marine waters. Iraqi Journal of Aquaculture: No. (2) Vol. 10:107-122p. 2013.