An analysis of some heavy metals in the water, sediments and some fishery organisms from Yewa Lagoon, Nigeria

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Abstract

The concentration of heavy metals (Zn, Ni, Pb, Cd and Cu) in the muscle of three fishery organisms (*Chrysichthys nigrodigitatus*, *Sarotherodon galilaeus* and *Peneaus monodon*) and in environmental samples of water and sediment were tested in Yewa Lagoon, Nigeria. Five fishing villages along the lagoon were selected as the sample sites where these metals were tested. The heavy metal content in the muscle of the fishery organisms was Zn > Ni > Pb > Cu > Cd; Zn > Ni > Pb > Cd > Cu and Zn > Ni > Pb > Cd > Cu in *C. nigrodigitatus*, *S. galilaeus* and *P. monodon* respectively. The heavy metal concentrations in the sediment was Zn > Pb > Cu > Ni > Cd. However, nickel and cadmium were not present in the water at two sampling sites of Yewa Lagoon. The water of Yewa Lagoon is polluted with all the five heavy metals which were all higher than the WHO standard. The concentration of Zinc in the fishery organisms were below the WHO standard. However, the high concentration of zinc in the water (which is well above the WHO standard) could be associated with the fact that zinc is naturally abundant in Nigeria soils.

Keywords: Heavy metals, sediments, fishery organisms, lagoon,

Introduction

As ecosystems, estuaries are under threat from human activities such as pollution and overfishing. They are also threatened by sewage, coastal settlement, land clearance and much more. Estuaries are impacted by events far upstream, and concentrate materials such as pollutants and sediments (Branch, 1999). Land run-off and industrial, agricultural, and domestic wastes enter rivers and are discharged into estuaries. Contaminants can be introduced which do not disintegrate rapidly in the marine environment, such as plastics, pesticides, furans, dioxins, phenols and . Unlike many organic pollutants which eventually degrade to carbon dioxide and water, heavy metals tend to accumulate in the environment, especially in lake, estuarine or marine sediments. However, some heavy metals like copper and zinc are essential elements and are required in

minute quantities (APIS, 2012).

Heavy metals is a general collective term applied to a group of metals with an atomic density greater than 4g/m³ (Duffus, 2002). Heavy metals include chromium, cadmium, arsenic, lead, mercury, copper, zinc, and boron. Heavy metals are elements which occur naturally in the Earth's crust. Accumulation of heavy metals in aquatic ecosystems is of global importance. Metals generally enter the aquatic environment through atmospheric deposition, erosion of geological matrix or due to anthropogenic activities caused by industrial effluents, domestic sewage and mining wastes (Eciukynaset *al.*, 2004). The metal contaminants in aquatic systems usually remain either in soluble or suspension form and finally tend to settle down to the bottom or are taken up by the organisms. The progressive and irreversible accumulation of these metals in various organs of marine

creatures ultimately leads to metal-related diseases in the long run because of their toxicity, thereby endangering the aquatic biota and other organisms (Mansour, 2002). Fishes being one of the main aquatic organisms in the food chain may often accumulate large amounts of certain metals (Bartram *et al.*, 1999). This study was undertaken to examine the pollution status in Yewa lagoon, Nigeria through the assessment of the presence of heavy metals in the muscle of some commercially important fishery organisms (*Sarotherodon galilaeus*, *Chrysichthys nigrodigitatus* and *Penaeus monodon*) and the environment (water and sediment).

Materials and Methods

Five fishing villages bordering the lagoon were selected from the 18 fishing villages based on the number of fishers, importance of activities associated with fishing and degree of isolation. At each site fishery organisms, water and sediments were sampled. Three fishery organisms namely: *Sarotherodon galilaeus*, *Chrysichthys nigrodigitatus* and *Penaeus monodon* which are of commercial importance were sampled. 1g of fish muscle was collected from each fish sample and digested to test for five heavy metals (copper, lead, zinc, cadmium and nickel). 1g of fish muscle is first digested, using 15ml of nitric acid and 5ml of sulphuric acid. The digested solution is poured into sampling bottles with a little water to dilute. The Atomic Absorption Spectrophotometer was then used to determine the levels of heavy metals in the muscle of the fishery organisms sampled.

For water, 10ml of hydrochloric acid was poured into 100ml of the water sample to digest. It was left for 20 minutes in a fume cupboard. The solution would have reduced

in volume, it is then filtered with a little water and allowed to drop into the sampling bottles and diluted with water. The Atomic Absorption Spectrophotometer is then used to determine levels of heavy metals in the water samples.

For sediment, the sediment was put on a sheet of paper and air dried. The air dried sediment was put in a conical flask and 10ml each of nitric sulphuric acid was added and placed in a fume cupboard. A little water was added to the digested solution and filtered into sampling bottles. It was then diluted with water and the Atomic Absorption Spectrophotometer was used to determine levels of heavy metals in the sediment samples.

The mean values for the heavy metals were determined in the parameters and line graphs were drawn using Microsoft Excel to show the trend of the heavy metals from the various fishing villages sampled. The data was subjected to analysis of variance (ANOVA) to determine the variation of heavy metals in the water body, fish muscle and sediments among the fishing villages.

Results

Table 1 shows the levels of heavy metals detected in the muscle of the fishery organisms (*Sarotherodon galilaeus*, *Chrysichthys nigrodigitatus* and *Penaeus monodon*) from Yewa Lagoon, the water and sediments of the lagoon. The WHO minimum acceptable levels are in parenthesis (Table 1). The zinc content in the muscle of the fishery organisms are way below the WHO standard of 150mg/g for acceptable limits in fish muscle (Table 1).

The Lagoon is polluted with nickel, WHO standard for nickel in fishery organisms is 0.4mg/g and in water, 0.1mg/l. Of the three fishery organisms, Nickel levels are highest in *S. galilaeus* (14.94 mg/g) and lowest in *C. nigrodigitatus* (5.62 mg/g). Lead and

cadmium are also higher in *S. galilaeus* (4.4 mg/g) than in *C. nigrodigitatus* (3.2mg/g) and *P. monodon* (3.9mg/g). The WHO standard for lead is 0.01mg/l for water and 1.5mg/g for fishery organisms. Thus the lead levels in the Yewa Lagoon and fishery organisms are above the WHO safe standard level for safe consumption. The levels of Cadmium was lowest in *C. nigrodigitatus* (0.52mg/g), compared to *S. galilaeus* (4.01mg/g) and *P. monodon* (3.75mg/g) with the water in Yewa Lagoon containing 0.64mg/l. These levels are high relative to the WHO values of 0.2 mg/l for water and 0.005 mg/g for fishery organisms. The concentration of copper in the water (3.27mg/l) is higher than the WHO standard of 0.5-1mg/l. However, the copper levels in *S. galilaeus* (0.77 mg/g) was lower than the WHO standard of 1-3 while that of *C. nigrodigitatus* (2.35 mg/g) and *S. galilaeus* (2.76) are within the WHO tolerance levels'.

Discussion

The water in Yewa Lagoon can be said to be polluted (22.93mg/l) with Zinc, the WHO standard of 3.0 mg/l. The high concentration of zinc in the water could be associated with the fact that this metal is naturally abundant in Nigeria soils and since the source of metal depositories are the aquatic systems (Kakulu et al., 1988; Nwajei et al., 2001; Adefemiet al., 2008).

The fishery organisms investigated contained heavy metals at a concentration

higher than the World Health Organization (WHO) standard. Hence, one may conclude that the level of heavy metals in the samples analysed could constitute a health hazard. On this basis fishery organisms from the Yewa lagoon could be considered unsafe for human consumption and the need for continuous monitoring to prevent bioaccumulation is necessary (Adefemiet al., 2008).

The levels of Zinc, Copper and Lead detected in the sediment samples were 26.61mg/g, 2.81mg/g and 9.2mg/g respectively with zinc having the highest concentration. Nickel and cadmium was not present in the sediment sample. The presence of zinc, copper and lead may be due to human activities such as the discharge of untreated sewage and uses of metals and industrial materials that contain metals as well as the ability of the sediment to act as a sink (Benedict et al., 1991; Kakulu et al., 1988). However, these levels are much lower than that given by the Consensus-Based Sediment Quality Guidelines (CBSQG). This indicates that the levels of heavy metals in the sediment are within or lower than acceptable limits.

Conclusion

Analysis of water, fishery organisms and sediment reveals that the Yewa Lagoon is contaminated by certain heavy metals. The water of Yewa Lagoon is polluted with all the five heavy metals which were all higher than the WHO standard. Zinc levels

Table 1: Mean values for heavy metals(ppm)

	Copper	Zinc	Cadmium	Lead	Nickel
<i>C. nigrodigitatus</i>	0.024	0.222 (15)	0.052 (2)	0.032 (6)	0.056 (0.04)
<i>S. galilaeus</i>	0.078	0.192	0.040	0.044	0.149
<i>P. monodon</i>	0.028	0.208	0.038	0.039	0.119
Sediment	0.028	0.266	0.006	0.092	0.035
Water	3.27(0.5-1)	22.93(3)	Nil	2.9 (1)	Nil(0.1)

* Figures in parenthesis is the maximum acceptable limits (Choi, 2011);

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The graphical trend of the levels of heavy metal concentration between the fishing villages is shown in Figure 1.

concentration in the catfish, tilapia and shrimp were below the WHO standard. However, the high concentration of zinc in the water (which is well above the WHO standard) could be associated with the fact that zinc is naturally abundant in Nigeria soils. Also the Lead levels in the water and fishery organisms are quite high indicating that the water and aquatic organisms in Yewa lagoon are not fit for human consumption. The concentrations of the heavy metals in the sediments of Yewa lagoon are either within or lower than acceptable limits with zinc > copper > lead. Nickel and cadmium was not present in the sediment. This high level of heavy metal pollution of Yewa lagoon and its fisheries resources is of great concern considering its location and its dependence on the livelihood of the people. The fishery organisms are sold in the heavily metropolitan city of Lagos and the water is used for domestic purposes. It is therefore, of immediate concern that the Lagoon be protected from further pollution.

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