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Assessment of Metal Contamination in Aquaculture Fish Ponds South Eastern, Nigeria

[1,2]*S.C. Onuoha*

[1]Department of Biotechnology, Ebonyi State University, PMB 053 Abakaliki, Ebonyi State, Nigeria
[2]Microbial Ecology Laboratory, Arid Land Research Center, Tottori University, Tottori, Japan

Abstract: This study assessed the metal qualities of fish ponds in Abakaliki, Southeast, Nigeria between June and October, 2015 with a view to determine the level of contamination of these elements in the pond water. Water samples were collected from five fish ponds and the metal contents was determined using atomic absorption spectrophotometery(AAS). Four (4) out of the total metals tested(iron, calcium, sodium and manganese) were found to be present in the water samples although at a level within the WHO permissible limit, while sodium and magnesium was not detected in the samples. Pond waters should be evaluated at intervals in order to ensure that the consumption of aquatic resources from these ponds does not contain toxic metals that may cause serious health hazards through food chain magnification.

Key words: Abakaliki · Aquaculture · Fish Pond · Metal Contamination

INTRODUCTION

Pollution of the aquatic environment with heavy metals has become a worldwide problem in recent years because heavy metals are indestructible and most have a toxic effect on organisms [1].

Heavy metals consists of both essential and non-essential elements and they are known to be of particular significance in ecotoxicology. Some of them such as Fe, Zn, Cu Cr, Ni are essential nutrients required in small amounts for enzymatic biochemical activities [2], while others such as Cd, Hg, Pb are potential poisons not even required in small amount but have valuable industrial applications with resultant effect on the environment if not controlled [3]. However, all metals are toxic if the exposure level is sufficiently high to exceed the tolerance level [4].

The occurrence of toxic metals in pond, stream and river water affects the lives of humans and animals that depend upon these water sources for their daily life[5].The consumption of aquatic resources containing toxic metals may cause serious health hazards through food chain magnification [6]

There is need to assess the metal quality of fish pond in our environment so as to be able to address the increasing problems of toxic metal pollution in our aquatic resources which may cause serious health hazards through food chain magnification. This problem has been reported in various parts of the world, hence, various studies have evaluated metal pollution in aquatic environment both quantitatively and qualitatively and found out that heavy metal contains toxic substance that make up an important fraction of environmentally hazardous substances.

In view of the fact that no data have been reported about metal quality of different fish pond within the study area and due to rapidly growing aquaculture fish business in Nigeria, toxic metals often introduced into the environment via anthropogenic or natural sources, this work was aimed to determine pollutant levels of metals in selected fish pond water within the study area.

MATERIALS AND METHODS

Sample Collection, Procession and Determination of Metals in Water: A total of twenty (20) water samples used in this research work was collected from five(5) different fish ponds in Abakaliki namely:Fije Mold Fish Pond(FMFF), Josel Fish Farm(JFF), Chiboy Fish Farm(CFF), Local Fish Farm (LFP) and Sam Egwu Fish Farm(SEFF) between June – October, 2015. Water sample was taken below the water surface from the fish pond using one (1) liter acid-leached polythene bottles. About 0.5L of the water samples was taken at each sampling site. Samples were acidified with 10% HNO_3, placed in an ice bath and brought to the laboratory. The samples were

Corresponding Authors: S.C. Onuoha, Department of Biotechnology, Ebonyi State University, PMB 053 Abakaliki, Ebonyi State, Nigeria Microbial Ecology Laboratory, Arid Land Research Center, Tottori University, Tottori, Japan. Tel: +2348032385682, E-mail: sconuoha@yahoo.com.

filtered through a 0.45µm micropore membrane filter and kept at 4^0C until analysis. Metals (Mg, Na, Cu, Fe, K, Mn, Ca) were determined in the water samples using an Atomic Absorption Spectrophotometer, Perkin Elmer Model 306.

Statistical Analysis: Data obtained were presented as mean ± SD (standard deviation). Significance of difference between different treatment groups was tested using one-way analysis of variance (ANOVA) and significant results were compared with Duncan's multiple range tests using SPSS window 7 version 1.6 software. For all the tests, the significance was determined at the level of P<0.05.

RESULTS

The result of metal concentration in water samples from the different fish pond are presented in Fig. 1-4. Analysis of the different metals from different fish pond waters showed some slight variation in the level of the concentration of the metals found in them. The result showed that iron concentration was highest in Fije Mold Fish Pond(FMFF)with (0.32±0.04) mg/ml, followed by Josel Fish Farm(JFF)(0.19±0.05) mg/ml,Chiboy Fish Farm(CFF)(0.19±0.07) mg/ml and Local Fish Farm(LFP)(0.08±0.05)mg/ml had same concentration,while Sam Egwu Fish Farm(SEFF) had the lowest concentration of iron(0.07±0.00) mg/ml,however the concentrations from the different pond waters following statistical analysis at P<0.05 showed no significant difference (Fig. 1)

The results of the calcium concentration was found to be highest in FMFF(13.20±0.03) mg/ml, followed by SEFF(10.77±0.05) mg/l, LFP(9.22±0.48)mg/ml, JFF(1.13±0.06) mg/ml, while the least concentration was obtained from CFF(0.71±0.35) mg/ml, however Calcium concentrations in CFF and SEFF showed no significant difference whereas there was significant variation among other groups. (Fig. 2) The results of sodium concentration was highest in JFF(27.20±0.22) mg/ml, followed FMFF(25.00±) mg/ml, SEFF(12.80±0.006)mg/ml, CFF(12.01±0.03) mg/ml, while there was a negligible concentration in LFP(0.003±0.005) mg/ml, The concentrations of sodium in FMFF when compared to that of JFF showed no significant difference at P<0.05 whereas it varied significantly with those of CFF, LFP and SEFF(Fig. 3).Manganese showed highest concentration in JFF(0.08±0.04)mg/ml, followed by FMFF(0.04±0.04) mg/ml, CFF(0.02±0.05) and LFPhad no trace of any manganese found in it. There was significant difference in the manganese concentrations of CFF and JFF, while those of other groups have no significant differences in their manganese concentration.(Fig. 4).

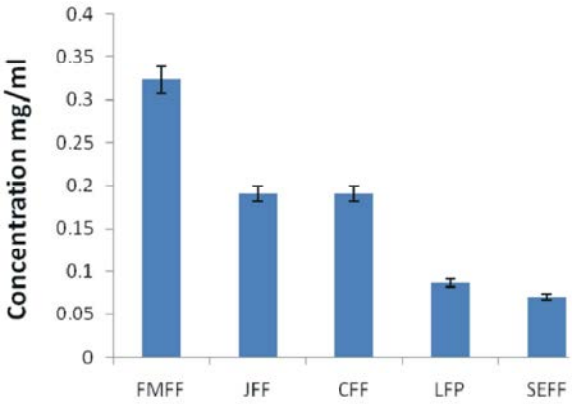

Fig. 1: Concentration of Iron in different pond water
Keys:FMFF= Fije Mold Fish Farm, JFF = Josel Fish Farm, CFF =Chiboy Fish Farm, LFF= Local Fish Farm, SEFF: Sam Egwu Fish Farm.

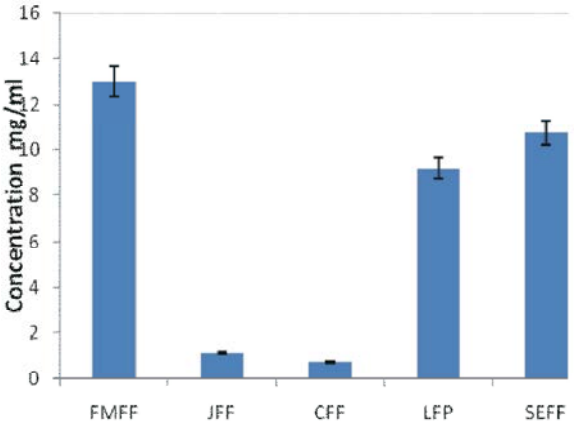

Fig. 2: Concentration of Calcium in different pond water
Keys: FMFF= Fije Mold Fish Farm, JFF = Josel Fish Farm, CFF =Chiboy Fish Farm;LFF=Local Fish Farm, SEFF:Sam Egwu Fish Farm.

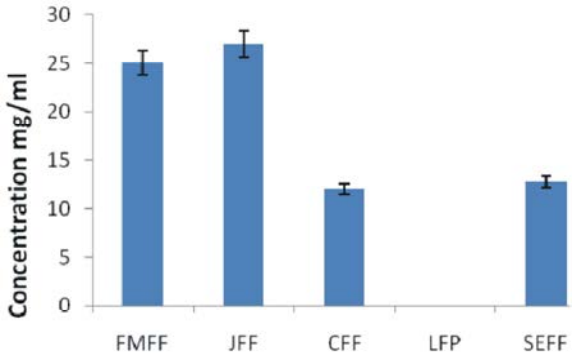

Fig. 3: Concentration of Sodium in different Pond Water
Keys: FMFF= Fije Mold Fish Farm, JFF = Josel Fish Farm; CFF =Chiboy Fish Farm, LFF = Local Fish Farm, SEFF: Sam Egwu Fish Farm.

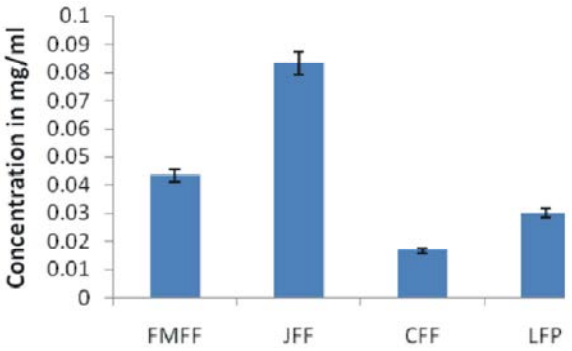

Fig. 4:Concentration of manganese in different pond water Keys: FMFF= Fije Mold Fish Farm, JFF = Josel Fish Farm, CFF =Chiboy Fish Farm, LFF = Local Fish Farm.

DISCUSSIONS

The result of the assessment of the level of metal pollution in the fish ponds showed that only four metals; iron, Calcium, sodium and Manganese was detected in the water, while other metals were found to be absent. The result of iron concentration showed slight variations from the pond waters, but such variations was not statistically significant at $P < 0.05$. The iron content of the samples was also found to be lower than the WHO permissible limit [7], in four out of the five fish ponds, while it was exactly 0.3 mg/ml WHO permissible limit in Fije Mold Fish farm(Fig. 1). The result of this finding is in contrast with most previous studies where the level of iron was high in fish pond waters[8-10]. The high concentration of Fe in fish pond may be attributed to industrial/ factory effluents and agricultural activities around the area which discharge or filters into the pond. It could also be a reflection of discharges from dumpsites and raw sewage that are channeled into the pond. A look at the study area showed that there were no such industrial activities within or around the location of the ponds, such could have been the reasons for the low level of iron as against what is prevalent with other previous studies.

Calcium concentration was found to be highest in FMFF(13.20±0.03) mg/ml, while the least concentration was obtained from CFF(0.71±0.35) mg/ml, however calcium concentrations in CFF and SEFF showed no significant difference whereas there was significant variation among other groups(Fig. 2). The finding from this study is consistent with the work done by Adewunmi*et al.*[11] where he recorded high levels of calcium from Fish, Water and sediments of some ponds in Ado, Ikere and IyinEkiti, Ekiti State, Nigeria. Magnesium however was not detected in the pond waters as against other previous studies where magnesium and calcium are normally found to be present together. Calcium for each sample in the present study is within the WHO recommended range [7] indications that the water from the pond is desirable and there is no risk or any adverse effect on consumers of fish obtained from the pond as a result of bioaccumulation. Calcium helps in blood clotting, in muscles contraction and in certain enzymes in metabolic processes. It serves as a coordinator among inorganic elements; when potassium, magnesium or sodium is in excess in the body, calcium is capable of assuming a corrective role [12]. However, excessive calcium and magnesium in water are undesirable as they are capable of causing scale formation in water.

The concentration of sodium was highest in JFF(27.20±0.22) mg/ml, while there was a negligible concentration in LFP(0.003±0.005) mg/ml, The concentrations of sodium in FMFF when compared to that of JFF showed no significant difference at $P<0.05$ whereas it varied significantly with those of CFF, LFP and SEFF (Fig. 3). The result obtained is consistent with previous authors who have done similar work[9-11] the values obtained for sodium fall within the WHO/USEPA guidelines [7]. However, potassium was not detected; sodium and potassium are needed in small amount in fish pond. Optimum concentration of this element is unknown; however it is readily available and needed in stimulating the growth of aquatic flora. Sodium controls body water balance and plays a role in muscle contraction. Potassium spares sodium in the human body and its concentration in food when higher than sodium has a nutritional advantage.

Manganese was also detected in four out of the five fish ponds sampled with the highest concentration found in JFF(0.08±0.04)mg/ml, followed by FMFF(0.04±0.04) mg/ml, CFF(0.02±0.05) and LFP had no trace of manganese. There was significant difference in the manganese concentrations of CFF and JFF, while those of other groups have no significant differences in their manganese concentration(Fig.4). The level of manganese in the fish pond waters are all within the WHO permissible limit [7], indications that the water from the pond is desirable and there is no risk or any adverse effect on consumers of fish obtained from the pond as a result of manganese contamination.Manganesefunctions as an essential constituent for bone structure, for reproduction and for normal functioning of the nervous system. It is also part of the enzyme system [12].

A study of this nature could not be completed without some limitations the researcher encountered, some of them are; samples was taken over a short period of time and may not have depicted seasonal variation.

Secondly, because only pond water was used, the study was unable to determine the level of accumulation of the metals in other sources such as the fish tissues and sediments.

CONCLUSION

This work has assessed the level of metal concentration in some fish ponds within Abakaliki area. The results revealed that there was an indication of some level of metal pollution in the aquaculture fish ponds, although values of these metals are within acceptable range. The results present a valuable baseline data for future work.

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