PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 9 (1): 81-85, 2010
ISSN 1680-5194

Assessment of Trace Metal Composition in Fish Samples from Nworie River

I.J. Alinnor and I.A. Obiji
Department of Pure and Industrial Chemistry, Federal University of Technology,
P.M.B. 1526, Owerri, Imo State, Nigeria

Abstract: This investigation surveyed heavy metal content of fish samples from Nworie river. The elements studied were Pb, Fe, Cd, Mn, Hg, Cu and Zn. The fish samples were collected from different locations in the river. The fish samples were analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS). The elemental toxicants Fe, Cd, Mn were identified in fresh fish specie *Tilapia guineensis* of mean values 3.275, 0.048 and 0.103 ppm, respectively, whereas Pb was below detection level. The analysis also shows Cu and Zn level of mean values 1.247 ppm and 3.241 ppm in *Tilapia guineensis* respectively. Also Hg was below detection level in *Tilapia guineensis*. The analysis of frozen fish samples purchased from Ekeonunwa market located 3 km from the river shows Pb, Fe and Cd levels of mean values 0.50, 4.73 and 0.05 ppm respectively. Also frozen fish analysis shows concentration of Mn, Hg, Cu and Zn of mean values 11.82, 0.0083, 8.00 and 1.02 ppm, respectively. There are three institutions that discharge untreated waste products into Nworie river. In view of this, there is need to determine the level of contamination of the river, since the inhabitants depend on the river for fishing and other domestic uses. This study is aimed at determining the level of heavy metal contaminants in fish samples from Nworie river. The effects of these elemental toxicants and the associated health hazards were examined.

Key words: Associated health hazards, heavy metals, fish samples, Nworie river

INTRODUCTION

Contamination of rivers, water bodies and aquatic animals by heavy metals have been a global problem especially in developing countries such as Nigeria. The rate of industrialization has affected the level of pollution of rivers and aquatic animals. This may be attributed to discharge of untreated waste products into the river and water bodies. Nworie river flows in Owerri the Imo State of Nigeria. It flows through the Federal Medical Centre, (FMC), Owerri; Alvan Ikoku Federal College of Education (AIFCE), Owerri and Holy Ghost College, Owerri. All these institutions discharge their untreated waste into Nworie river. The river acts as a source of drinking water, fishing and other domestic uses for the inhabitants. In view of the activities of these institutions, which discharge their untreated waste products into the river, it is necessary to investigate the level of contamination of fish in the river, since the inhabitants carry out fishing activity in the river for protein requirement.

Fishes are major sources of protein. They constitute major components of most aquatic habitats and they act as bio-indicator of heavy metal levels in aquatic environment. They have been recognized as good bio-accumulators of organic and inorganic pollutants (King and Jonathan, 2003). Heavy metals gain access into the aquatic environment from natural and anthropogenic sources and distributed in the water bodies, suspended solids and sediments during the course of their transportation (Olajire and Imeokparia, 2000). Reports have shown that heavy metal pollution of ecosystems is more in sediments and aquatic animals than in elevated concentrations in water (Luinnik and Zubenko, 2000). Elemental toxicants could enter fish either directly through the digestive tract due to consumption of contaminated water and food or non-dietary routes across permeable membranes such as gills (Burger *et al*., 2002).

Obodo (2004) working on Anambra river in Nigeria reported heavy metal contamination of fish samples such as Pb, Cu, Zn, Mn and Fe. These heavy metals may be ingested directly by eating the fish contaminated with elemental toxicants. Different fish samples from Kaduna river in Nigeria have been analyzed for toxic elemental contaminants such as Hg, Cd, Ph, V, Zn and Fe were identified in appreciable amount in all the fish samples studied (Nwaedozie, 1998). These contaminants cause unhealthy effects to the fish and this may be transferred to man by eating the fish that is contaminated. Odoemelam (2005) reported accumulation of heavy metals such as Ni, Cu, Mn, Pb, Zn, Fe, Hg, Cr, V and Cd in fish samples from Oguta lake in Nigeria. Some of the detrimental effects attributed to heavy metal-ingestion include mercury poisoning in fish sample in the Minamata Bay (Irukayama, 1964).

MATERIALS AND METHODS

Collection of fish samples: The fresh fish samples were collected from the river as shown in Fig. 1. Only fresh fish Tilapia species (*Tilapia guineensis*) were found in the river. The frozen fish Scale mullet (*Liza*

Corresponding Author: I.J. Alinnor, Department of Pure and Industrial Chemistry, Federal University of Technology, P.M.B. 1526, Owerri, Imo State, Nigeria

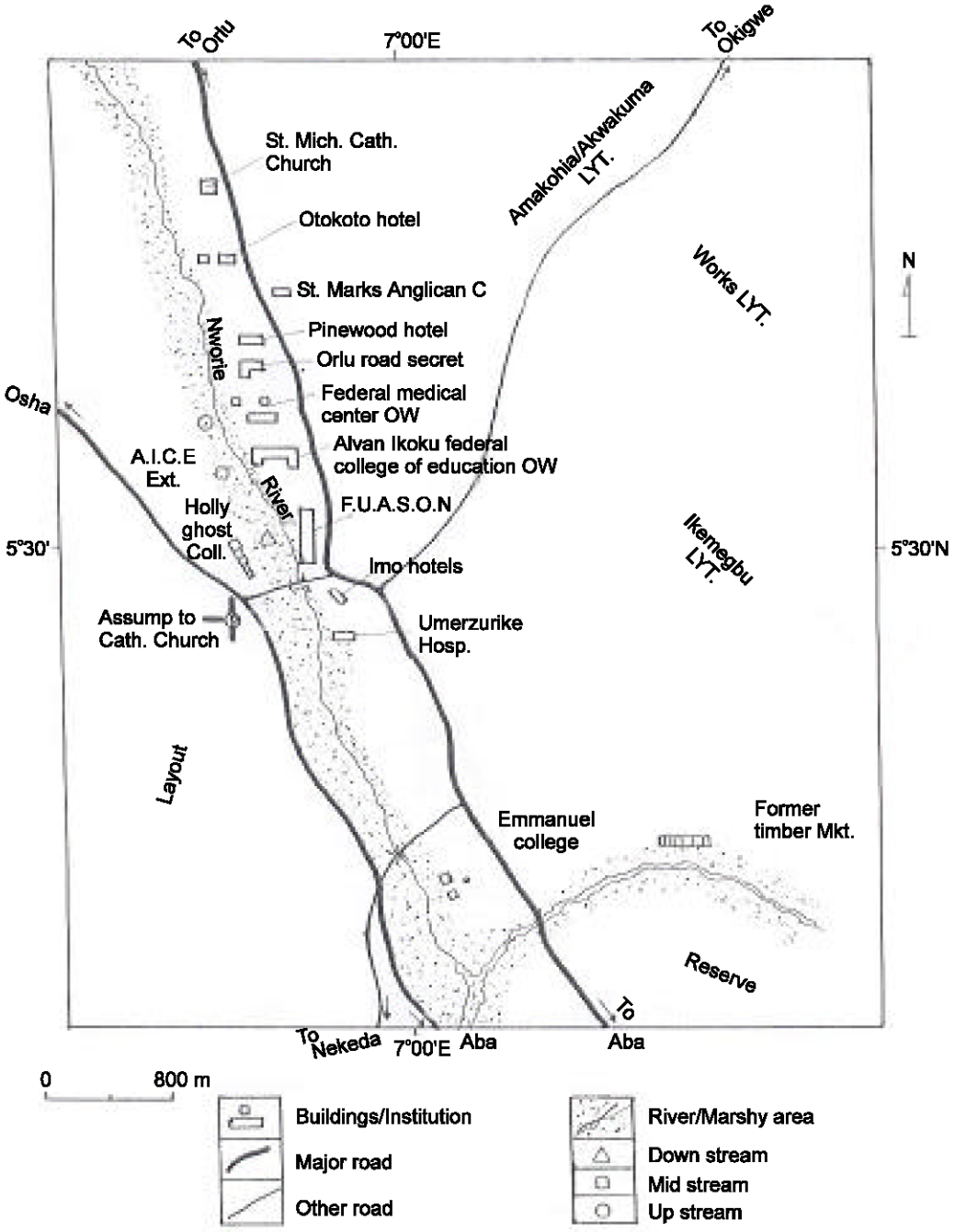

Fig. 1: Location map of the study area

grandisaquamis), Sole (*Synaptura insitanica*) and Barracuda (*Sphyraena sphyraena*) were purchased from Ekeonunwa market 3 km from the river. The fish samples were collected from the bank of the river during the wet season of the year precisely between July and August. Three samples of fish were collected with locally made wire net of 2.5 mm diameter. The samples were stored below 4°C in a refrigerator until use.

Analysis of fish samples: The fish samples were dried in an electric oven at 70-80°C for 3 days. The fish samples were ground and 2 g homogenized samples were weighed in an analytical balance and ashed in a furnace at 550°C. The samples were digested in a flask with 10 ml each of concentrated HNO_3 and HCl for 2-3 h in a fume cupboard until brown fumes ceases to evolve (Cappon, 1987).

The digested samples were filtered through a whatman GFK glass filter and solution made up to 100 ml mark with deionized water and kept ready for Atomic Absorption Spectrophotometer (AAS) analysis. The digested samples were analyzed using Unicam 919 AAS according to the technique as described by (Frank *et al*., 1992). All chemicals used were of analytical reagent grade.

RESULTS AND DISCUSSION

Table 1 shows the levels of heavy metal contamination in fish samples obtained from Nworie river and frozen fish samples sold at Ekeonunwa market about 3 km from the river. Results of the analysis shows that Pb concentration in *Tilapia guineensis* found in the river were below detection level, whereas Pb level in frozen *Liza grandisaquamis* and *Synaptura insitanica* were of mean values 0.3125 ppm and 0.8215 ppm, respectively. The frozen Barracuda fish has the highest accumulation of Pb concentration of mean value 0.50 ppm. Odoemelam (2005) working on Oguta lake reported Pb concentration of mean value 10.90 ppm in *Alestes nurse*. Nwaedozie (1998) working on Kaduna river reported Pb concentration of mean value 0.94 ppm in *Labeo cabic*. The Australian National Health and Medical Research Council (ANHMRC) standard (Bebbinton *et al*., 1997) for Pb in seafood is 2.00 ppm. This study shows that Oguta lake is contaminated with Pb, whereas Nworie river is not contaminated with Pb when compared to ANHMRC standard. The high accumulation of Pb in fish samples from Oguta lake and Kaduna river may be attributed to wastes being discharged into the lake and waste from Kaduna refinery being discharge into kaduna river. However, fish samples purchased from Ekeonunwa market were contaminated with Pb. These frozen fishes being a common source of protein for the inhabitants poses health hazards. Pb is a well-known toxicant and it has deleterious effect even at low concentration on human being. It reduces neuro-psychological function leading to intelligence quotient deficiency and also it leads to reduction in nerve conduction (Waldboh, 1978).

The result of the analysis shows that Fe level in frozen fish were higher than the fresh fish. Barracuda has the highest concentration of Fe of mean value 4.73 ppm. Whereas Sole fish and Scale mullet have Fe level of mean values 3.50 ppm and 4.25 ppm, respectively. Fresh *Tilapia guineensis* has the least concentration of Fe of mean valued 3.275 ppm. Alinnor (2005a) working on Aba river reported Fe concentration of mean value 9.419 ppm in *Hetretis niloticus*. Oboh and Edema (2007) have reported Fe concentration of mean value 2.447 ppm in *Citharinus citharus* from River Niger. This study shows that fish samples from Aba river is contaminated with Fe when compared to values obtained from Nworie river and River Niger. High concentration of Fe found in fish samples from Aba river may be attributed to industries that manufacture soaps, glasses, beverages and breweries that discharge their untreated wastes into Aba river. Iron is one of the essential components of haemoglobin, which is responsible for the transportation of oxygen in the body. Studies have shown that fish generally concentrate metallic iron in their body organism directly or indirectly through ingested food (Vinikour and Goldstein, 1987; Kakulu *et al*., 1980).

Table 1 shows the level of Cd in *Tilapia guineensis* and *Synaptura insitanica*. The concentrations of the two species of fish were similar of mean values 0.048 ppm and 0.05 ppm for *Tilapia guineensis* and *Synatpura insitanica* respectively. Whereas *Liza grandisaquamis* and *Sphyraena sphyraena* have Cd level of mean values 0.042 ppm and 0.019 ppm, respectively. Abdulrahman and Tsafe (2004) working on Sokoto Rima river in Nigeria reported Cd concentration of mean value 0.013 ppm in *Synodontis clarias*. Also (Ibok *et al*., 1989) working on streams in Ikot Ekpene area of Nigeria reported Cd level of mean value 0.45 ppm in A. *fasciatus*. The ANHMRC acceptable level for Cd in seafood is 2.0 ppm. The result of this study indicate that Cd in fish samples from Nworie river, Sokoto Rima river and Ikot Ekpene streams were below ANHMRC standard, but long period of accumulation of Cd in fish poses health hazards. Cadmiam shows no indication of being an essential element in biological processes, instead it is toxic. It causes slight anaemia due to competition between Fe and Cd in the body resulting to iron deficiency (Lauwerys, 1979).

This study identified low concentration of Mn in fresh Tilapia fish of mean value 0.103 ppm, whereas the frozen fish samples have Mn concentration of mean values 9.99, 11.82 and 9.00 ppm for Scale mullet, Soles fish and Barracuda fishes, respectively. Alinnor (2005b) working on Aba river reported Mn concentration of mean value 0.861 ppm in Oriochronis niloticus, whereas (Obodo, 2001) identified Mn concentration of mean value 0.081 ppm in fresh fish obtained from River Niger. This study revealed that Aba river is contaminated with Mn when compared to values obtained from Nworie river and River Niger because of industries that discharge their untreated wastes into Aba river. Manganese in trace amount is an essential element. Eating fish contaminated with Mn can result in manganese poisoning. Mn poisoning results in chronic manganism, which is the disease of the central nervous system and this can be transferred to man on consumption of fish contaminated with Mn. One of the first toxic effects of Mn is its interference with iron metabolism, specifically haemoglobin formation.

Mercury concentration in *Liza grandisaquamis* and *Sphyraena sphyraena* were of mean values 0.0083 ppm and 0.0083 ppm respectively. Hg was below detection level in fresh Tilapia fish and frozen Soles fish. Nwaedozie (1998) working on kaduna river reported Hg

Table 1: Concentration (ppm) of some heavy metals in fish Samples from Nworie River

Name of fish	English Name	Nature	Fish Sample	Pb	Fe	Cd	Mn	Hg	Cu	Zn
Tilapia guineensis	Tilapia		A	Nd	3.285	0.048	0.101	Nd	1.174	3.401
		Fresh	B	Nd	3.175	0.034	0.105	Nd	1.262	2.910
			C	Nd	3.365	0.061	0.103	Nd	1.302	3.412
Liza grandis aquamis	Scale Mullet		D	0.2904	4.01	0.031	9.86	0.0071	5.20	0.46
		Frozen	E	0.2957	4.34	0.058	10.37	0.0092	4.86	0.41
			F	0.3515	4.39	0.037	9.75	0.0086	5.55	0.58
Synaptura Insitanica	Soles		M	0.2814	3.10	0.041	11.63	Nd	4.50	0.73
		Frozen	N	0.3041	3.82	0.062	10.92	Nd	3.95	0.80
			P	0.3520	3.58	0.047	12.90	Nd	5.95	0.75
Sphyraena Sphyaena	Barracuda		R	0.45	4.76	0.017	8.50	0.0078	8.46	1.05
		Frozen	S	0.58	4.68	0.021	9.50	0.0096	7.31	1.01
			T	0.52	4.74	0.019	9.00	0.0074	8.23	0.99

Nd = Non-detectable (below detection level)

level of mean value 0.32 ppm in *Lates niloticus*. Odoemelam (2005) has shown that Hg level in *Synodontis nigritis* from Oguta lake was of mean value 0.08 ppm. The ANHMRC standard for Hg in seafood is 0.50 ppm. The result indicate that Hg level in Nworie river is below ANHMRC permissible limit. The high concentration of Hg in fish samples from Kaduna river may be due to textile industries, refineries, breweries and automobiles that discharge their untreated waste products into the river. This study also shows that two species of fish purchased from Ekeonunwa market were contaminated with mercury. In view of this, the inhabitants that buy fish from the market may be accumulating mercury in their body through the consumption of fish purchased from the Market. Mercury is not required in the body even in trace amounts. Mercury serves as a poison in the body. The presence of mercury in the body affects the nervous system which includes anxiety, depression, lack of concentration (Holtzclaw and William, 1988). Mercury affects the reproductive system causing spontaneous abortion (Waldboh, 1978). Mercury alter enzymatic and metabolic processes in organisms and interferes with functions of brain, kidney and liver. Therefore, eating fish contaminated with mercury poses health hazards.

The result of this study showed that all the fish samples both fresh and frozen were contaminated with copper. The fresh fish Tilapia has copper concentration of mean value 1.247 ppm. Whereas frozen Soles fish, Scale mullet and Barracuda have copper concentrations of mean values 4.80, 5.20 and 8.0 ppm, respectively. Okoye *et al*. (2002) working on Warri river in Nigeria reported Cu level of mean value 2.02 ppm in aquatic organism. Alinnor (2005a) also reported Cu concentration of mean value 0.229 ppm in *Orichronis niloticus* from Aba river. The level of Cu in aquatic organism from Warri river is high as compared to Nworie river probably due to waste discharged from Warri refinery into Warri river. The ANHMRC permissible limit for Cu in seafood is 30.0 ppm. In view of this, fish samples from Nworie river were not contaminated with Cu. Copper is an essential element and it enhance the enzymatic activity of the body. However, if poses health hazard when ingested in large amount.

Zinc level of fresh Tilapia fish has a mean value 3.24 ppm as shown in Table 1. whereas *Liza grandisaquamis*, *Synaptura insitanica* and *Sphyraena sphyraena* have Zn levels of mean values 0.48, 0.76 and 1.02 ppm, respectively. This study indicate that fresh Tilapia fish obtained from Nworie river is contaminated with Zn when compared to values of frozen fish sample from Ekeonunwa market. Odoemelam (2005) reported high accumulation of Zn in *Synodontis nigritis* of mean value 156.0 ppm from Oguta lake. Williams and Kasali (2008) reported Zn level of mean value 316.02 mg/kg in *Chrysichthys nigrodigitatus* obtained from Lagos Lagoon in Nigeria. The ANHMRC standard for Zn in seafood is 1000 ppm. This result indicate that fish samples from Nworie river is below ANHMRC standard. Nwaedozie (1998) reported that zinc concentration has effect on the hepatic distribution of other trace metals in fish. This is due to heavy metals such as Zn, Cu and Mn, which are essential elements that exhibit similar atomic structure and could therefore compete for the same site.

Conclusion: This study shows that untreated waste products are being discharged into Nworie river by various institutions located near the river without consideration of the aquatic life. Also frozen fish samples purchased from Ekeonunwa market were contaminated with heavy metals. These elemental toxicants will be transferred to man on consumption of fish obtained from the river and the market. These heavy metals transferred to man through the consumption of fish poses health hazards because of their cumulative effect in the body. As a result of contamination of Nworie river by heavy metals only one specie of fish is found in the river. This report is significant because it gives an idea to the mechanism of depletion and possible extinction of fish species in Nworie river that contains heavy metals. In view of these findings strict method of waste disposal control should be adopted to ensure the safety of the environment and safeguard our aquatic life.

ACKNOWLEDGEMENTS

The authors are grateful to Mr Uzodinma Ezirim for his assistance in taking some of the measurements. Also the authors are grateful to University of Uyo, Nigeria for making use of their Central Research Laboratory for this work.

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