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Evaluations of the Levels of Heavy Metals in River Water and Selected Species of Fish from Ogba River in Benin City, Nigeria

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ABSTRACT: Ogba River provides source of drinking water in Benin City metropolis and also serves as repository for urban drainage and agrochemical wastes which could potentially impact the water and biota such as fish. This study was therefore aimed at assessing the concentrations of copper, cadmium, chromium and lead in water and fish from Ogba River (Nigeria). The dominant fish species encountered in the study are *Clarias gariepinus, Hemichromis fasciatus* and *Tilapia mariae* with mean weight of 127.86g, 116.60 and 74.46g respectively. Water and whole fish tissues were acid digested and analyzed for metal concentrations using the atomic absorption spectrophotometer. The results showed that in water and fish species, copper concentrations of 0.211 mg/l and 0.760 mg/kg were highest in station one, while chromium concentrations of 0.002 mg/l and 0.040 mg/kg were lowest in station two. There was significant difference in the mean concentration of the heavy metals in the selected fish species ($P<0.05$). The need for enforcement of regulations inhibiting unwise use of aquatic resources and regular monitoring of environmental matrices (water, sediment, and fauna) is advocated given that fish from Ogba River is unfit for human consumption. © JASEM
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Key words: Heavy metals, Ogba River, fish.

Heavy metals are found as natural components in aquatic ecosystems and anthropogenic influences can result to enrichment. The overload of background concentrations has become worrisome due to the accumulation of metals in acute toxic levels to aquatic biota (Obasohan *et al;* 2006). Fish has been widely used as a suitable bio-indicator of metal contamination due to their relative ease of accumulation and the potential to biomagnify in man via consumption (Izegaegbe and Oloye, 2017, Wanboje and Oronsanye, 2013) Studies have also demonstrated that fish on exposure to high amounts of heavy metals can accumulate reasonable quantities into tissues (Wangboje and Oronsaye, 2001). Fish could also regulate metal burden but only to certain level beyond which bioaccumulation occurs (Wanboje and Ikhuabe, 2015). Bioaccumulation and biomagnification are two processes that often result when fish are exposed to even low concentrations of heavy metals (Wangboje and Oronsaye, 2013). The human health risk arising from the consumption of fish contaminated heavy metals is a growing concern in Nigeria, a region which is heavily populated and where large populaces depend on fish for protein sources. This invariably underscores the importance of possible health hazard associated with heavy metal tainted fish.

Ogba River is a source of drinking water in Benin metropolis and situates a government owned farm. The river also serves as repository for urban drainage and agrochemical wastes which could impair water quality and aquatic biota (Obasohan *et al;* 2006). Studies on Ogba River have been reported (Obasohan and Oronsaye, 2004, Wangboje and Oronsanye, 2001, Obasohan *et al;* 2006, Obasohan, 2007) to be contaminated with heavy metals in the environmental matrices (water, sediment and fish fauna). However, there is little available information on the commonly consumed fish species from this particular river. The choice of *Tilapia mariae*, *Hemichromis Fasciatus* and *Clarias gariepinus* is largely due to its relevance in the fisheries of the area for
consumption and economic purposes. The aim of the study is to ascertain the levels of heavy metals in w ater and selected fish species and thus provide a basel ine for future research. The objective of this paper is to investigate the levels of some heavy metals in river water and selected fish species in Ogba River in Benin City, Nigeria.

MATERIALS AND METHODS

Description of study area: The study was conducted in Ogba River in Benin City, southern Nigeria with Latitude 6.5^0 N and Longitude 5.8 ^{0}E (Fig. 1). The river receives and drains effluent which originates from a large drainage channel fed by the Benin City drainage system. Influxes of municipal wastes, wood treatment factory and a Rubber processing factory as well as runoffs from the surrounding agrochemicals empties into the river which could impair water quality. The climate of the area is characteristically tropical and annual temperature ranges between 22 to 32^0C, while annual humidity is between 69 and 96%. The marginal vegetation is largely composed by

Emilia, Commelina and Ipomea species while *Azolla and Ceratophyllium* species constitute the dominant macrophytes (Obasohan, 2008). The study was carried out on two stations; the Ogba Zoological Garden (Station one) and the Ogba Bridge (Station two). These are approximately 4km apart from each other. Station one is downstream of the point source of municipal waste through the drainage channel. While in Station two, anthropogenic activities such as bathing, washing of clothes and vehicles, traditional worshiping, water baptism and sand excavation are known to characterize the area.

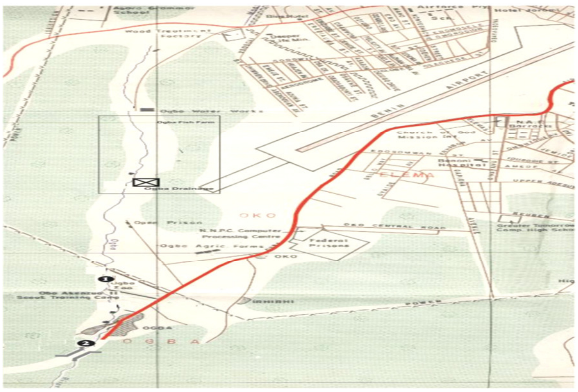

Fig 1: Ogba River showing sampling stations

Collection of water and fish samples: Water samples from each station were collected at 30 cm depth into plastic bottles with screw caps and frozen at -5 ^{o}C. The water samples were acidified with 5 ml of concentrated nitric acid prior to preservation to ensure that heavy metals did not get adsorbed to the walls of container during transportation and storage and to reduce any possibility of microbial activity in the sample. Fish samples were collected using baited hooks and raffia basket with the assistance of fishermen and then placed into an ice box and transported to the laboratory within 24 hours.

Preparation of water and fish samples: Water samples were transferred into a 250 ml conical flask and perchoric and nitric acid (1:3) were added to the flask and mixture digested using hotplates. Digestion was completed until the volume was reduced to 10 ml. The digest was transferred into a 250 ml volumetric flask and made up to 30 ml with distilled water. Meristic measurements (total lengths, standard lengths and body depth) of fish samples were determined by means of measuring board to the nearest 0.1 cm while fish weight was determined with an electronic scale balance (Mettler PE360) and values were recorded to the nearest 0.1 g. Fish samples were wrapped in foil paper, labeled and oven dried at a temperature of 80 ^{o}C for 48 hours until constant weight was attained. 2 g of the dried fish sample was weighed into 250 ml conical flask and a ratio of 1:3 perchoric and nitric acids were added to the flask and mixture was heated till the solution became clear. 5 ml of HCl was added the mixture and filtered into a 100 ml volumetric flask using whatman filter paper and made up to 30 ml mark with distilled water.

Analysis of water and fish samples: Water and fish digests stored in 100 ml plastic reagent bottles was analyzed using atomic absorption spectrophotometer (Unicam 696 series) for metal concentrations.

Data evaluation of water and fish samples: Descriptive statistics (mean and standard deviation) were analyzed using Statistical package for Social sciences (SPSS IBM 24), graphs were performed using Microsoft excel.

RESULTS AND DISCUSSION

Heavy metals in River Water: The mean concentrations of heavy metals in water varied spatially from 0.002 mg/l for Cr to 0.211 mg/l for Cu at zoo station and bridge station respectively (Fig. 2). These reveal that Cu and Cr concentrations were highest and lowest in terms of spatial variation. Heavy metal accumulation in water has been shown to be highest in Cu at station 1 which could be influenced by proximity to the point source of pollution where large influx of municipal waste flow from the drainage channel. The mean concentration obtained in the study for Cu (0.21 mg/l) is higher than 0.18 mg/l recorded each in Ikpoba River by Igbinedion and Oguzie, (2016) and in River Niger by Wangboje and Ikhuabe, 2015. Cu is known to be present in wood preservatives and pesticides which may have influenced the bioavailability at station 1(Ogba Zoo). In this study, the mean concentration of Cr (0.03 mg/l) was slightly higher than 0.02 mg/l reported by Obasohan *et al;* 2008 in Ikpoba River, but lower than 0.09 mg/l in Ovia River by Agboligba *et al;* 2005.

Heavy metals in Selected Fish Species: The mean concentrations of heavy metals in fish ranged spatially from 0.040 mg/kg for Cr at zoo station to 0.76 mg/kg of Cu at bridge station (Fig. 3). This reveals that Cu and Cr concentrations in fish were highest and lowest at the stations. Cu accumulated more at station 2 (bridge) more than other metals possibly due to influence of anthropogenic inputs. The mean concentration of metals in individual fish species ranged from below detection/quantification limit for Pb in *Tilapia mariae* to 0.861 mg/kg of Cu in *Clarias gariepinus* (Fig. 4).

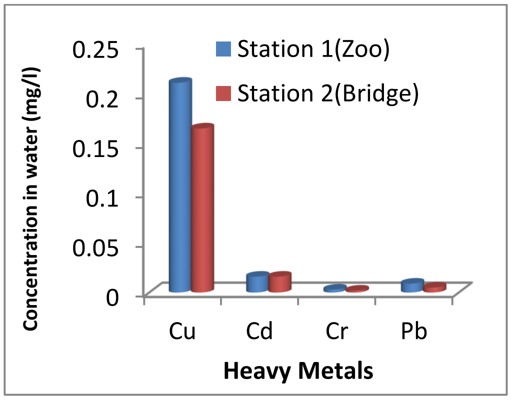

Fig 2: mean heavy metal concentration (mg/l) in water at stations

Highest mean concentrations of Cu recorded in this study for *C. gariepinus* (0.86 mg/kg) were slightly higher than 0.85 mg/kg in *Hemichromis. fasciatus* and 0.96 mg/kg in *Oreochromis niloticus* from River Niger by Wangboje and Ikhuabe, 2015. The high concentration of Cd in fish at station 1 may have resulted from disposal of waste water from associated industries which influenced its bioavailability and potential to bioaccumulate. However, Cd concentrations in water did not fully correlate with allthree fish species, as bioaccumulation occurred onl y in *C. gariepinus*. Consequently, consumption of Cd contaminated *C. gariepinus* may result in kidney disease and lung damage. Chromium is a non-essential element which is sourced from fertilizers, fossil fuels, batteries, alloys and paints. Mean Cr concentration (0.067 mg/kg) in fish species at station 2 (bridge) was lower than in *H. fasciatus* (0.75 mg/kg) from Ogba River (Obasohan, 2008). The result was consistent with the findings of Wangboje and Oronsaye, 2013 who reported 0.02 mg/kg in *Synodontis clarias* from Ikpoba reservoir. One likely source of chromium to these fish species is through run offs of agro waste, alloys and batteries which were generated from the several anthropogenic activities at station 2. Fish do not accumulate much Cr in their tissues from water, which explains that the source of the chromium was not from the drainage channel but possibly from the car and bike washing activities at station 2 (bridge). Long term exposure to chromium has been linked to lung cancer, stomach upsets, liver and kidney damage. In this study, lead concentrations in water and fish bioaccumulated in *C. gariepinus* and *H. fasciatus* indicating correlation except in *T. mariae*. Pb concentrations recorded in this study in *Clarias gariepinus* (0.08 mg/kg) was lower than 0.13 mg/kg recorded for *H. fasciastus* from Warri River by Ezemonye, 1992. Also, the report by Wangboje and Oronsaye, 2012 would indicate that Pb concentrations of 2.22 mg/kg in the freshwater *Crysichthys nigrodigitatus* were high as compared to this study (0.08 mg/kg) and further higher than 0.022 mg/kg for fishes of Ikpoba River by Oguzie, 2003. The bioavailability of Pb is due to the anthropogenic activities at station 2 and consequently, consumption of lead contaminated fish will have potential health risk. Lead (Pb) toxicity alters nervous coordination and prolonged exposure may cause weakness in wrist and fingers

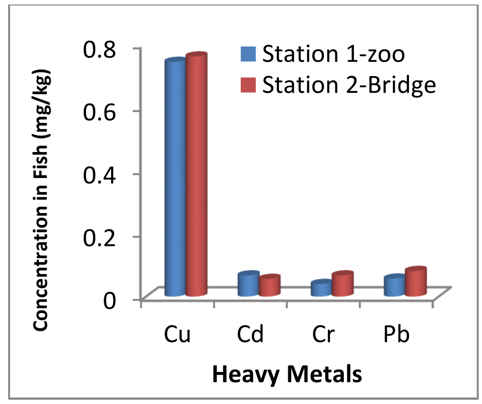

Fig 3: Mean heavy metal concentration (mg/kg) in fish at various stations

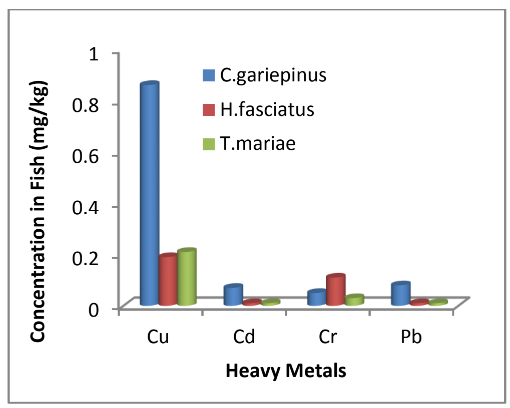

Fig 4: Mean comparison of heavy metal concentration (mg/kg) in the various fish species

The study provides information on the level of heavy metal contamination in the water and fish species of Ogba River and the likelihood to bioaccumulate. The study also reveal that fish species from Ogba River is unsafe for human consumption. More so, in particular, consumption of *C. gariepinus* and *H. fasciatus* with high metal burden can have serious health implications. Therefore, a strong advocacy that regular monitoring of aquatic ecosystems such as Ogba River be sustained and strict laws be enforced to ward off anthropogenic disturbances to the ecosystem. In addition, a long term biomonitoring program should be encouraged to incorporate other aquatic biota for proper understanding of metal bioavailability. This is due to the fact that fish do not adequately reflect spatial bioavailability of metal due to their ease of mobility.

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