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Levels of selected metals in the fillets of native fish species in Saba River, Osogbo, Nigeria

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Abstract
The concentrations of selected heavy metals (cadmium, chromium, lead, arsenic and zinc) in the water and fillet of native fish species in Saba River, Osogbo were assessed. Water and fish samples were collected fortnightly for a period of six months, and their heavy metals concentration were analysed for the selected metals using Atomic Absorption Spectrophotometry. Heavy metal analyses in the water and fish fillet samples revealed that the concentration of zinc was highest amongst the selected metals assayed in both the water and fish fillet. The cadmium and lead concentration of the water samples (19.0 - 38.5 µg/L) were found to be above recommended regulatory acceptable limits of 3 µg/L for cadmium and 20 µg/L for lead of WHO and FEPA while the cadmium level in the fillets of all the four fish species assayed (13.17 µg/g and 24.83 µg/g) and the lead concentration in the fillet of *T. zillii* (21.33 µg/g) were above the recommended acceptable limits of 1 µg/g per day in fish for cadmium and 20 µg/g for lead of WHO and FEPA. The study concluded that the metallic ion concentration in the water samples from Saba River indicated that the river was polluted and also negatively impacted the fish fillet quality raising human health consumption safety issues.

Keywords: Heavy metals, water samples, fish fillets

Introduction

Saba River which flows through the metropolitan city of Osogbo, is subjected to exploitation especially for agricultural purposes, and as well as municipal waste disposal. Although, the Osun State government had enacted laws to prohibit dumping of wastes into waterbodies as flood waters wreck havoc in the metropolis during heavy rainfall due to blockage of waterways by these wastes, wastes are still being continually dumped into the river. Utilisation of the water by a mechanic workshop for the purpose of washing of car engines, discharge of organic wastes from a nearby market, channelisation of the water for the purpose of fish culture, and the use of the water for irrigation purpose are among other factors responsible for the pollution of Saba River. Industrial discharges, domestic waste disposal, application of agrochemicals on farmlands among others have been reported to be the major sources of contamination in surface water [1].

Bioaccumulation occurs when an organism absorbs a toxic substance at a rate greater than that which the substance is removed [2]. Animals can accumulate metals as well by consuming diets and water with elevated metal concentrations. These ingested metals are not excreted by the animals; rather, they accumulate mostly in the organs as well as the skin, hair, and bones [3]. Bioaccumulation of heavy metals in fish has been shown to critically influence the growth rate, physiological and biochemical status and consequently the meat quality of fish [4]. Fish is considered as one of the most important indicators of pollution in freshwater systems because they occupy various trophic levels, and are the key species in several trophic chains, with high capacity to concentrate large amounts of metal ions, and are subsequently widely consumed by humans or wild predators [4].

Metallic ion contamination in freshwater fish is a recognized environmental problem [5] as several studies have also shown that fish are able to accumulate and retain heavy metals from their environment depending upon exposure concentration, duration of exposure, salinity, temperature, hardness and metabolism of the animals [6, 7, 8, 9, 10]. Studies on pollution effects in waterbodies and as well as its resultant bioaccumulative effects on fish organs and tissues have been reported in Nigeria. Bolawa and Gbenle (2009) [11] evaluated lead, cadmium and chromium in *Tilapia* fish from Makoko and Carter Bridge Rivers in Lagos, Nigeria, and reported that all the *Tilapia* fish caught from Makoko River and Carter Bridge River contained heavy metal levels higher than the USEPA permissible levels for heavy metals in fish. Ekpo *et al.* (2008) [12] also reported the lead, cadmium and mercury in surrounding water and organs of some species of fish from Ikpoba River, Benin city, which ranged from 0.001 mg/l, 0.001 – 0.002 mg/l and 0.001 – 0.002 mg/l respectively; values which were within World Health Organization (WHO) permissible limits for potable and drinking water but however reported that the amount of lead reported in the muscle, kidney and liver of the various fish species collected ranged from 0.002 – 0.008 mg/kg, 0.012 – 0.015 mg/kg and 0.004 – 0.010 mg/kg respectively and submitted that the levels of cadmium reported were in the range of 0.001 - 0.002 mg/kg, 0.004 – 006 mg/kg and 0.002-0.004 mg/kg while those of mercury in the muscle, kidney and liver were in the range of 0.001 - 0.002 mg/kg, 0.004 - 0.006 mg/kg and 0.002 - 0.00 4mg/kg respectively. The values reported were higher than that of the surrounding waters, which they attributed to the fact that these fishes bio-accumulate the heavy metals over time. With the evidence of bioaccumulation of heavy metals by fishes from polluted waters, it is therefore essential to assess the metallic load which has potential to accumulate from the polluted Saba River water in the aquatic biota, hence this study was aimed at assessing the levels of selected heavy metal in water and fillet of the native fish species in Saba River, Osogbo, Nigeria.

Materials and methods

Study Area

Saba River in the Osogbo metropolis flows from Lake 264 in Saba community and empties into the Osun River. The distance of the River from Lake 264 to Osun River is 5.02 km. The fishes were caught around Rascoe junction, with geographical coordinates 07 ^{0}78'20.7'' North, 04^{0}54'75.4'' East of the Saba River. The presence of organic wastes and the depth of this point could be responsible for the abundance of the fishes there compared to other sites on the river.

Sample Collection

The fish samples were collected between January and June 2015 using the cast netting with the help of a fisherman [13]. The collected fish specimens were transported to the Fish Culture Laboratory, Department of Zoology, Obafemi Awolowo University, Ile-Ife, for identification using fish identification keys prepared by Adesulu and Sydenham [14]. The fish specimens were washed with running tap water to remove dirt and descaled. The fillet of the fish specimens were dissected out using dissecting set and kept in properly labelled specimen bottles which were stored in the refrigerator until needed for further processing.

Water samples were also collected fortnightly at the sub-surface level from the selected sampling station along the river channel for a period of six months between January and June, 2015.

Sample Preparation

The water samples and (2)g of the dried fish fillet (at 70 °C in Gallenkamp hot air oven) were digested according to the method of Ademoroti [6] and were analysed for the concentrations of the selected heavy metals (Cadmium, Chromium, Lead, Arsenic and Zinc) using Atomic Absorption Spectrophotometry at appropriate wavelengths [15].

Statistical Analysis

Data obtained were subjected to descriptive and inferential statistics using SPSS version 20.

Results and discussion

Composition and Morphometrics of Fishes Collected from Saba River

One hundred and ten (110) fish specimens belonging to two (2) families of four (4) species were collected during the period of study. The fish species included: *Oreochromis niloticus*, *Tilapia zillii*, *Sarotherodon galilaeus* and *Clarias gariepinus* (Table 1). *O. nilotics, T. zillii* and *S. galilaeus* belong to the family Cichilidae while *C. gariepinus* was the only Clariidae. Generally, *O. niloticus* was the most abundant fish species (38) with 34.55% of the total fish caught during the period of the study while *C. gariepinus* which made 16.36% of the total caught was the least fish sample caught during the period of study. Irrespective of the month of sampling and species sampled, higher number of fish samples was recorded in the month of April while the least sample of fish specimen was caught in June 2015.

The total and standard lengths of the *O. niloticus* ranged between 13.2 cm to 23.5 cm and 10.22 cm to 18.60 cm respectively with a mean total length of 17.7 ± 4.05 cm and a mean standard length of 13.94 ± 3.29 cm. The weight of *O. niloticus* specimens ranged between 49 g and 109 g with mean weight value of 79.17 ± 23.22 g (Table 2)

The *T. zillii* and *S. galilaeus* specimens used in this study had a total length which ranged from 13.40 cm to 21.00 cm; and 15.80 cm and 17.00 cm respectively with a mean value of 17.02 ± 3.11 cm (*T. zillii*) and 16.32 ± 0.51 cm (*S. galilaeus*) (Table 2). *C. gariepinus* specimens which was the only Claridae fish caught during the period of study had a total and standard length ranging from 26.00 cm to 28.50 cm and 23.60 cm to 26.20 cm respectively. Generally, highest mean total length 26.67 ±1.07 cm), standard length (245.33 ±0.94 cm) and weight (158.83 ± 2.48 cm) was recorded in *Clarias gariepinus* specimen collected during the period of sampling while the lowest mean total length (16.32 ±0.51 cm) and standard length 913.38 ±0.39 cm) was recorded in *S. galilaeus* specimen sampled during the period of study. However, the lowest mean weight (74.17 ±16.90 cm) of the fish sample was recorded in *T. zillii* specimen during the period of study.

Table 1: Composition of the Sampled Fish Specimens Collected from Saba River

Family	Fish Species	Jan	Feb	Mar	Apr	May	Jun	Total	Total%
Cichlidae	*O. niloticus*	4	6	7	13	4	4	38	34.55
	T. zillii	3	3	4	10	4	4	28	25.45
	S. galilaeus	4	4	3	8	4	3	26	23.64
Clariidae	*C. gariepinus*	3	2	2	6	3	2	18	16.36
	Total	14	15	16	37	15	13	110	100

Table 2: Morphometrics of the Fish Specimens Collected from Saba River

Family	Fish species	Total number caught	Total Length (cm)	Mean Total Length (cm)	Standard Length (cm)	Mean Standard Length (cm)	Weight (g)	Mean Weight (g)
Cichlidae	*O. niloticus*	38	13.20 - 23.50	17.70 ±4.05	10.22 - 18.60	13.94 ±3.29	49.0- 109.0	79.17 ±23.22
	T. zillii	28	13.40 – 21.00	17.02 ±3.11	10.30 – 17.20	13.78 ±2.79	55.0– 98.0	74.17 ±16.90
	S. galilaeus	26	15.80 – 17.00	16.32 ±0.51	12.80 – 13.90	13.38 ±0.39	69.0– 103.0	85.83 ±17.03
Clariidae	*C. gariepinus*	18	26.00 – 28.50	26.67 ±1.07	23.60 – 26.20	24.33 ±0.94	156.0– 162.0	158.83 ±2.48

Table 3: Monthly Means of Heavy Metal Concentration in the Water Samples during the Period of Study

	Month (2015)					
Parameters (µg/L)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**
Cadmium	20.50 ±2.12	29.50 ±4.95	38.50 ±2.12	31.50 ±9.19	25.00 ±2.83	19.00 ±1.41
Lead	21.50 ±0.71	28.00 ±4.24	33.50 ±2.12	32.50 ±0.71	24.00 ±2.83	22.50 ±0.71
Zinc	910.00±42.43	990.50±21.92	980.50±48.79	932.00±56.57	865.50±27.58	886.50±109.60
Arsenic	3.50 ±0.71	4.50 ±0.71	5.00 ±0.00	4.50 ±0.71	3.00 ±0.00	2.00 ±0.000
Chromium	1.00 ±0.00	2.50 ±0.71	3.00 ±0.00	2.50 ±0.71	1.50 ±0.71	1.00 ±0.00

Table 4: Means of Heavy Metal Concentration in the Fillet of the Different Fish Species during the Period of Study.

Metals	*O. niloticus* (µg/g)	*T. zillii* (µg/g)	*S. galilaeus* (µg/g)	*C. gariepinus* (µg/g)
Cadmium	13.17±0.04	23.33±0.13	19.50±0.02	24.83±0.05
Lead	10.33±1.12	21.33±0.07	13.00±0.34	18.83±0.20
Zinc	115.67±0.37	103.83±1.05	116.17±0.50	116.50±0.32
Arsenic	0.33±0.3	0.33±0.03	0.50±0.02	0.50±0.02
Chromium	0.50±0.2	0.33±0.03	0.67±0.01	0.50±0.02

Heavy Metal Concentration in the Fillet of the Fish

The mean concentration of heavy metal in the fillet of the sampled fishes from Saba River is shown in Table 4. As shown in the table, Cadmium and Lead concentrations were reportedly lowest (13.17±0.04 and 10.33±1.12 µg/L respectively) in the fillet of *O. niloticus* while the highest concentration of the metals were recorded in the fillet of *C. gariepinus* (24.83±0.05 µg/L) and *T. zillii* (23.33±0.13 µg/L). Comparative analysis showed that cadmium concentration in *O. niloticus* was significantly different (P<0.05) from the mean concentration in the fillet of the other fish specimens. However, *S. galilaeus* which were not significantly different (P>0.05) from eachother were significantly different (P<0.05) from the concentration in the fillet of the remaining fish species. The correlation analysis in the cadmium levels between the water and the fillet of the fish species assayed showed no linear correlation in *O. niloticus*, strong negative correlation in *T. zillii*, weak negative correlation in *S. galilaeus* and moderate negative correlation in *C. gariepinus* (Table 5, Figure 1). The pattern of cadmium accumulation in the fillet of the fish species analysed was *S. galilaeus* < *O. niloticus* < *T. zillii* < *C. gariepinus* while the pattern of lead accumulation in the fish fillets analysed was *O. niloticus* < *S. galilaeus* < *C. gariepinus* < *T. zillii*. The cadmium concentration level in the fillet of the fish species analysed were found to be above the recommended acceptable limits of 1 µg/g of WHO (1984) [16] and FEPA (2007) [17] per day in fish. These concentrations in the fillets of the fish species assayed could be attributed to bioaccumulation of this metal from the water.

The lead concentration level in the fillet of the fish species which were 10.3 µg/g in *O. niloticus*, 13.0 µg/g in *S. galilaeus* and 18.8 µg/g in *C. gariepinus* were found to be below the recommended acceptable limits for lead in fish (20µg/g) WHO (1984) [16] and FEPA (2007) [17]. However, the concentration of the element in *T. zillii* fillet were found to be slightly higher (21.3 µg/g) than the WHO (1984) [16] recommended limit in fish samples. Correlation analysis in the lead levels between the water and the fillet of the fish species assayed showed no linear correlation in *O. niloticus*, weak negative correlation in *T. zillii* and *S. galilaeus* and moderate negative correlation in *C. gariepinus* (Table 5, Figure 2). The pattern of accumulation of lead could probably be dietary related as the microphagus feeders (*O. niloticus* and *S. galilaeus*) accumulated less lead in the fillet compared to the omnivorous feeder (*C. gariepinus*) and much less than the herbivore (*T. zillii*) which feed on macrophytes [14] which were probably higher repository of the element. The accumulation of lead in the fillet of the fish species assayed could also be attributed to the lead levels in the water as shown in the analyses of the water samples.

Generally, irrespective of the heavy metals analysed in all the fish specimens, zinc concentration was reportedly highest. The highest mean concentration of zinc (116.50±0.32 µg/L) was however recorded in the fillet of *C. gariepinus* specimens which was closely followed by *S. galilaeus* (116.17±0.50 µg/g) while the lowest mean concentration (103.83±1.05 µg/L) was recorded in the fillet of *T. zillii*. The correlation analysis in the zinc levels between the water and the fillet of the fish species assayed showed no linear correlation in *O. niloticus, S. galilaeus and C. gariepinus* but moderate negative correlation in *T. zillii* (Table 5, Figure 3). The zinc concentration in the fillet of all the fish species caught in Saba River during the period of study were found to be below the recommended acceptable limits of between 2000 µg/g to 13000µg/g by FAO/WHO (2002) [18].

The mean concentration of the Arsenic and Chromium in the fillets of the fish specimen analysed ranged from 0.33 ±0.03 µg/L (*O. niloticus* and *T. zillii*) to 0.50 ±0.02 µg/L (*S. galilaeus* and *C. gariepinus*) and 0.33 ±0.01 µg/L (T. zillii) to 0.67 ±0.01 µg/L (*S. galilaeus*). Arsenic and chromium ion concentrations in Saba River during the sampling period which occurred in trace amounts in both cases were below the acceptable limit of 10 µg/L for potable water (WHO, 2000; FEPA, 2007) [16, 17]. The relatively low values of the two elements could probably be attributed to various awareness programmes and policies of so many agencies trying to phase-out the use of these two very poisonous metals from various products. The correlation analysis in the arsenic levels between the water and the fillet of the fish species assayed showed strong negative correlation in *O. niloticus*, weak negative correlation in *T. zillii*, no correlation in *S. galilaeus* and moderate negative correlation in *C. gariepinus* (Table 5, Figure 4) while the correlation analysis in the chromium levels between the water and the fillet of the fish species assayed showed no linear correlation in *O. niloticus* and *T. zillii*, but weak negative correlation in *S. galilaeus* and *C. gariepinus* (Table 5, Figure 5).

Table 5: Correlation

Metals	Fish Species			
	O. niloticus	***T. zillii***	***S. galilaeus***	***C. gariepinus***
Cadmium	-0.028	-0.761	-0.370	0.539
Lead	0.231	-0.393	-0.432	-0.502
Zinc	0.241	-0.668	-0.200	-0.014
Arsenic	-0.919	-0.306	0.000	-0.577
Chromium	0.186	-0.131	0.322	0.365

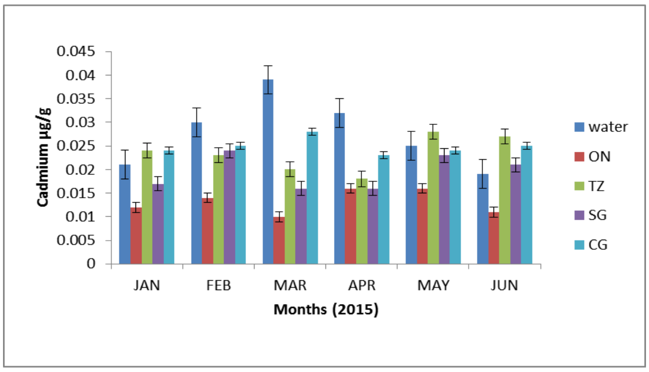

Fig 1: Correlation of the Concentration of Cadmium between the Water and Fish Fillets

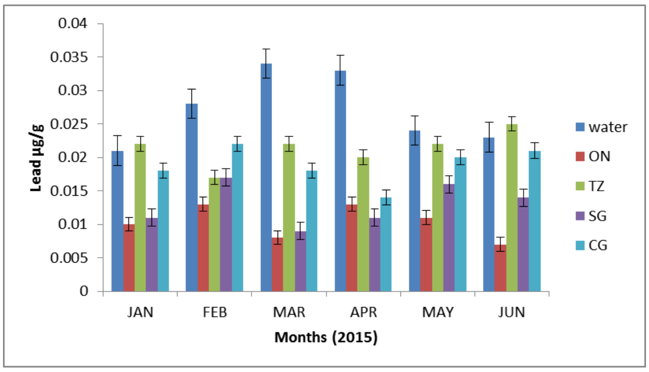

Fig 2: Correlation of the Concentration of Lead between the Water and Fish Fillets

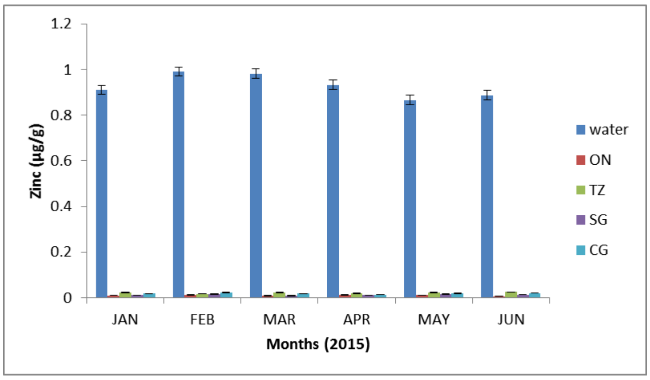

Fig 3: Correlation of the Concentration of Zinc between the Water and Fish Fillets

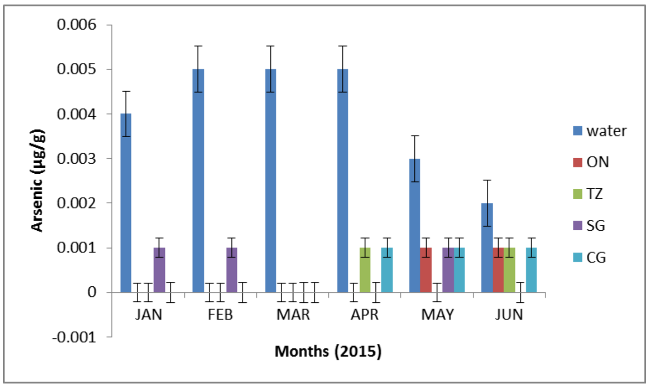

Fig 4: Correlation of the Concentration of Arsenic between the Water and Fish Fillets

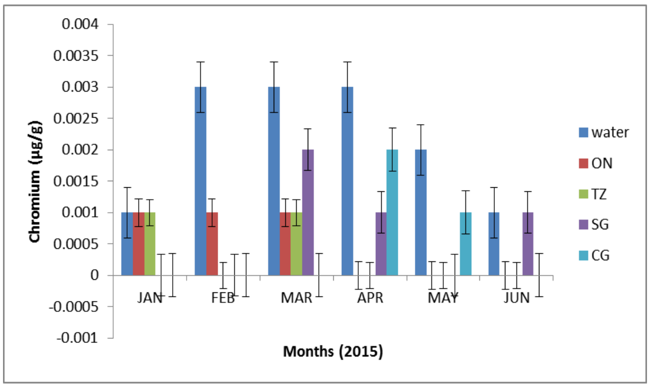

Fig 5: Correlation of the Concentration of Chromium between the Water and Fish Fillets

Conclusion

The concentration of selected heavy metals in fillet of the fishes assayed during the period of study showed that cadmium and lead were above the recommended acceptable limits set by WHO and FEPA as the water was heavily impacted mostly by solid wastes during the period of study which inturn reflected in the fillet of the fishes assayed.

Recommendation

There is the need for extended studies which should be carried out in order to determine the effect of the age and sex of the fish and the role they play in the bioaccumulation potential of heavy metals in the fillet and other organs of the native fish species. Due to the high level of cadmium and lead in the water and fillets of the fishes from Saba River during the period of study, fishes from the river poses health risk consumption safety to consumers. In safeguarding the health of large population of fish consumers, the government should ensure periodic analysis on fish harvested from known polluted rivers, so as to ensure consumed fishes do not exceed the permissible limits of toxic metals. Various fish ponds that channel the river water as their source of water supply to culture fishes should endeavour to carry out routine physico-chemical and metallic ion content analyses of such water prior to use to ensure the fish being cultured are not contaminated.

References

1. Kennicutt MC, Wade TL, Presley SBJ. Assessment of Sediment Contamination in Casco Bay. Casco Bay Estuary Project, Texas A and M University, 1992, 113.
2. Monisha J, Naresh A, Tenzin T. Bioaccumulation of Lead Metal Ions from Paint Industry Effluents by Indigenous Bacteria. Journal of Environment Pollution

and Human Health. 2000; 2(1):1-6.

3. CHSR. Human Health Effects of Heavy Metals. Kansas State University, 104 Ward Hall, Manhattan KS 66506, 2009; 785-532-6519. www.engg.ksu.edu/CHSR/
4. Authman MN, Mona SZ, Khaliaf EA, Abbas HH. Use of Fish as Bio-indicator of the Effects of Heavy Metals Pollution. Journal of Aquatic Research and Development. 2015; 6(4):23-25.
5. Staniskiene B, Matusevicius P, Budreckiene R, Skibniewska KA. Distribution of Heavy Metals in Tissues of Freshwater Fish in Lithuania. Polish Journal of Environmental Studies. 2006; 15(4):585-591.
6. Ademoroti CM. Environmental Chemistry and Toxicology, Foludex Press Ltd. Ibadan. 1996, 171-204.
7. Cusimano RF, Brakke DF, Chapman GA. Effects of pH on the Toxicity of Cadmium, Copper and Zinc to Steelhead trout (Salmo gairdneri). Canada Journal of Fisheries and Aquatic Science. Transnational Journal of Science and Technology. 1986; 2(5130 43):1497-1503.
8. Heath AG. Water Pollution and Physiology. CRC press Inc., Boca Raton. 1987, 145.
9. Allen P. Chronic Accumulation of Cadmium in the edible Tissues of Oreochromis aurus (Steindachner): Modification by Mercury and Lead. Arch. Environmental. Contam. Toxicology. 1995; 29:8-14.
10. Karthikeyan S, Palaniappan PL, Sabhanayakan S. Influence of pH and Water Hardness upon Nickel Accumulation in Edible Fish Cirrhinus mrigala. Journal of Environmental Biology. 2007; 28:484-492.
11. Bolawa OE, Gbenle GO. Evaluation of Lead, Cadmium and Chromium in Tilapia fish obtained from Makoko and Carter Bridge Rivers in Lagos, Nigeria. African Journal of Pure and Applied Chemistry. 2009; 4(10):221-227.
12. Ekpo KE, Asia IO, Amayo KO, Jegede DA. Determination of Lead, Cadmium and Mercury in Surrounding Water and Organs of Some Species of Fish from Ikpoba River in Benin City, Nigeria. International Journal of Physical Sciences. 2008; 3(11):289-292.
13. Babatunde EE, Lucian OC, Lateef OA. Cast Net Design Characteristics, Catch Composition and Selectivity in Tropical Open Lagoon. African Journal of Biotechnology. 2008; 7(12):2081-2089.
14. Adesulu EA, Sydenham DHJ. The Freshwater Fishes and Fisheries of Nigeria. Macmillan Nigeria Publishers Ltd. Ibadan. 2007, 397.
15. APHA. (American Public Health Association), AWWA (American Water Works Association), WPCF (Water Pollution Control Facilities) (1992): Standard Methods for the Examination of Water and Wastewater, 18th Ed. American Public Health Association Washington, D.C. 1289, 874.
16. WHO. Guidelines for Drink Water Quality. Vol. I: Recommendations, WHO, Geneva. 1984, 193-199.
17. FEPA. (Federal Environmental Protection Agency), Guidelines and Standards for Environmental Pollution Control in Nigeria, 2007.
18. FAO/WHO. Zinc. In: Human Vitamin and Mineral Requirements. Report of a Joint FAO/WHO Expert Consultation. FAO, Rome. 2002, 257-270.