J. Appl. Environ. Biol. Sci., 1(10)453-459, 2011

ISSN: 2090-4215
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Determination of Heavy Metals in Four Common Fish, Water and Sediment Collected from Red Sea at Jeddah Isalmic Port Coast

Abdelrahim. A. Ali, Elhadi. M. Elazein, Mohamed. A. Alian

Chemistry Dept. Faculty of Science and Education, Taif Univ. (Khorma Branch), Taif, KSA

ABSTRACT

In this study the heavy metals concentration in (liver, gut, and muscles) of four common fish, water and sediment collected from Jeddah Red Sea Coast were investigated for (Copper Cu, Mercury Hg, Cadmium Cd, Lead Pb, Arsine As and Zink Zn) concentration. Large differences in heavy metal concentration mg/g dry weight were observed between different tissue, water and sediments. In sediments, heavy metal concentration was Cd 35.5, Pb, 41.40, Cu 22.5, Zn 32,2, Hg1.85 Where as in water heavy metal concentration mg/l 0.31, Pb, 1.20, Cu 0.40, Zn 0.41, Hg not detected. Generally metal concentration in liver is the highest where as in muscles is the lowest, in liver Cd 1.09- 3.35, Pb 2.95-7.84, Zn 41.97 – 57.21, Cu 12.23-32.22 in muscles ranged between 0.13- 1.06, Pb 1.03-6.10, Zn 3.98 – 9.30, Cu 0.13 – 0.91. Hg not detected in all samples except the sediment.

KEY WORDS: Heavy Metals, Fish, Water, Sediment.

INTRODUCTION

Fish is one of the major sources of proteins in the Kingdom of Saudi Arabia, its believed to be contaminated with heavy metals at Jeddah Coast due growing industry, shipping and human wastes, due to the strategic location as one of the shipping, industry, and urbanization centers of Saudi Arabia, a large number of toxic chemicals and effluent-producing industries are located in and around Jeddah City.(**24**)

The rapid industrial growth has resulted in an increasing production and usage of toxic chemicals such as trace elements in Jeddah. Some metals are known to be toxic even at low concentrations, including arsenic, cadmium, mercury and lead (**28**).Others, such as copper and cobalt, are known to be essential elements and play important roles in biological metabolism at very low concentrations (**28**) and either an excess or deficit can disturb biochemical functions in both humans and animals (**20**). Heavy metals, unlike organic pollutants, cannot be chemically degraded or biodegraded by microorganisms. Thus, their content has steadily increased in soils and subsequently accumulated in plants, animals, and even in humans (**14**). The pollutants like heavy metals after entering into aquatic environment accumulate in tissues and organs of aquatic organisms. The amount of absorption and assembling depends on ecological, physical, chemical and biological condition and the kind of element and physiology of organisms (**25**). The concentration of any pollutant in any given tissue therefore depends on its rate of absorption and the dynamic processes associated with its elimination by the fish (**4**). Chemicals of industrial effluent and products of ship and boats such as heavy metals which find their way in different water system can produce toxic effect in aquatic organism (**11**). Petroleum products are one of the most relevant pollutants to aquatic ecotoxicology. Exposure to crude oil derivatives can induce a variety of toxic symptoms in experimental animals Petroleum hydrocarbons can act as amediator in free radical generation in fish (**36**) recorded four pollution sources at Jeddah coast: the untreated the untreated domestic sewage waste , oil pollution from oil refinery of factory Petromin, fish waste from the fish market of Bankalah region and probably desalination plant effluents.

Heavy metals are well known environment pollutions that cause serious health hazard to human, their effects are not immediate and show up after many years (**12, 26**). Increasing on the need for documentation of both nutrients and contaminant s in fish and sea food, with balance risk assessment (**15**).

Heavy metals discharge into the marine environment can damage both marine species diversity and ecosystems, due to their toxicity and accumulative behavior (**16**, **38**). Cadmium, copper, lead and zinc salts are usually found in agricultural and industrial liquid waste (**29**, **34**) which discharged into water resources. These metals are toxic to aquatic life at low concentration, particularly in soft water interments. Such metals may be accumulated from water to higher level in fish tissue (**35**,**37**,**38**), Liver and gills as main organs for metabolism and respiration are target organs for contaminants accumulation as reported by many authors concerning Structural damage to organs and tissues related to the exposure of fish to

***Corresponding Author:** Abdelrahim. A. Ali, Chemistry Dept. Faculty of Science and Education, Taif Univ. (Khorma Branch), Taif, KSA. Email: abdelraheem999@yahoo.com

petroleum derivatives (**18**,**27**)Evidently these metals accumulated frequently in fish flesh and in internal organs (**15**,**39**). The excess of heavy metals intake, especially mercury and lead, causes many harmful and neurotoxic effects to the human health. Hg is the most toxic heavy metals that affects the brain causing the syndromes of nerve disturbances and insomnia, in addition to its harmful effects on inhabiting growth activity of some enzymes(**9**,**19**,**23**)

The Saudi Arabian Standards Organization, SASO (1977), had suggested maximum allowable limits (MALs) for some of the more toxic heavy metals in fish.species, as follows:

Cadmium, Cd 0.5 mg/g
Mercury, Hg 1.0 mg/g
Lead, Pb 2.0 mg/g
Arsene, As 1.0 mg/g
Copper, Cu 20.0 mg/g
Zinc, Zn 50.0 mg/g

So the main objective of this study is to determine the concentration of some heavy metals (Cu, Hg, Cd, Pb, As and Zn) in some local consumed fish captured from Jeddah coast at different location, and know whether it's safe for consumption.

MATERIALS AND METHODS

Water and sediment samples were taken at different places at Jeddah Port by a PVC tube column sampler at depth of half meter from the water surface. The samples were mixed in a plastic bucket and a sample of 1 liter was placed in a polyethylene bottle, kept refrigerated and transferred cold to the laboratory for analysis. Surfacial sediment samples were collected using core sampler as described in (Boyd and Tucker, 1992), then kept in cleaned plastic bags and chilled on ice box for transport to the laboratory for heavy metals determination

Water

Heavy metals in water samples were extracted with conc. HCl and preserved in a refrigerator till analysis for As, Hg, Zn, Cu, Cd and Pb (**32**).

Sediment

In the laboratory, the sediment samples were dried at 105 ºC, grinding, sieving and about (1.0 gm) of the most fine dried grains were digested with a mixture of conc. H2O2, HCl and HNO3 as the method described in. (**31**) and preserved in a refrigerator till analysis.

Fish Sampling

Four different species of common fish were collected from the shipping area near the port of Jeddah fish specimens were examined, the samples were weighed, measured, cleaned with deionized-distilled water, stored in pre-cleaned plastic bags, and kept frozen at -18 0C until further analysis. Muscles, liver and guts were taken out and dried in a pre-cleaned glass container at 103 ± 2 0C to a constant weight. Sampling, pretreatment, preparation of subsamples and analysis were made according to FAO Technical Paper No. 212 (1983).. Metals in fish tissue/organs were extracted as described by (**5**). Atomic Absorption Spectrophotometer (Model Thermo Electron Corporation, S. Series AA Spectrometer with Gravities furnace, UK,) instrument was used to detect the heavy metals. The concentrations of heavy metals were expressed as mg/l for water and µg/g. dry wt. for sediment samples and fish organs.

RESULTS AND DISCUSSION

This study conducted to determine heavy metals concentration (Cd, Zn, Cu, Pb, As, and Hg) in different organs of four fishes, water and sediments collected from Jeddah Islamic Port Coast, Figure (1) showed the map of Jeddah Islamic Port were the sample has been collected. Figure (2) represents the concentration of heavy metals in sea water and sediment, from the results below, Table 1 represent the Concentration (mg\g dry weight) of heavy metals in muscles , Table 2 Concentration (mg\g dry weight) of heavy metals in guts and Table 3 represents Concentration (mg\g dry weight) of heavy metals in liver.

Heavy Metals concentrations in water were found in the following order Pb 1.21. Cu 0.4, Zn,0.31, Cd 0.04, Hg and As not detected (Figure2). The high level of Pb in water of Jeddah Port could be attributed to the shipping, industrial and agricultural discharge as well as from spill of leaded petrol from fishing

boats and dust which holds a huge amount of lead from the combustion of petrol in automobile cars (**22**).Higher levels of Pb often occur in water bodies near highways and large cities due to high gasoline combustion (**10**)

Table (1): Concentration (mg\g dry weight) of heavy metals in muscles of four species of common fish collected from Jeddah coast.

Species	Cu	Zn	As	Pb	Cd	Hg
Lethrinus nebulous	0.13	3.98	2.08	1.03	0.13	ND
Caranx sexfaciatus	0.91	5.33	2.12	3.4	0.9	ND
Carans melampygus	0.63	8.37	4.33	6.4	0.26	ND
Lethrinus mahsena	0.47	9.30	2.98	6.10	1.06	ND

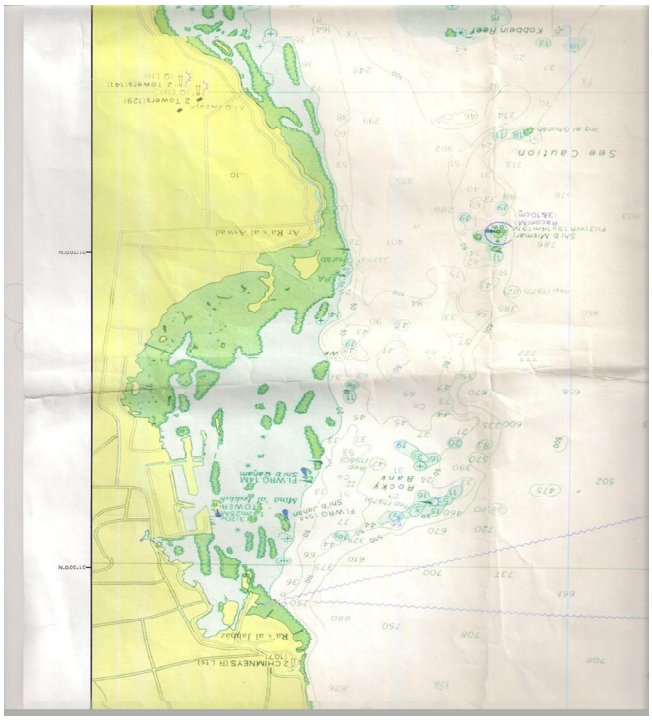
ND Not Detected

Table (2): Concentration (mg\g dry weight) of heavy metals in the guts of four species of common fish collected from Jeddah coast.

Species	Cu	Zn	As	Pb	Cd	Hg
Lethrinus nebulous	6.09	25.42	4.02	6.80	1.87	ND
Caranx sexfaciatus	3.23	32.03	2.97	9.76	1.96	ND
Carans melampygus	5.49	43.11	4.63	7.66	1.13	ND
Lethrinus mahsena	5.94	24.16	5.45	5.57	0.80	ND

ND Not Detected

Figure (1) Jeddah Islamic Port Coast



The metals concentrations in bottom sediment of Zn, Cu, Hg, Cd, As and Pb values are shown in Figure (3) Zn and Pb concentrations among the other metals showed higher concentrations, where as Hg and As are the least concentrations obtained in the sediments of Jeddah coast The high level of Cd and Pb sediments could be attributed to the industrial and agricultural discharge as well as from spill of leaded petrol from fishing boats which are distributed in the Jeddah Islamic Port. Also, dust which holds a huge amount of lead from the combustion of petrol in automobile cars led to increase Pb content(**22**)

Figure (2) Heavy Metal Concentration mg/l in Water Collected From Jeddah Islamic Port

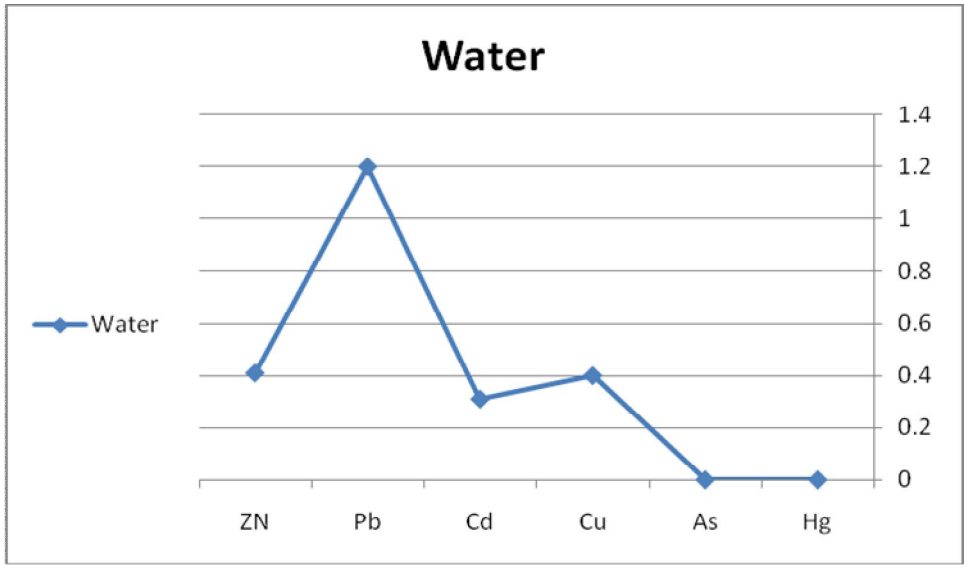
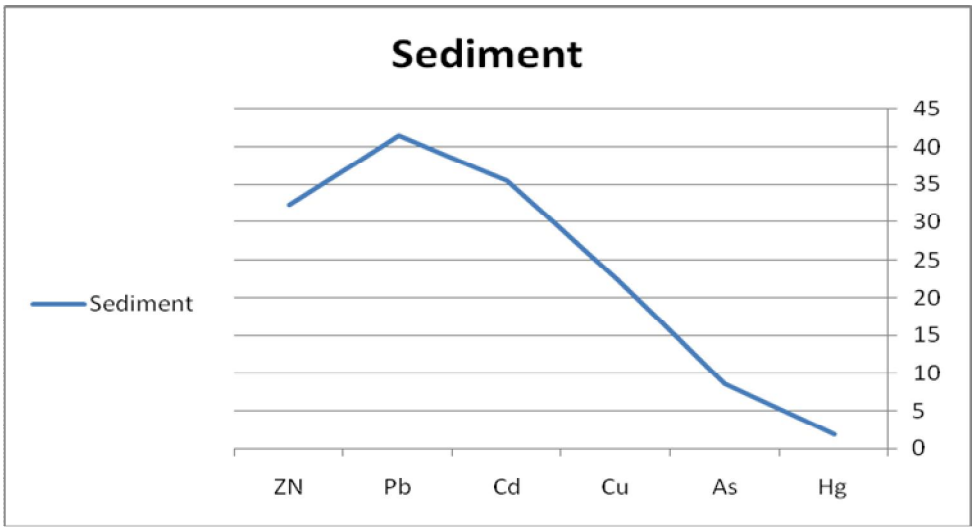


Figure (3) Heavy Metal Concentration mg/g in Sediment Collected From Jeddah Islamic Port



Cadmium.

Compared to other heavy elements determined Cd showed relatively low concentration level in the different organs in the fish whereas higher means were found in guts and livers it ranges from 0.13 – 1.06 mg\g dry weight in the muscles, 0.8 -1.87 mg\g dry weight in guts and 1.16 -3.35 mg\g dry weight as shown in Tables 1,2 and 3 respectively. Cadmium is accumulated primarily in major organ tissues of fish rather than in muscles (**30**). In general, it can be stated that the concentrations of Cd found in edible part in the present study are still considered as those of uncontaminated fish (< 1.5). Cadmium when detected occurred at fairly low levels, within SASO limits, in the muscle tissues of fish. The same can be said regarding concentration levels of Zn, Cu, and Pb, which all lie below, or well below, the limits (Table 1). Although, the level of Cd in the edible fish muscles showed values within SASO's recommended maximum limit of 0.5 mg/kg, its level in gills and shrimp tissues, only slightly exceeded this limits.

Table (3): Concentration (mg\g dry weight) of heavy metals in the livers of four species of common fish collected from Jeddah coast.

Species	Cu	Zn	As	Pb	Cd	Hg
Lethrinus nebulous	12.23	41.97	3.55	2.95	3.35	ND
Caranx sexfaciatus	22.74	45.48	3.36	7.84	2.97	ND
Carans melampygus	32.22	46.69	2.11	3.71	1.09	ND
Lethrinus mahsena	15.101	57.21	3.31	6.72	1.16	ND

ND Not Detected

Table (4): relationship between weight (g) of fish and length (cm)

Species	Weight of fish (gm)	Length of fish (cm)
Lethrinus nebulous	165.80	22.50
Caranx sexfaciatus	144.10	22.50
Carans melampygus	197.30	21.00
Lethrinus mahsena	174.60	24.00

Copper

Relatively high mean concentrations of Cu were found in livers (32.22) and guts (6.09) of the fish examined, compared to those found in muscles (0.91). There was also a wide variation in Cu content in livers among species as it ranged from 12.23 for *Lethrinus nebulous* to 32.22for *Carans melampygus*. In muscles, there was a narrower range of concentration (0.13- 0.91) (**6,7**) found relatively high mean concentration of Cu in liver followed by stomach and lastly muscles. The data indicate that the fish in Jeddah coast compare to other fish worldwide and are not more contaminated with Cu than that at other marine environments (**3**). Liver and gill as main organs for metabolism and respiration are target for contaminants accumulation as reported by many authors concerning structural damage to organs and tissue related to the exposure of fish to the petroleum derivatives (**18,27**)

Zinc

Zn concentrations were slightly higher compared to e.g. Cd, As, Hg & Pb. It occurred in both muscles and guts of some fish species. Similar results of Zn concentration in muscles of several marine fish species, being higher than the above mentioned (and other) trace elements, were also reported (**1**). The tendency of Zn to bio-concentrate in muscles may be attributed to its particular tendency to accumulate in the skin layers of fish species (**41**). Since muscle samples used in the current study were not intentionally skinned, variability in the Zn content of muscles will be expected to occur in as much as there are skin fractions associated with the muscular tissues. This appears to partly contribute to observed variability of Zn content in muscles of the same species.

Arsenic & Mercury

Arsenic, As, was detected in low level of concentration compared to Zn, Cu in liver and guts , mercury, (Hg) invariably undetectable in all samples of different organs of fish collected , over the whole study period (Table.1). Hg is the most toxic heavy metals that affects the brain causing the syndromes of nerve disturbances and insomnia, in addition to its harmful effects on inhabiting growth activity of some enzymes (**9,23**)

Lead

The mean concentration of Pb was lowest in the muscles (0.45) and livers (2.95) of the fish examined, while the highest was in the guts (6.80) of these fishes this could be due to contamination of water with oil from the shipment area (**36**) recorded four pollution sources at Jeddah coast: the untreated the untreated domestic sewage waste oil pollution from oil refinery of factory Petromin, fish waste from the fish market of Bankalah region and probably desalination plant effluents. Recently Badr|,s group (**8**) confirmed the heavy metals pollutions at sea bed of Jeddah Coast. The concentration of Pb is below the limits in edible part of fish because Pb toxicity in humans include abnormal size and hemoglobin content of erythrocytes, hyper stimulation of erythropoesis inhibition of both haeme synthesis and some enzyme activity in anemia and permanent damage of the brain, liver and central nervous system (**34**)

These results are consistent with what has been reported by (**30**) that there is often little accumulation of Pb in the muscles of marine and freshwater fish species. Low concentrations of Pb in the muscles of marine fish were reported from coastal areas of England and Wales (< 1.0 µg g^{-1}

wet weight) (**33**), West Malaysia (< 0.5 mg kg' wet weight) (**9**),), and Gulf of Aqaba (0.8-2.6 µg g^{-1})(**40**). In fishes of the Red Sea Pb ranged between 0.01-0.66 µg g^{-1} in the muscles 0.1-2.4 in the livers, and <0.05-0.14 in the gonads (**21**). Our data indicate that the fish in the Gulf contain higher levels of Pb compared to other fish at other marine environments world wide

CONCLUSIONS

Analytical results revealed that very low concentration levels of toxic metals are encountered in Jeddah Islamic Port Coast. No concentration levels that are abnormally high were observed in the tissues muscles of the test species. Toxic metal levels analyzed in this study meet the available maximum allowable limits recommended by SASO for fish and shrimp species, so the fish in the coast of Jeddah Port are safe for consumption.

REFERENCES

1-Abul-Naja**,** W. M., (1996), "Comparative Study of Trace Metals Accumulated inthe Muscle Tissues of the Most Marketable Seafood in Alexandria Waters", *Int. J.Environ. Health Res., Vol.* ***6*** *no*. 4, pp. 289-300.

2-Achuba, F.I. and S. Osakwe, (2003). Petroleum-induced free radical toxicity in African catfish (Clarias gariepinus). *Fish Physiol. Biochem*., 29: 97-103.

3-Ahmad H, S. ismail., (2008). Heavy metals in eleven common species of fish from the Gulf of Aqaba, Red Sea. *Jordan Journal of Biological Science*. 1:13-18.

4-Al-Kahtani. M.A (2009). Accumulation of heavy metals in tilapia fish *(Orechromis nilotica)* from Al-Khadoud Spring. Al-hassa- Saudi Arabia. *Am. J. App. Sci*., 69(12):2024-2029.

5-AOAC 1990. The Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. "Atomic Absorption Method for Fish". Washington, D.C.

6-Ashraf W (2006). Levels of selected heavy metals in tuna fish. Arabian *J. Sci. Eng*. 31(1): 89-92.

7-Ashraf W, Seddigi Z, Abulkibash A, Khalid M (2006). Levels of selected metals in canned fish consumed in Kingdom of Saudi Arabia.Environ. Monit. Assess. 117(1-3): 271-279Krenkel, P. A., (1975), "Heavy Metal in the Aquatic Environment ", (Ed.), pp 27-30.

8- Badr, N.B.E., A.A. El-Fiky, A.R. Mostafa and B.A. Al-Mur, 2008. Metal pollution records in core sediments of some Red Sea coastal areas, Kingdom of Saudi Arabia. Environ. Monit. Assess.,155: 509-526.

9-Baji, A,H., Z,B. Awang and M.S. Embong, (1986).Monitoring heavy metals contents of coastal water fish in Malaysia. Proc.Int. Conf. Dev.Managt. Trop. Living Aquat. Resources Serdang, Malaysia, 2-5 Aug.1983, pp:219-224.

10-Banat I. M, E. S. Hassan, M. S. El-Shahawi and A. H. Abu-Hilal. 1998. Post-gulf-war assessment of nutrients, heavy metal ions, hydrocarbons, and bacterial pollution levels in the United Arab Emirates coastal waters. *Environ. Inter*., 24 (2): 109–116.

11-Bernet, D., H. Schmidt, W. Meier, P. Burkhardt-Holm and T. Wahli, (1999). Histopathology in fish proposal for a protocol to assess aquatic pollution. *J. Fish Dis*., 22: 2534.

12-Boguszewska, A. and K. Pasternak. (2004).Mercury-influence on biochemical process of the human organism . *Ann. Univ. Mariae Curie Sklodowska*, 59: 524-527.

13-Boyd, C. E. and C. S. Tucker. 1992. Water Quality and Pond Soil Analysis for aquaculture. Alabama Agricultural Experimental Station. Auburn Univ. 183 pp.

14-Che D, Meagher RB, Rugh CL. Kim T. Hearton ACP, Merkle, SA.(2006). Expression of organomercurial lyase in Eastern Cottonwoodenhances organomercury resistance. In vitro Cell Dev. *Biol-Plant* 42:228-234

15-Dural, M., M.Z.L. Goksu and A.A. Ozak, (2007). Investigationof heavy metal levels in economically important fish species captured from the Tuzal Laagoon. *Food Chem*, 102:415-421.

16-Edward, J.W., K.S. Edyvane, V.A. Boxalls, M. Hamann and K.L. Soole, (2010). Metal levels in Seston and marine fish flesh near industrial and metropolitan centers in South *Australia. Pollution Bulletin*, 42(5):389-396.

17-Ellias, L.D. (1996). Chemical and toxicological studies on hazardous waste sites in Harris country. M.Sc. Thesis, Faculty of Science, Texas Solution Univ. USA.

18-Engelhardt, F.R., M.P. Wong and M.E. Duey, (1981).Hydromineral balance and gill morphology in rainbow trout Salmo gairdneri, acclimated to fresh and sea water as affected by petroleum exposure. *Aquat. Toxicol*., 1: 175-186.

19-FDA, (2001). Fish and fisheries Products Hazards and Controls Guidance, third ed Center for Food Safety and Applied Nutrition, US Food and Drug Administration

20-Gulec., A.K., Yildrim. N.C. Danabas. D., Yildirim. N., (2011). Some haematological and biochemical parameters in common carp *Cypinus carpio* L 1758 in Munzur River, Tunceli, Turkey, *Asian. J. Chem*. 23(2)910-912.

21-Hanna RGM. (1989). Levels of heavy metals in some Red Sea fish before Hot Brine pools' mining. Mar. Pollut. Bull. 20:631-635.

22-Hardman, D. J., S. Mceldowney and S. Watte. 1994. Pollution, ecology and biotreatment. Longman Scientific, Technical, England, 322 pp.

23-Hgjeb P, Jinap S, Ismail A, Fatimah AB, Jamilah B, Abdul Rahim M(2009). Assessment of mercury level in commonly consumed marine fishes in *Malaysia*. *Food Control*, 20(1): 79-84.

24-Iman Alsaleh . Neptune Sehrenani (2002) , Preliminary Report on Four Fishes Species From Arabian Gulf of Saudia , Chemosphere 7: 749-75

25-Jaffer, M., M. Ashraf., M. Rasoal A., (1988) Heavy metals contents in some selected local freshwater fish and relevant water Pakistan. J. Sci. Ind. Res. 31:189-193.

26-Jarup, L., (2003). Hazards of heavy metal contamination. Br. Med. Bull., 68:167-182.

27-Khan, R.A., (2003). Health of flatfish from localities in Placentia Bay, Newfoundland, contaminated with petroleum and PCBs. Arch. Environ. *Contam. Toxicol*., 44: 485-492.

28-Le QD, Shirai K, Nguyen DC, Miyazaki N, Arai T (2009). Heavy metals in a tropical eel *Anguilla marmorata* from The Central Part of Vietnam. Water Air Soil Pollut., 204: 69–78. Doi: 10.1007/s11270

29-McCea, R.C. and J.D. Fischer, (1986), Heavy metals and organ-chlorine contaminates in the liver in the five major Ontario Rivers of the Hudson Bay Low land Poll Res. *J. Can*.,21: 225-234.

30-Moore JW & Ramamoorthy S. (1984). Heavy Metals in Natural waters Applied Monitoring and Impact Assessment. Springer-Verlag, New York, 268 pp.

31-Page, A. L., R. H. Miller and D. R. Kenney, (editors). 1982. Heavy metals determination. In: Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. American Society of Agronomy, Madison, WI, USA. 8 pp.

32-Parker, R. C. 1972. Water analysis by atomic absorption spectroscopy. Varian techtron, Switzerland. In: E. I. Adeyeye (Editor), Determination of trace heavy metals in Illisha Africana fish and in associated water and sediment from some fish ponds. *Int. J. Environ. Stu*d. 45: 231-238.

33-Portman J.E. (1972). The levels of certain metals in fish from coastal waters around England and Wales. Aquacult. 1:91-96.

34-Qiao-qiao, H.I., Z.H.U. Guang-Wei and Langdon, (2007). Bioaccumulation of heavy metals in fishes from Taihu Lake, China. J. Environ. Sci. 19:1500-1504.

35-Rowayayshed, G.H., A.M. Sharaf. and S.M. el-Sayed, (2002).Heavy metals pollution in bolti *(Oreochromis niloticus)* fish as affected by the common cooking and processing methods. *Annals of Agric. Sci., Moshtohor*, 40 (4):2211-2222.

36-Saad, M.A.H. and M.A. Fahmy, (1994), Heavy metals pollution in coastal Red Sea water, Jeddah*, J KAU, Mar. Sci.* 7:67-74.

37-Sankar, T.V., A.A. Zynudheen, R.Anandan and P.G. Viswanathan-Nair, (2006). Distribution of organochlorine pesticide and heavy metal residues in fish and shellfish from Colicut region, *Kerala, India Chemosphere* 65:583-590.

38-Sivaperrumal,P., T.V. Sankar and P.G. Viswanthan-Nair, (2007). Heavy metal concentration in fish, shellfish and fish products from internal markets of India vis-à-vis international standards. *Food Chemistry*, 21: 225-234.

39-Turkmen, A. M. Turkmen, Y. Tepe and I. Akyurt, (2005). Heavy metals in three commercially valuable fish species from Iskenerun Bay North East Mediterranean Sea , Turkey . *Food Chemistry*, 91:167-172.

40-Wahbeh MI & Mahasneh D.M. (1987). Concentrations of metals in the tissues of six species of fish from Aqaba, Jordan. Dirasat. 14: 119-129.

41-Zhou, H. Y., Cheung R.Y. H., Chan K. M. and M. H. Wong, (1998), "MetalConcentration in Sediments and Tilabia Collected from Inland Waters of Hong Kong" Wat. Res., **32** (11), 3331 –3340.