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TRACE METAL DISTRIBUTION IN SURFACE WATER, SEDIMENT, AND TISSUES OF FRESHWATER CATFISH (*CLARIAS. GARIEPINUS*), FROM OKE- AFA CANAL, LAGOS NIGERIA

Aderinola, O.J[1]
Kusemiju, V[2]
Clarke, E, O[3]

ABSTRACT

This paper discusses concentrations of 7 essential trace metals (chromium,cadmium, copper, lead,nickel, manganese and zinc) in water, sediment and freshwater fish (Clarias. gariepinus) tissues from Oke-Afa Canal, Lagos Nigeria The sampling and analysis of the samples from Oke Afa canal were carried out between the month of June-October, 2011 and experimental procedures used followed the description of American Public Health Association (APHA) The results showed that Liver concentrated highest level of zinc, copper and lead (6.851±0.005 mg/Kg, 1.876±0.001mg/Kg and 0.143±0.001mg/Kg respectively). This was followed by sediments with mean values of (nickel = 0.400±0.001mg/Kg, chromium-=0.127±0.003mg/Kg, mn =0.092±0.001mg/Kg and cadmium= 0.076±0.003mg/Kg). Surface water equally concentrated some metals such as Manganese, cadmium and lead with mean values of 0.069±0.101Mg/L, 0.043±0.011Mg/L, 0.039±0.016Mg/L respectively.

The order of bioaccumulation in sediment are Zn >Cu>Ni>Cr>Pb>Mn>Cd while the order of bioaccumulation in liver was Zn>Cu>Ni>Pb>Cd>Mn>Cr Also the order of concentration in surface water was Mn>Zn>Cd>Pb>Ni>Cu>Cr

Metal concentration in the fish tissues (flesh, bones gills and guts) was low in concentration, but the values were still significant at 95 percent confidence limit (P< 0.05) with the exception of Manganese. This suggest that the water quality of Oke Afa canal system is adversely affected and impaired by the discharge of domestic, agricultural and industrial wastes.

Comparison of these values with FAO/WHO limits in fish tissue showed that it is safe to consume the fish species from Oke -Afa canal for now but may be unsafe due to possible bioaccumulation of the metals in the organs of man since humans are at the top of food chain.

Key Words: Heavy metal pollution, Bioaccumulation, Clarias gariepinus, Oke-Afa Canal, Chromium, Copper, Manganese, Zinc. Lead, Cadmium, Nickel

INTRODUCTION

Rivers all over the world have supported the growth of human civilization since the first towns appeared some 7000 years ago (Meybeck, 1996) but as a result of this growth and the diversification of activities, most of the world's rivers have been negatively affected. Human activity has profoundly affected rivers and streams in all parts of the world to such an extent that it is now extremely difficult to find any stream which has not been in some way altered and probably quite impossible to find any such river'. Historically, canal does not only serve sanitary purposes, the structure assisted in irrigating fields for farmers and gardeners and greatly boosted the growth of gardening in the community.

[1] Department of Zoology and Environmental Biology, Faculty of science, Lagos State University, Ojo, Lagos Nigeria
E-mail: Toyinaderinola@yahoo.com
[2] Department of Zoology and Environmental Biology, Faculty of science, Lagos State University, Ojo, Lagos Nigeria
[3] Department of Fisheries, Faculty of science, Lagos State University, Ojo, Lagos Nigeria

In Lagos Nigeria, the notable amongst the canals are located in Oke-Afa-Isolo, Mile 2, Alaka, Orile, Oyingbo, Apapa areas.To date, there has been no systematic monitoring of canal water quality in Lagos State to evaluate what type of remedial actions may be necessary for the canals. There are many different types of contaminants present in the environment. These range from synthetic chemicals to trace metals that are required for life. Concerns about these contaminants range from possible harmful effects on the ecosystem to possible harm to humans consuming contaminated organisms (Melancon, 1995). According to Adams (1990) organisms like fish are continuously challenged or stressed by the normal demands of the aquatic environment and may be exposed to sub-lethal levels of contaminants and to unfavorable environmental variables like temperatures, water velocities, sediment loads, dissolved oxygen concentrations, food availability and other variables. These factors can impose stress on physiological systems.

However, in recent years, there has been a remarkable population growth, accompanied by intense urbanization, an increase of industrial activities and a higher exploitation of cultivable land. These transformations have brought about a huge increase in the quantity of discharges and a wide diversification in the types of pollutants, including heavy metals that reach Oke Afa Canal waters and have undesirable effects on its environment. Surveying literatures showed that data on heavy metals in Oke Afa Canal waters are scanty (Olowo *et. al*, 2009)

Heavy metals are one of the serious pollutants in natural environment due to their toxicity, persistence and bioaccumulation problems (Pekey, 2006; Nouri *et al.*, 2006). The impact of anthropogenic perturbation is most strongly felt by estuarine and coastal environments adjacent to urban areas (Nouri *et al.*, 2008). Heavy metals from incoming tidal water and fresh water sources are rapidly removed from the water body and deposited onto the sediments (Tam and Wong, 2000; Samarghandi *et al.*, 2007). Over the last decades, the study of sediment cores has shown to be an excellent tool for establishing the effects of anthropogenic and natural processes on depositional environments. (Vinodhini and Narayanan, 2008; Nadia, 2009).because sediment analysis offers certain advantages over water analysis for the control and detection of metal pollution in estuaries (Forstner and Wittman, 1983; Luamo, 1990), although its metal concentrations can also fluctuate over time (Araujo *et al.*, 1988) .In the same vein, it was observed that the rate of change is well below that of the water (Boyden *et al.*, 1979). On the other hand, surface sediment often exchanges with suspended materials, thereby affecting the release of metals to the overlying water (Zvinowanda *et al.*, 2009). Therefore, the top few centimetres of the sediments reflect the continuously changing present-day degree of contamination, whereas the bottom sediments record its history.

Among animal species, fishes are the inhabitants that cannot escape from the detrimental effects of these pollutants (Olaifa *et al.*, 2004; Clarkson, 1998; Dickman and Leung, 1998). Fish are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death in the aquatic systems (Farkas *et al.*, 2002; Yousuf and El-Shahawi, 1999). The studies carried out on various fishes have shown that heavy metals may alter the physiological activities and biochemical parameters both in tissues and in blood (Canli, 1995; Tort and Torres, 1988; Basa and Rani, 2003). The organisms developed a protective defense against the deleterious effects of essential and inessential heavy metals and other xenobiotics that produce degenerative changes like oxidative stress in the body (Abou EL-Naga *et al.*, 2005; Filipovic and Raspor, 2003). *Clarias gariespinus* was selected due to its adoption in polluted aquatic environment. The purpose of this research is to quantify the concentration of heavy metals in Oke-Afa canal surface water, sediment and in organs to the amount accumulated in different organs of organs of *Clarias gariepinus.*

MATERIALS AND METHODS

Description of Sampling Site

Oke Afa canal is a 13.3 km stretch water body in Lagos Nigeria. It is on latitude of 6.45^{0}N and longitude 3.47^{0}E. Along the stretch of the canal are located the Isolo open dumpsite, Oke Afa Plank market, mechanic workshop and sand mining sites. This same canal also receives industrial

waste water from industrial areas of Fatai Atere, Ilupeju, Ogba and Ladipo industrial estate and also domestic waste from these areas , alongside the domestic area of Oshodi, Apakun, Shasha , Airport Road then liked to Mile 2 canals and finally to the Lagos harbour.
SAMPLING OF WATER, SOIL, AND FISH

Water

Samples were collected in 250ml glass bottle for chemical parameters. The bottles were pre-cleaned by washing with non-ionic detergents, rinsed in distilled water. Before sampling, the bottles were rinsed three times with sample water before being filled with the sample. The samplings were done midstream by dipping each sample bottle at approximately 20-30 cm below the water surface, projecting the mouth of the container against the flow direction. The samples were then transported in cooler boxes to the laboratory. In the laboratory, water samples were acidified with concentrated HCl and preserved in a refrigerator till analysis for Zn, Mn, Cu, Cd, Cr Ni and Pb.

Sediment

The bottom sediments at the sampling sites collected using ekman grab.
In the laboratory, the sediment samples were dried at 105 °C, grinding, sieving and about (10 gm) of the most fine dried grains were digested with a mixture of conc. H_2O_2, HCl and HNO_3 as the method described in Page *et al.* (1982) and preserved in a refrigerator till analysis.

FISH SAMPLES: Adult *Clarias gariepinus* were purchased from the Oke Afa from the fishermen fishing there using set nets. It was then preserved in a cooler with ice and then transported to the laboratory for further analysis.

Digestion of samples: The samples were digested in open 50ml beakers on a hot plate.10 grams of each organ (wet weight) were weighed out in an open beaker and 10 ml of freshly prepared 1:1 nitric acid – hydrogen peroxide added. The beaker was covered with a watch glass till initial reaction subsided in about 1 hour. The beaker was placed in a water bath on a hot plate and the temperature gradually allowed rising to 160°C and the content boiled gently for about 2 hours to reduce the volume to between 2 – 5 ml. The digests were allowed to cool and transferred to 25 ml volumetric flasks and made up to mark with de-ionized water (FAO/SIDA, 1993). The digests were kept in plastic bottles and later the heavy metal concentrations were determined using an atomic absorption spectrophotometer (AAS).

Statistical Analysis

The obtained data were subjected to descriptive statistical analysis (95 % confidence limit). The computation were achieved with the use of statistical package for social sciences (SPSS 17) to determine the mean, standard deviation, and standard error of mean values of metal concentration in the surface water, sediments and tissues of *Clarias gariepinus*

RESULTS

The results obtained for the analysis were as represented below. The result showed wide variability in the sediment, surface water and the different organs of *Clarias gariepinus* analysed

Lead

The results showed that the concentration of lead in the liver has the highest mean value compared to all other organs of *Clarias gariepinus* with the mean value of 0.143±0.001 mg/kg. Other organs such as gills, guts, bone and muscle have lower concentration of lead with mean values of 0.048±0.001mg/Kg, 0.037±0.001mg/Kg, 0.012±0.001mg/Kg, and 0.006±0.001mg/Kg respectively
In the sediment however, the concentration of lead was equally high with mean values of 0.095±0.001mg/Kg

In the surface water, the value recorded was 0.039±0.016 mg/L. This are represented in Table 1, Fig.1.The concentration values of this element in the fish has exceeded the allowable concentration of 0.0002 mg/kg (USEPA, 1987). Similarly, this concentration is significant at (P<0.05) confidence limit.

Chromium

Figure 2 showed that the sediment has the highest concentration of chromium with mean value of 0.0127±0.003 mg/kg; the surface water has the mean value 0.012±0.006 mg/l. The liver, gill and the gut has relatively low result with the following mean value 0.009±0.001 mg/kg, 0.004±0.001 mg/kg, and 0.03±0.001 mg/kg respectively. For the bone and muscle, they both have the same mean value of 0.001±0.000 respectively. However, the concentration was found to be significant at (P<0.05) confidence limit.

Cadmium

The level of cadmium analyzed in sediment has a high mean value of 0.076±0.003 mg/kg and surface water with mean value0.043±0.011 mg/l. However the mean value of liver is 0.061±0.001 mg/kg which is also high. The gut and the gill have the following mean value 0.014±0.001 mg/kg and 0.010±0.000 mg/kg. The bone has the lowest mean value which is 0.002±0.001 mg/kg. The ANOVA result showed that the concentration was significant at (P<0.05) confidence limit.

Manganese

In fig 4, the level of manganese in the sediment had the highest mean manganese value compared with water and fish. The mean values of 0.092±0.001 mg/kg next to the surface water with value of 0.069±0.101 mg/l. The liver has 0.024±0.001 mg/kg, 0.009±0
.001 mg/kg in the gut, 0.007±0.001 mg/kg in the gill, the bone has the mean value of 0.005±0.000 mg/kg. The muscle has the lowest mean value of 0.004±0.001 mg/kg.
Analysis of variance indicated that, values were not significant at (P>0.05) confidence limit.

Nickel

Fig 5 showed that nickel was more concentrated in the sediment compared with water and tissue .The concentration of nickel in the sediment has the mean value of 0.400±0.001 mg/kg. However the surface water has the mean value of 0.033±0.013 mg/l.In the organs of the fish, liver,gut, gill, bone and flesh had the following mean values of 0.157±0.001 mg/kg,0.020±0.001mg/kg,0.016±0.001 mg/kg, 0.008±0.001 mg/kg and 0.006±0.001 mg/kg respectively. However, the concentration were found to be significant at (P<0.05) confidence limit.

Copper

The mean concentration of copper was established in fig.6. The highest values were found in the liver with 1.876±0.001mg/kg , the gut has 0.792±0.021 mg/kg, bone, flesh are relatively low with mean value of 0.184±0.115 mg/kg and 0.107±0.000 mg/kg. The level of copper in the sediment is high with mean value of 1.573±0.003 mg/kg, the concentration of copper in the surface water 0.029±0.010mg/L. The concentration was found to be significant at (P<0.05) confidence limit.

Zinc

Fig 7 showed that the level of zinc in the liver was of very high with the mean value of 6.851±0.005 mg/kg .However the gut, gill, bone and flesh mean valueswere 2.884±0.001 mg/kg, 0.568±0.288 mg/kg, 0.515±0.001 mg/kg and 0.387±0.001 mg/kg respectively. The concentration of zinc in the sediment has the mean value of 4.415±0.013 mg/kg which is also high. The water has the lowest mean value of 0.068±0.020 mg/l.
However, the concentration were found to be significant at (P<0.05) confidence limit.

CHAPTER FIVE DISCUSSION

The concentration of the trace metals determined in the sediments surface water and organs of *Clarias gariespinus* from Oke Afa canal were as indicated in Tables 1 and Fig. 1-7. zinc, nickel, lead, manganese, cadmium, chromium and copper were detected in the samples analyzed with sediments having the highest concentrations. The high content of nickel, chromium, manganese and cadmium were found in the sediment (Nickel = 0.400±0.001Mg/Kg, Chromium = 0.127±0.003Mg/Kg, Mn =0.092±0.001Mg/Kg and Cadmium= 0.076±0.003Mg/Kg) respectively may be because of the nature of the bottom sediment which was found to be clayey or muddy material that forms the canal bed in the area sampled. This may explain the high concentration recorded in the fish liver. The fish, being carnivores may have taken the lead from polluted bed material along with food which is in an agreement with previous report(Adeniyi *et al* 2007).

Not only that, the disposal of industrial liquid waste, dischargingof agricultural drainage as well as sewage effluent from industries around the area could be responsible for the high levels of heavy metals in Oke Afa canal. This opinion was equally shared by Abdel Sabour, (1998) ,Adefemi*et. al*2008. In view of this, sedimentation has long been recognized as the principal process in the removal of heavy metals from the water not only in natural wetlands, but also in constructed ones (Walker and Hurl, 2002).

Furthermore, the value of lead in sediment (0.095±0.009mg/kg (Fig 1) was higher than the value obtained in water; the value is still within the acceptable limitof CEQG, 2003 standard of 350mg/kg. The reason for high concentration of lead in sediment could be adduced to the fact that many of these are rapidly removed from waters into the underlying sediments. Sediment quality is a good indicator of pollution in water column, where it tends to concentrate the heavy metals and other organic pollutants. The highest pb concentrations in sediment samples obtained from this study is an indication of leakage of oil, grease and anti-fouling paints which are serious pollution sources for Pb, Also the printing byproduct wastes contain high levels of Pb which appeared at the sites. This is corroborated by the findings of Mourad, (1996); ETPS, (1995). Consequently, in the event of pollution in an aquatic ecosystem, sediments are known to habour more of the contaminants (Aderinola, *et.al*, 2009, Adeniyi *et al.*, 2008; Yusuf and Osibanjo, 2006; Monteiro and Roychoudhury, 2005; Awofolu et al., 2005; Ikem *et al.*, 2003).

The heavy metals such as chromium (Cr), cadmium (Cd) Copper (Cu) lead (Pb) nickel (Ni), manganese (Mn) were analyzed in different organs like gills, liver, bone and flesh of *Clarias gariepinus* .The liver accumulates relatively higher amounts of zinc, copper and lead0.851±0.005 Mg/Kg, 1.876±0.001Mg/Kg and 0.143±0.001Mg/Kg respectively. The liver has the concentration of lead with mean value 0.143±0.001mg/kg which is very high compared to other organs such as gills, gut, bone and flesh. The concentration of lead in the environment was found to be significant at ($P<0.05$) confidence limit. The high concentration of zinc, copper and lead found in the fish could Suggest that their uptake was probably through food which agrees with the opinion of Enk and Mathis (1977) and Fortner and Wittmann (1981) that the bio-availability and nature of food items, affect metals bioaccumulation in fish. *Clarias gariepinus is* a known carnivorous predator, which feeds on small fish such as *Tilapia zillii*,and other smaller fishes(Reed *et al*, 1967) and mollusks (Idodo-Umeh, 2000) and therefore forms an important link in the food web of aquatic ecosystems in the locality. Fish has been reported to accumulate metals from water by diffusion via skin and gills as well as oral consumption (Nussey et al, 2000; Oguzie, 2003).

The gills concentrated high values of 0.048±0.001mg/Kg, 0.010±0.000 mg/Kg and 0.392±0.035 mg/Kg for Pb, Cd and Cu respectively. The concentration of this metal element were found to be significant at ($P<0.05$) confidence limit .The allowable limit of cadmium in fish is 2.000 according to WHO, (1985).

Jennings, *et. al.*, (1996) reported in his findings that death or permanent damage to the central nervous system, the brain, and kidneys could occur with increase in concentration of lead in the environment. Gbem, *et. al*, 2001reported that liver and kidney are also known to accumulate high amounts of metals The higher accumulation in liver may alter the levels ofvarious biochemical parameters in liver. This may alsocause severe liver damage (Ferguson, 1989; Mayersand Hendricks, 1984) Surface water concentrated high values for some metals such as Manganese, cadmium and lead with mean values of 0.069±0.101Mg/L, 0.043±0.011Mg/L, 0.039±0.016Mg/L respectively. The result obtained showed that, the trace metal concentrations in water exceeded the WHO standard (World. Health Organisation, 1992). The concentration of metal in lead and cadmium were found to be significant at ($P<0.05$) confidence limit, but manganese was not significant.

These findings imply that consumption of the polluted water by animals or human beings could be hazardous to their health.The resultant increased in metal concentrations can be toxic to fish and render the water unsuitable for other uses. Monitoring and reducing human actions will help keep Oke Afa canal safe.

CONCLUSSION

Metals (copper, lead, cadmium, zinc,chromium,nickel and zinc determined in the Oke Afa canal water , sediment and fish samples were found at elevated levels. This gives cause for concern. The socio- economic activities around the canal catchment are the probable sources of these contaminants. Elevated levels of metals in water have been implicated as risk to human health and the "health" of the aquatic system. The continuous monitoring of metal pollution of the canal system is essential. Activities that predict point source and diffuse contamination should be discouraged by the appropriate governmental agencies.

REFERENCES

Abel, P.D. (1989). Water Pollution Biology.Ellis Horwood Publishers, Chicher. 231pp.

Abou EL-Naga, E. H.; EL-Moselhy, K. M.; Hamed, M. A., (2005) Toxicity of cadmium and copper and their effect on some biochemical parameters of marine fish Mugil seheliEgyptian. J. Aquat. Res., Vol.31, No.2, pp.60-71

Adami, G. M.; Barbieri, P.; Fabiani, M.; Piselli, S.; Predonzani, S.; Reisenhofer, E., (2002). Levels of cadmium and zinc in hepatopancreas of reared Mytilus galloprovincialis from the Gulf of Trieste (Italy). Chemosphere, Vol.48, No.7, pp.671 – 677.

Adams, S.H. (1990) Status and Use of Biological Indicators for Evaluating the Effects of Stress on Fish. In: Biological Indicators of Stress in Fish. (Edited by S. M. Adams), American Fisheries Symposium 8: 1 - 8, Bethesday, Maryland.

Adeniyi AA, Yusuf KA, Okedeyi OO (2008) Assessment of the exposure of two fish species to metals pollution in the Ogun rivercatchments, Ketu, Lagos, Nigeria. Environ. Monit.Assess., Vol.137, pp.451- 458

Aucoin, J.; Blanchand, R.; Billiot, C., (1999) Trace metals in fish and sediments from lake Boeuf, South Eastern Louisiana. Micro. Chem. J., Vol.62, No.2, pp.299-307

Awofolu OR, Mbolekwa Z, Mtshemla V, Fatoki OS (2005) Levels of trace metals in water and sediments from Tyume river and its effectson an irrigated farmland. Water SA., Vol.31, pp.87-94.

Basa, Siraj, P.; Usha Rani, A., (2003). Cadmium induced antioxidant defense mechanism in freshwater teleost Oreochromis mossambicus (Tilapia). Eco.Toxicol.Environ.Saf., Vol.56, No.2, pp.218 – 221.

Boyden, C. R.; Aston, S. R.; Thornton, I., (1979) Tidal and seasonal variation of trace elements in two Cornish estuaries.Estuarine Coast Mar. Sci., Vol.9, No.3, pp.303-317 (15 pages).

Brown, V., Shurben, D., Miller, W. and Crane, M. (1994). Cadmium toxicity to rainbow trout Nocorhynchus mykiss Walbaum and brown trout Salmo trutta L. over extended exposure periods.Ecotoxicity and Environmental Safety. Vol.29, pp.34-46.

Canli, M., (1995). Natural occurrence of metallothionein like proteins in the hepatopancreas of the Norway lobster Nephrops Norvegicus and effects of Cd, Cu, and Zn exposures on levels of the metal bound on metallothionein. Turk. J. Zool., Vol.19, pp.313-321.

Clarkson, T. W., (1998). Human toxicology of mercury. J.Trace. Elem. Exp. Med., Vol.11, No.2-3, pp.303-317.

Dickman, M. D.; Leung, K. M., (1998) Mercury and organo chlorine exposure from fish consumption in Hong Kong. Chemosphere, Vol, 37, No.5, pp.991-1015.

Enk, M .D and Mathis, B. J. (1977) Distribution of Cadmium and Lead in a Stream Ecosystem. *Hydrobiologia*, Vol. 52, pp.153 – 158.

ETPS, (1995): Environmental testing of pollution status in Lake Temsah, Abu-Attwa water environment on fisheries resources, The Environmentalist, Vol.23, No.4, pp.297-306.

F.E.P.A.(Federal Environmental Protection Agency). (2003); Guidelines and Standards for Environmental Pollution Control in Nigeria. 238pp.

FAO/SIDA (1983) Manual of Methods in Aquatic Environmental Research, part 9. Analyses of metals and organochlorines in fish . FAO fisheries Technical Paper, 212. Federal Environmental

Farkas, A., Salanki, J.; Specziar, A., (2002) Relation between growth and the heavy metal concentration in organs of bream Abramis brama L. populating lake Balaton. Arch. Environ. Contam.Toxicol., Vol.43, No.2, pp.236-243.

Ferguson, H. W., (1989). Systematic pathology of fish. Ames.: Iowa State University, Press.

Filipovic, V.; Raspor, B., (2003) Metallothionein and metal levels in cytosol of liver, kidney and brain in relation to growth parameters of Mullus surmuletus and Liza aurata.From the eastern Adriatic Sea. Water Res., Vol.37, No.13, pp.3253-3262.

Forstner, U. and Wittmann, G. T. W. (1981) Metal pollution in the Aquatic Environment. Springer-Verlag. Berlin, Heideberg New York. 486pp

Förstner, U.; Wittman, G. T. W., (1983) Metal Pollution in the Aquatic Environment. Springer Heidelberg., 486.

Gbem T.T, Balogun J.K, Lawal F.A, Annune P.A.(2001). Trace metal accumulation in Clarias gariepinus (Teugels) exposed to sublethal levels of tannery effluent. *Sci Total Environ. Vol.*23, No.271(1-3), pp.1-9.

Hynes, H.B.N. (1970). The ecology of running waters, Liverpool University Press

Idodo-Umeh, G. (2000) Freshwater fishes of Nigeria (Taxonomy, Ecological Notes, Diet and Utilization). Idodo-Umeh Publishers, Benin City, Nigeria.

Ikem A, Egiebor NO, Nyavor K (2003) Trace elements in water, fish and sediment from Tuskegee Lake, South eastern U.S.A. Water, AirSoil Poll., Vol.149, pp.51-75.

International Symposium on Restoration of Lakes and Wetlands: Proceedings of Lake 2000,

Jennings G.D and Sneed R.E (1996). Nitrate in drinking water, North Carolina Cooperative Extension Service, Publication Number: AG pp. 473-474.

Lee, H.S., Hwang, P.P. and Lin, H.C. (1996) Morphological changes of integumental chloride cells to ambient cadmium during the early development of the telecast, Oreochromis mossambicus. Environ. Boil. Of Fishes. Vol.45, pp.95-102.

Luoma, S. N.; (1990). Processes affecting metal concentrations in estuarine and coastal marine sediments. Heavy metal in the marine Environment., CRC press., Boca Raton, FL, pp.51-66.

Mayers, T. R.; Hendricks, J. D., (1984) Histopathology. In GM Rand, S.R. Petrocelli, Eds. Fundamental of aquatic

Melancon, M.J. (1995) Bioindicators Used in Aquatic and Terrestrial Monitoring. In: Handbook of Ecotoxicology. (Eds. D.J. Hoffman, B.A. Rattner, G.A. BuKirkhan. M. B. 1983., Jr. and J. Cairns, Jr.), Lewis Publishers, London, pp. 220 – 240.

Meybeck, M. (1996) River water quality: Global ranges, time and space variabilities, proposal for some redefinitions, Internationale Vereinigung fur theoretische und angewandte Limnologie, Vol.26, pp.81-96

Mourad, F.A. (1996) M. Sc. thesis. National Institute of Oceanography and Fisheries (NIOF) Suez

Nadia, B. E.; Badr Anwar, A.; El-Fiky Alaa R.; Mostafa, Bandr A.; Al-Mur., (2009) Metal pollution records in core sediments of some Red Sea coastal areas, Kingdom of SaudiArabia. Environ. Monit.Assess., Vol.155, No.1-4, pp.509-526 **(18 pages)**.

Nouri, J.; Karbassi, A. R.; Mirkia, S., (2008) Environmental management of coastal regions in the Caspian Sea. Int. J.Environ. Sci. Tech., Vol.5, No.1, pp.43-52

Nouri, J.; Mahvi, A. H.; Babaei, A.; Ahmadpour, E., (2006) Regional pattern distribution of groundwater fluoride in the Shush aquifer of Khuzestan County IranFluoride. Fluoride., Vol.39, No.4, pp.321-325

O.J. Aderinola, E.O. Clarke, O.M. Olarinmoye, V. Kusemiju and M.A. Anatekhai, (2009) Heavy Metals in Surface Water, Sediments, Fish and Perwinklesof Lagos Lagoon. J. Agric. & Environ. Sci., Vol.5, No.5, pp.609-617.

Olaifa, F. G.; Olaifa, A. K.; Onwude, T. E., (2004) Lethal and sublethal effects of copper to the African Cat fish (Clarias gariepnus). Afr. J. Biomed. Res., Vol.7, pp.65-70.

Pekey, H., (2006) Heavy metal pollution assessment in sediments of Izmit Bay, Turkey. Environ. Monitor. Assess.,Vol.123, No.1-3, pp.219-231

Rehwoldt, R. and Karimian-Teherani, D. (1976) Uptake and effect of cadmium on zebrafish.Bulletin of Environmental Contamination & Toxicology. Vol.15, No.4, pp.442-446.

Samarghandi, M. R.; Nouri, J.; Mesdaghinia, A. R.; Mahvi, A.H.; Naseri, S.; Vaezi, F., (2007) Efficiency removal of phenol, lead and cadmium by means of UV/TiO2/H2O2processes. Int. J. Environ. Sci. Tech., Vol.4, No.1, pp.10-25

Sudhira H.S. and Kumar V.S. (2000) Monitoring of lake water quality in Mysore City. In:

Tam, N. F. Y.; Wong, Y. S., (2000) Spatial variation of heavy metals in surface sediments of Hong Kong mangrove swamps.Environ.Pollut., Vol.110, No.2, pp.195-205

Tort, L.; Torres, P., (1988) The effects of sub lethal concentration of cadmium on hematological parameters in the dog fish, Scyliorhinus Caniccula. J. Fish. Biol., Vol.32, No.2, pp.277-282.

TYLER G (1972) Heavy metals pollute nature, may reduce productivity. *Ambio Vol.***1**, No.2, pp.52-59.

Vinodhini, R.; Narayanan, M., (2008) Bioaccumulation of heavy metals in organs of fresh water fish Cyprinus carpio (Common carp). Int. J. Environ. Sci. Tech., Vol.5, No.2, pp.179-182

Walker, D.J.; Hurl, S. (2008) The reduction of heavy metals in a storm water wetland.Ecological Engineering, v. 18, p. 407-414, 2002.Adefemi S O, Asaolu S S and Olaofe O, *Res J Environ Sci.*, Vol.2, No.2, pp.151-155.

Waqar, A., (2006) Levels of selected heavy metals in Tuna fish.Arab. J. Sci. Eng., Vol.31, No.1A, pp.89–92.

WHO (World Health Organization) (1985) Guidelines for drinking water quality.Vol. 1. Recommendations, W.H.O. Geneva. 130pp.

Yong, R.N.; Mohamed, A.M.O. and Warkentin, B.P. (1992) Principles of contaminant transport in soils. Developments in Geotechnical Engineering, 73.Elservier Science Publishers B.V Amsterdam.The Netherlands 327pp.

Yousuf, M. H. A.; El-Shahawi., (1999) Trace metals in Lethrinuslentjan fish from Arabian Gulf: Metal accumulation in Kidney and Heart Tissues. Bull. Environ. Contam.Toxicol., Vol.62, No.3, pp.293-300.

Yusuf KA, Osibanjo O (2006) Trace metals in water and sediments from Ologe lagoon, southwestern Nigeria. Pak. J. Sci. Ind. Res., Vol.49, pp.88-89.

Zvinowanda, C. M.; Okonkwo, J. O.; Shabalala, P. N.; Agyei, N.M., (2009) A novel adsorbent for heavy metal remediation in aqueous environments. Int. J. Environ. Sci. Tech. Vol.6, No.3, pp.425-434

Table-1: Mean values of heavy concentration in surface water, sediments and organs of Clarias gariepinus from Oke Afa Canal

	Lead (pb) (mg/kg)	Chromium (mg/kg)	Cadmium (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Copper (mg/kg)	Zinc (mg/kg)
Liver	0.143±0.001	0.009±0.001	0.061±0.001	0.024±0.001	0.151±0.001	1.876±0.001	6.851±0.005
Gut	0.037±0.001	0.003±0.001	0.014±0.001	0.009±0.001	0.020±0.001	0.792±0.021	2.884±0.001
Gill	0.048±0.001	0.004±0.001	0.010±0.000	0.007±0.001	0.016±0.001	0.392±0.035	0.568±0.288
Bone	0.012±0.001	0.001±0.000	0.002±0.001	0.005±0.000	0.006±0.001	0.184±0.115	0.515±0.001
Flesh	0.006±0.001	0.001±0.000	0.007±0.001	0.004±0.001	0.008±0.001	0.107±0.000	0.387±0.001
Sediment	0.095±0.001	0.127±0.003	0.076±0.003	0.092±0.001	0.400±0.001	1.573±0.003	4.475±0.013
Water	0.039±0.016	0.012±0.006	0.043±0.011	0.069±0.101	0.033±0.013	0.029±0.010	0.068±0.020
Total	0.054±0.046	0.022±0.043	0.031±0.028	0.032±0.051	0.088±0.136	0.677±0.704	2.157±2.454

Fig-1. Mean values of lead concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

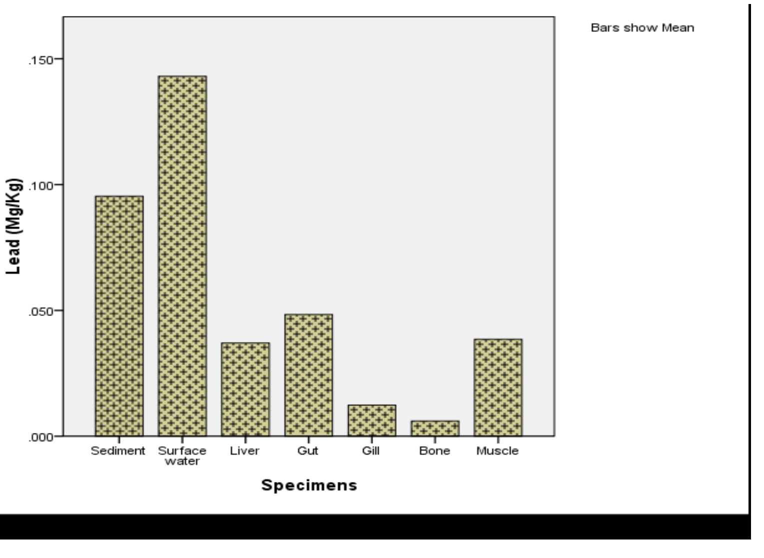

Fig-2. Mean values ofChromium concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

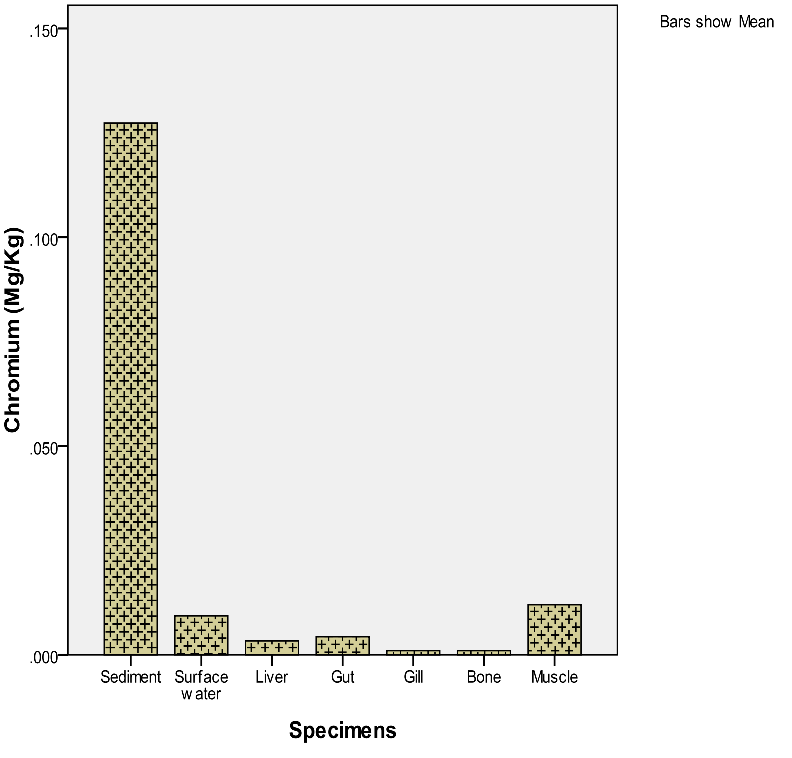

Fig-3. Mean values of Cadmium concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

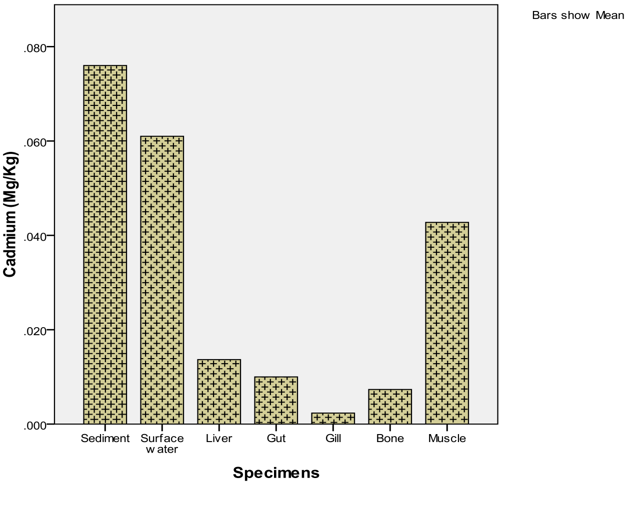

Fig-4. Mean values of Manganese concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

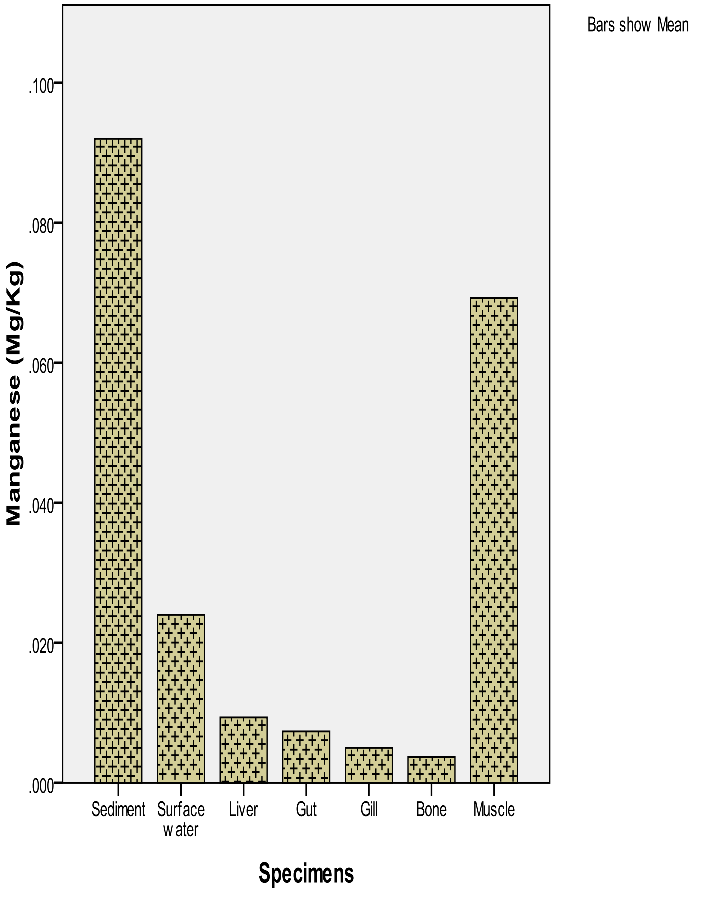

Fig-5. Mean values of Nickel concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

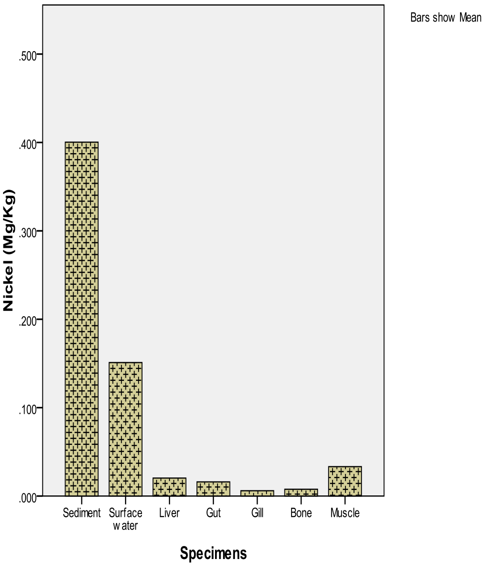

Fig-6. Mean values of Copper concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal

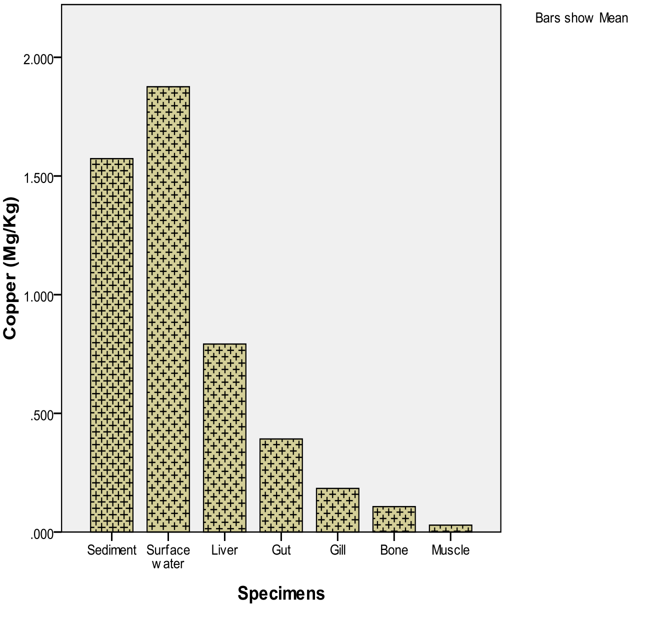

Fig-7. Mean values of Zinc concentration in surface water, sediments and organs of *Clarias gariepinus* from Oke Afa Canal metals and organochlorines in fish . FAO fisheries Technical Paper, 212. Federal Environmental