# COMPARATIVE ANALYSIS OF THE EFFECT OF CADMIUM BIOACCUMULATION ON THE AGE AND BODY WEIGHT OF FISHES IN DIFFERENT WATER BODIES IN EBONYI STATE

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**Abstract**
The study comparatively underscored the effects of Cadmium bioaccumulation on the age and body weight of fishes in three (3) water bodies of Ebonyi State. After taking fork length measurements and weights of all the fishes caught from each water body, 5 fishes were selected based on age. Inferential statistics in the form of ordinary least square simple regression analysis was used to identify the similarities or differences on the impact of Cadmium on the fish age and body weight of the different Ebonyi river systems; vis a vis; Ameka dam, Enyigba river and Ebonyi river. The results obtained showed that in Ameka dam, Cadmium exerted negative influence on body weight and age of fishes but had higher influence on the body weight of fishes than on the age of fishes with $R^2$ values of 46.00% and 3.90% respectively. In Enyigba river, it was observed that Cadmium exerted higher influence on body weight than age of fishes with $R^2$ values of 3.0% and 0.1% respectively, though while the influence on age was positive, the influence on body weight was negative. In Ebonyi river, Cadmium exerted higher effect on the body weight of fishes than on the age of fishes with $R^2$ values of 57.60% and 0.60% respectively, though while the influence on age was positive, the influence on body weight was negative. Among the recommendations was that fishes caught in slow flowing dams should be monitored of cadmium bioaccumulation to forestall it constituting a hazard to human health.

**Keywords: Comparative, Influence, Cadmium, Fish and Ebonyi River**

## Introduction

Fish is known all over the world as an important food source for the human body nourishment. Fish provides the essential fatty acids like omega 3, proteins, vitamins and minerals. Despite its nutritive value, consumption of fish brings many times a potential hazard concern for the human consumers (Duffy and Zhang, 2002). Heavy metals enter the aquatic environment mainly by anthropogenic sources. Fish has been identified to be at the top of the aquatic food chain, and during its life can accumulate large amounts of toxic elements (Nwabunike, 2013). Heavy metals are defined by their weight. To be classified as a heavy metal, it must have a specific gravity of 2.7, example is Cadmium. Any heavy metal can destroy life when it concentrates in the body above acceptable levels (Oaijire *et al.,* 2004). Heavy metals have the tendency to accumulate in various organs and muscle tissue of fish. Contaminated fish enter the human body through consumption and it causes health hazards (Evans *et al.,* 2005). Cadmium is a chemical element with symbol Cd and atomic number 48. This soft, bluish-white metal is chemically similar to the two other stable metals in group 12, zinc and mercury (Abde *et al.,* 2001). Like zinc, it has oxidation state +2 in most of its compounds and like mercury, it shows a low melting point compared to transition metals (Abdel *et al.,* 2001). Cadmium is soft, malleable, ductile, bluish-white, and divalent. It is resistant to corrosion and as a result used as a protective layer when deposited on other metals. It can be accumulated in living organisms when exposed to such though it is insoluble in water (Adeniyi, 2008). This research was based on the bridge in knowledge identified by the researcher that despite the many

literatures on heavy metals and its effect on living organisms, there seems to be a bridge in knowledge on the particular effect of cadmium on the age and body weight of fishes in different water bodies in Ebonyi state, so the research was conducted with the objective of comparing the different effects of cadmium bioaccumulation on ages and body weights of fishes in different water bodies in Ebonyi state.

## Materials and Methods

### The Study Area

The study area is Ebonyi State of Nigeria. The State lies approximately 7°3' N and longitudes 5°4' E and 6°45' W. It is located in the Eastern part of Nigeria. The state is made up of thirteen (13) local government areas, which are divided into three (3) agricultural zones, namely: Ebonyi North, Ebonyi Central and Ebonyi South. It has a landmass of approximately 5,932 square kilometers. It is bounded in the East by Cross River State, in the North by Benue State, in the West by Enugu State, and in the South by Abia State (Ebonyi State Ministry of Information, 2005). Ebonyi State has a population of 2.1 million people (NPC, 2006). The vegetation of the state is a mixture of savanna and semi-tropical forest with agriculture and mining as the mainstay of the economy. It lies in an area of moderate relief of between 125 metres and 245 metres above sea level. The soil is texturally clay loam, fairly to poorly drained, with gravely subsoil in some locations especially the upland adjacent to lowland areas (Ekpe *et al*., 2005). Crops grown in the area include; rice, yam, cassava, cocoyam, groundnut, cowpea and vegetables. Livestock farming, especially the extensive system of rearing sheep, goats and native cattle, is also practiced by the people. Fishing activities are predominant in all the zones of the state

### Field Sampling

Three locations within the river systems in Ebonyi State, lying close to mine sites were sampled. Then culture pond water using urban tap water to culture *Clarias albopunctatus* was used as control 1. Specimen of *Clarias albopunctatus* were collected from the Ebonyi state university earthen pond and acclimatized to the laboratory conditions for fifteen days. The fishes were fed with industrial coppen industrial feed at the 3% body weight twice daily. The fishes, measuring 4 to 6cm in length and weighing 8 to 10gm were selected for the experimental purpose. The physiochemical parameters of the water were estimated according to (Aroviata, 2006). The test specimens were stocked in a concrete pond supplied with urban tap water. The water was changed bimonthly. The experiment was sampled monthly, for onward processing and preservation for analytical purpose. Samples for water quality were taken and analyzed in IITA according to Fishers Standard Methods (FSM standards) for sediments samples. Multimesh gillnets were used to monitor the abundance and structure of the fish fauna (Rasheed, 2001). Stratified random sampling was carried out in each water body. The fishes were caught, identified, counted, graded, measured and weighed according to species. The species for chemical and histological analysis were taken immediately after weighing to the laboratory.Concentration of Cadmium was studied in fish blood (Petterson *et al*., 2002). Toxicity of metals is mostly associated with vital physiological functions, such as enzyme activity, modifications in membrane, lipid composition and changes in tissue structures. The research looked at the effects of Cadmium on the physiology of juveniles and table size *Clarias albopunctatus* in the laboratory of the Fisheries and Aquaculture Department of Ebonyi State University, Abakaliki.

### Analysis of Cadmium Bioaccumulation

After taking fork length measurement and weights of all the fishes caught from each water body, 5 fishes were purposively selected based on age. The blood samples were collected with a syringe guage of syringe into a centrifuge vial and samples of skeletal muscles (2-3) were dissected from the

left side between the dorsal fin and the lateral line of each fish. The whole livers were dissected, dressed and cleaned with $HNO_3$. Each vial was cleaned with $HNO_3$ for 5 hours and washed thoroughly with deionized water, rinsed 3 times, dried. Samples were dried at $105^0$C for about 12 hours, ground, packaged, labeled, pre-weighed and packed in plastic boxes with lids. Samples for Cadmium bioaccumulation, enzyme and lipid analyses were taken from each fish simultaneously and placed in separate vials and delivered for analyses at 11TA laboratory. Determination of Cd was done using Buck 211VGP AAS made by Buck scientific, Inc., East Norwalk. The digest of the ash of each sample above as obtained in calcium and potassium determination was washed into 100ml volumetric flask with distilled water and made up to mark. This diluent was aspirated into the Buck 211VGP Atomic Absorption Spectrophotometer (AAS) through the suction tube. The trace mineral element was read at its respective wavelength with its hollow cathode lamps using appropriate fuel and oxidant combination.

**Data Analysis**

Data collected from the laboratory analyses of fish for the body burden of Cadmium identified from the three sampling locations and controls were subjected to statistical analysis. Inferential statistics in the form of ordinary least square simple regression analysis was used to identify the similarities or differences on the impact of Cadmium on the fish population of the different Ebonyi river systems; vis a vis; Ameka dam, Enyigba river and Ebonyi river.

**Results and Discussion**

The result of simple regression on the effect of Cadmium on age of fishes in Ameka Dam as presented in Table 1 showed that Cadmium exerted negative influence on the age of the fishes as indicated by its negative co-efficient and was not statistically significant. This implied that the higher the quantity of bio-accumulated Cadmium in the blood of the fishes, the lower the growth rate over age. The extent of influence was measured by the co-efficient of determination ($R^2$) of 3.9%; which means that only 3.9% of the change in growth over age was explained by cadmium bioaccumulation while result of simple regression on the effect of Cadmium on body weight of fishes in Ameka Dam as presented in Table 2 showed that cadmium exerted negative influence on the body weight of the fishes as indicated by its negative co-efficient and was statistically significant ($P < 0.05$). This implied that the higher the quantity of bioaccumulated Cadmium in the blood of the fishes, the lower the body weight of the fishes. The extent of influence was measured by the co-efficient of determination ($R^2$ ) of 46.00%; which means that only 46.00% of the change in body weight of fish in Ameka dam was explained by cadmium bioaccumulation. This implied that cadmium exerted greater influence on the body weight than the age of the fishes in the Dam. This is similar to the research done by Faix (2005) who found out that Cadmium bioaccumulation is higher in dams unlike fast flowing rivers.

Subsequently, the result of simple regression on the effect of Cadmium on age of fishes in Enyigba River as presented in Table 1 showed that Cadmium exerted positive influence on the age of the fishes as indicated by its positive co-efficient and was not statistically significant ($P < 0.05$). This implied that the higher the quantity of bio-accumulated Cadmium in the blood of the fishes, the higher the growth rate over age. The extent of influence was measured by the co-efficient of determination ($R^2$) of 0.1%; which means that only 3.9% of the change in growth over age was explained by cadmium bioaccumulation while result of simple regression on the effect of Cadmium on body weight of fishes in Ameka Dam as presented in Table 2 showed that cadmium exerted negative influence on the body weight of the fishes as indicated by its negative co-efficient and was statistically significant at ($P < 0.01$). This implied that the higher the quantity of bio-accumulated Cadmium in the blood of the fishes, the lower the body weight of the fishes. The extent of influence

was measured by the co-efficient of determination ($R^2$) of 46.00%; which means that only 46.00% of the change in body weight of fish in Ameka dam was explained by cadmium bioaccumulation. This implied that cadmium exerted greater influence on the body weight than the age of the fishes in the Dam. This was also in line with the earlier finding of Faix (2005).

**Conclusion**

Having conducted this research and made some relevant findings that cadmium has higher effect on the body weight and age of fishes in slow flowing waters like dams, there is need to monitor the harvesting of fishes from dams to prevent causing hazards on humans. Also, there should be further study to identify the effect of other heavy metals like zinc, mercury etc. on the age and body weight of fishes in different water bodies.

**Table 1: Regression Analysis on the Effect of Cadmium on Age of Fishes in Different Water Bodies of Ebonyi State**

| Name of river (water body) | $R^2$ (%) | Adj $R^2$ (%) | S.E.E | F-ratio | Coefficient of constant | Coefficient standard error | Variable coefficient | Variable standard error | Durbin Watson constant |
|---|---|---|---|---|---|---|---|---|---|
| Ameka dam | 3.90 | -0.5 | 7.088 | 0.887 | 19.830 | 7.917 | -3.458 | $3.672^{NS}$ | 0.038 |
| Enyigba river | 0.10 | 4.4 | 7.226 | 0.021 | 11.264 | 8.688 | 0.573 | $3.967^{NS}$ | 0.020 |
| Ebonyi river | 0.60 | 3.9 | 7.207 | 0.142 | 11.192 | 3.774 | 1.226 | $3.258^{NS}$ | 0.021 |

**Source: Field survey, and SPSS analysis 2013**

**Table 2: Regression Analysis on the Effect of Cadmium on Body Weight of Fishes in Different Water Bodies of Ebonyi State**

| Name of river (water body) | $R^2$ (%) | Adj $R^2$ (%) | S.E.E | F-ratio | Coefficient of constant | Coefficient standard error | Variable coefficient | Variable standard error | Durbin Watson constant |
|---|---|---|---|---|---|---|---|---|---|
| Ameka dam | 46.00 | 43.60 | 3.851 | 18.766 | 46.122 | 4.302 | -8.644 | 1.995* | 0.991 |
| Enyigba river | 3.00 | 1.4 | 5.164 | 0.672 | 32.815 | 6.209 | -2.323 | $2.835^{NS}$ | 0.738 |
| Ebonyi river | 57.60 | 55.6 | 3.415 | 29.334 | 36.796 | 1.787 | -8.434 | 1.544* | 1.634 |

**Source: Field survey, and SPSS analysis 2013**

**References**


Abdel Tawwb, M., Shalaby, A.M.E., Ahmed, M.H., and Khattab, Y.A. (2001). Effect of Supplement dietary L– ascorbic acid (Vitamin C) on mercury intoxication and growth performance of Nile Tilapia (*Oreochromisnilotixus*L). *Journal of Agric. Sci.*39 (2): 961-973.

Adeniyi, A.A., Yusuf, K.A. and Okedeyi, O.O. (2008). Assessment of the exposure of two fish species to metals pollution in the Ogun river catchments, Ketu, Lagos, Nigeria. *Environmental Monitoring and Assessment*, 137:451–458.

Aroviita, J., Hamalainen, H. and Holopainen, I.J. 2006: Benthic macroinvertebrates in lakes affected by iron mining waste waters in Kostomuksha area, North-West Russia. Verh.Int. Ver. Limnol. 2.

Duffy, L.K. and Zhang, X., 2002. Mercury levels in Alaskan rivers: relationship between Hg levels and yang salmon. Water Resources Center Annual Technical Report FY 2001, 1-16. Available online http://water.usgs.gov/wrri/01grants/prog-compl-reports/2001AK3481B.pdf.

Ebonyi State Ministry of Information (2005) State Government Food and Agriculture year Report Ministry of Agriculture Technical paper 09, 87pp.

Ekpe, I.I. *et al*. (2005). "Physico-chemical properties of four ultisor under different vegetation cover in Southeastern Nigeria." *Journal of Science of Agriculture, Food Technology and Environment*, 5, 74-78.

Evans, D.H., Piermarini, P.M and Choe, K.P. (2005). The Multifunctional Fish Gill: Dominant Site of Gas Exchange, Osmoregulation, Acid-Base Regulation, and Excretion of Nigrogenous Waste. *Physiological Review*. 85: 97-177.

Faix, S., Faixova, Z., Boldizarova, K., Javorskly, P. (2005). The Effect of long-term high heavy metal intake on lipid peroxidation of gastrointestinal tissue in sheep. *Journal of Veterinary Medicine Czech*. 50(9): 401-405.

Nwabunike, M.O. (2013). Effects of mining effluents on the fisheries of Ebonyi river system. Ph.D. thesis, Enugu State University of Science and Technology, Enugu State, Nigeria.

Nigerian Popuation Commission (2006) Draft publication of 2006 population census in Ebonyi State Vision 2020 Blue print for the state Transformation.

Aijire, A.A., Imeokparia F.E., KingR.P and Jonathan G.E.(2000)Aquatic environmental perturbation and monitoring,25.African experience, USA. Bulletin of Chemistry Society and Environment. 14 (1) 24.

Pettersen, A.J., Andersen, R.A. and Zachariassen, K.E. (2002). Effects of dietary intake of trace metals on tissue contents of sodium and Comparative Biochemistry and Physiology Part C: *Toxicology and Pharmacology*, 132(1): 53-60.

Rashed, M.N. (2001). Cadmium and Lead Levels fish (Tilapia nilotica) tissues as biological indicator for lake water Pollution. *Enironmental Monitoring Assessment*. 68:75-89.