African Journal of Agricultural Research and Development, Volume 4, Number 2, 2011
 ISSN: 2141-0097 Devon Science Company

DETERMINATION OF SOME HEAVY METALS IN MINED-PONDS FISH IN BUKURU AREA OF PLATEAU STATE I

Daniang, Ishaya Ezekiel, Daniel, Nenman Victor, and Nimyel, Danboyi Nanven.
Department of Science,
Plateau State Polytechnic, Barkin –Ladi, Bukuru, Plateau State, Nigeria

ABSTRACT

Some heavy metals in mined-ponds fish of Bukuru, Jos-South Local Government Area of Plateau State were studied using Atomic Absorption Spectrophotometer (AAS). The fish used were tilapia (Oreochromis nilotica) and cat fish (Clarias Lazera). The metals investigated were Pb, Cd, Cr, Ni and Fe. The results show that fish bio-accumulate the metals. Levels of the metals depended on the type of metal and fish. The levels in tilapia were generally seen to be higher than those in cat fish. In both fish species, the metal levels were in the order Fe> Co > Cr > Pb > Ni. However, none of the levels was above the maximum allowed by the World Health Organization (WHO). The mined-ponds water could be used for raising fish, but with regular monitoring of the levels of these metals and other toxic compounds to avoid possible health consequences.

Key Words: Mined-ponds water, Heavy metals, Fish.

INTRODUCTION

Plateau State is one of the oldest mining areas in Nigeria. Minerals from this state and some others like Enugu, had been some of the main financial resources of Nigeria up to early 1960's [1]. When petroleum was discovered, attention was then diverted. Today, these mining sites still remain, either as unclaimed alluvial deposits or large pools of water, which have opened up opportunities for dry season farming. Recently, suggestions are being made for the use of water in these mined-pond pools as fish farms.

Fish is any of numerous cold-blooded aquatic vertebrates of the super class pisces, characteristically having gills, fins and streamlined body. This includes the class osteichthyes, which have body skeleton, and the chondrichtyes, a class that has cartilaginous skeleton like the sharks, rays and skates [2]. Fish is high in protein and it is free of cholesterol. It is therefore good for growth and repairs of tissues in the body. Fish is also a valuable source of mineral elements like calcium, phosphorus, iodine, fluorine, vitamins A and D, and also of omega-3 fatty acids [3]. It is normally recommended for those who are on weight-reducing diet. Fish is consumed, not only in renowned hotels, but also in our houses as an essential part of soup – at least to give the soup a better taste. These days, efforts are being made to raise fish in any little water body that is available. Farm ponds are being encouraged to boost family diet and economy. Suggestion to use the mined-ponds waters of Bukuru and Jos in Plateau State for fish farming is in line with such thinking. However, the United States Environmental Protection Agency indicated that mining wastes can pollute streams, ground water and harm wild life and fish in areas influenced by mining activities [4]. Fish may store up metals in their body by bio-accumulation, a process whereby organisms store up metals, acquired from their surrounding food medium, into their tissues by chelation process [5]. The heavy metals get into man who eats the fish. Most of these metals have serious health consequences on man when they accumulate to levels beyond their recommended maximum limits. Some of the metals that pose health hazards are Mercury (Hg), Cadmium (Cd), Nickel (Ni), Gold (Au) Platinum (Pt), Silver (Ag), Bismuth (Bi), Arsenic (As), Selenium (Se), Vanadium (v), Chromium(Cr), Thallium (Ti) and Lead (Pb)[6]. Lead adversely affects many body systems. Its health impairment depends on the period of exposure, whether just within short days (acute exposure) or as long as several years (chronic exposure). Common symptoms of acute lead poisoning are fatigue, moodiness, headache, joint or muscle aches, anemia and decreased sexual drive [7]. The World Health Organization (WHO) guideline for lead is 0.3mg/kg (dry weight) [4]. Though Nickel (Ni) is said to be needed by the body in small quantity for the production of red blood cells, its large quantity in the body may cause heart and liver damages and skin irritation. Cadmium is another metal that has health consequences on man. It is an extremely toxic metal and so it has a very low permissible exposure limit

Corresponding Author: (ishadaniang@yahoo.co.uk)

(PEL). The metal is said to be bio-persistent. Once absorbed, it remains resident in the body for decades [8]. Cadmium poisoning may lead to lung damage, kidney malfunction, stomach irritation, vomiting and diarrhea. For chromium, its health hazard is dependent on its oxidation state. The metal form is of low toxicity. The hexavalent form (Cr VI) is more toxic. Health impairment of this form includes lung cancer, irritation of the nose, throat, eyes and skin [9, 10]. Because of the health problem they pose, these and other toxic metals are a matter of great concern in industries and mining sites where they exist in high quantities. Most of the ponds in Bukuru, Jos and its environments that are being eyed for raising fish are left over features of tin mines. Earlier works have shown that the soil and insects around these areas contain some of these heavy metals [12, 13]. That being the case, do fish presently found in these ponds contain some of the heavy metals mentioned above? What are their levels, if found, in these fishes? What may be the possible health dangers of using these mined-ponds water for fish farming? This work was aimed at proffering answers to these questions.

MATERIALS AND METHOD

Fish Sampling Technique

Fresh Tilapia (Oreochromis nilotica) and Cat fish (Clarias lazera) were obtained from six (6) different ponds with the help of local fishermen in the area. Only two fish types, tilapia and cat fish, were found in the ponds, and this limited the work to these two species. They were taken to the laboratory for treatment and analysis.

Ashing of Fish Samples.

Seven (7) samples each of tilapia and cat fish were dried in an oven at 80^{o}C till constant weights were obtained. The dried fish samples were crushed and grinded using mortar and pestle. Ten (10) grammes of each of the grinded samples were placed in different crucibles and then placed in a furnace till all organic matter were destroyed, leaving behind fish ash in the crucibles.

Digestion of Samples.

10g triplicate samples of the fish ash were placed in beakers that had been thoroughly washed and rinsed with distilled water. 10ml each of concentrated HCl and HNO_3 acids were added in that order. They were digested on a hot plate in a fume cupboard till clear solutions were obtained. The solutions were allowed to cool, filtered into 100ml volumetric flasks and were made up to the mark with distilled water [14]. Heavy metals (Pb, Cd, Cr, Ni and Fe) in the fish samples were determined using a Unicam Solar 969 Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

The concentration of the heavy metals (Pb, Cd, Cr, Ni and Fe) in cat fish and tilapia, obtained from each of the ponds, are presented in Table 1 below. Average metal concentrations in each fish type are also presented in Table 2.

TABLE 1: Heavy Metal Concentrations (mg/kg dry wt) in Tilapia and Cat Fish of Bukuru Mined-Ponds Water

	Pond 1		Pond 2		Pond 3		Pond 4		Pond 5		Pond 6		Recomm. Max. Limit in Fish(mg/kg dry wt)
Metal	Tilapia	Cat Fish	Tilapia	Cat Fish	Tilapia	Cat Fish	Tilapia	Cat fish	Tilapia	Cat fish	Tilapia	Cat Fish	
Pb	0.01	0.01	ND	0.01	0.02	0.02	0.01	ND	0.01	ND	ND	ND	0.3*
Cd	0.10	0.08	0.05	0.03	0.10	0.10	0.15	0.08	0.08	0.06	0.07	0.07	0.2+
Cr	0.04	0.04	0.01	0.01	0.05	0.03	0.04	0.03	0.05	0.05	0.03	0.02	0.3+
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.02*
Fe	120..50	120.00	119.08	118.50	130.00	119.50	125.90	124.40	115.80	116.00	130.00	129.90	500+

* WHO (Ref. No.16) + ANZFA (Ref. No. 21) ND = Not Detected

TABLE 2: Average Heavy Metal Concentrations (mg/Kg dry wt) in Tilapia and Cat Fish of Bukuru Mined –Ponds Water.

METAL	TILAPIA	CAT FISH	Recomm..Max..Limit for Fish (mg/kg dry wt)
Pb	0.01	0.01	0.3*
Cd	0.09	0.07	0.2+
Cr	0.04	0.03	0.3+
Ni	ND	ND	0.02*
Fe	123.67	121.22	500+

* WHO (Ref. No. 16)
\+ ANZFA (Ref. No.21) ND = Not Detected.

DISCUSSION

Nickel was not detected in any fish sample. For those metals detected, the levels in tilapia ranged from a minimum of 0.01 mg/kg for lead to 123.67mg/kg for iron. Those in cat fish ranged from 0.01mg/kg (Pb) to 121.22mg/kg (Fe). In both fish samples, the metal levels were in the order Fe> Cd> Cr > Pb> Ni.
The absence of nickel in all the fish samples may be an indication of one or more of three factors. The metal may be absent in the soil and mined-ponds water. It may also be that the metal is not persistent in fish. Thirdly, the metal may be available in the fish, but at a level below the detectable limit of the instrument used (AAS). Nickel had been detected in some vegetables sold in Barkin Ladi market, [15] an area not far away from the site of the present work. That being the case, the last two factors are probably the reasons for the absence of nickel in the samples.

Detection of lead (Pb) in both fish samples is an indication that it is present in the soil and subsequently the water where the fish were picked. In Missouri, it was found that lead concentration in sediments was highly correlated with those in suckers and small sunfish [16]. Lead is a very toxic metal. Even though in this work, its average levels in both fish types did not reach the recommended maximum limit of 0.3mg/kg, its presence in fish is a pointer to danger. This is more so as emphasis is being laid nowadays on consumption of fish as alternative source of better protein [3]. The levels for chromium were 0.04mg/kg for tilapia and 0.03mg/kg for cat fish. None of the values reached the recommended maximum limit of 0.3mk/kg for fish [17]. It is reported that fish do not accumulate much chromium. Most chromium in water is said to bind to dirt and other materials and settles at the bottom, with just a small level dissolving in water [11]. In man, chromium (VI), which is the toxic state, is said to be easily converted to chromium (III), a state which is reported to be an essential nutrient that helps in the use of sugar, protein and fat. Fish may also have their natural way of controlling chromium, accounting for its low level. Iron recorded the highest levels in both tilapia and cat fish. Iron is reported to have no toxic effect on aquatic animals like other metals. It is said to be an essential nutrient for fish and small shell fish[18]. The high level of iron may be an indication of its level in the soil and water. Also, being essential to fish, it is expected that there is high tendency of its bio-accumulation. Cadmium was another metal detected. Its levels were higher than all other heavy metals investigated except iron. Cadmium is said to be a very toxic metal, hence it has a very low maximum permissible level [MPL] of 0.2mg/kg [9].

CONCLUSION

All the metals investigated were detected except nickel. Iron had the highest level in all the fish samples. Most of the levels in tilapia were found to be higher than those in cat fish. Reports by earlier workers have shown that small fish accumulate larger levels of heavy metals per unit of body weight than larger ones [19]. This is because the skin of fish is an important site for uptake of heavy metals concentrations. The presence of these metals in fish shows that they are available in the mined-ponds water, that fish bio-accumulate them and that the metals have some levels of bio-persistency. [5] Whereas it is a good idea to explore various means of boosting our economy and diet, the presence of these metals in fish samples indicates that suggestions to use the Jos and Bukuru old mined waters for fish farms

should be handled with care. If this is to be done, regular monitoring of the levels of these metals and other toxic compounds should be done to avoid possible health consequences.

REFERENCES

The New National policy on Solid Minerals, Ministry of Solid Minerals Development, January 1999.

The American Heritage Dictionary of English Language, 4th edition, Updated 2003; published by Houghton Mifflin Co. Fish and Your Health", A Publication of International Food Information Council (IFIC), January, 2006.

Fish and wildlife Advisory News – December, 2002, a publication of The U.S. Environmental Projection Agency (EPA), Pg.2. Ademoroti, C.M.A. (1996); Environmental Chemistry and Toxicology; Foludex Press Limited, Ibadan.

"Toxic metals", a Safety and Health Topic publication by U.S. Department of Labour, Occupational Safety and Health Administration (OSHA), Washington. "Lead – Health Effects", a Safety and Health Topic publication by U.S. Department of Labour, Occupational Safety and Health Administration (OSHA), Washington, DC.

"Safety and Health Topic–Cadmium", Occupational Safety and Health Administration (OSHA), 2005.www.osha.gov.

"Toxicological profile for Chromium", a Publication by the U.S.Agency for Toxic Substances and Disease Registry (ATSDR), September 2000.

Gibb, H.J. et al (2000); "Lung cancer among workers in Chromium Chemical Production", Am. Jour. of Industrial Medicine (AJIM), 38**(2)**, Pg 115 – 126.

"Public Health Statement for Chromium", a publication of the Agency for Toxic Substance and Disease Registry (ATSDR), Department of Health and Human Services, September, 2000. pg 4.

Egila, J.N. and Nimyel, D.N.(2002): Determination of Speciation of Trace Elements in Sediments of some selected Dams. Journal; of Chem. Soc. of Nigeria, Vol. 27(1).

Nenman Daniel Victor (2002); "Trace Metal Accumulation in Fresh Water Sediment Insect in Liberty Dam"' M. Sc thesis, Chemistry Department, University of Jos.

Oehlenschlager, J. (2002); "Identifying heavy metals in fish" in Safety and quality issues in Fish processing; H.A Woodheaf Publishing Ltd; Cambridge, UK, Pg 95 – 113.

Nimyel D. Nanven, Daniang, Ishaya E and Daniel V. Nenman (2007); "Determination of Trace Elements in some vegetables sold in Barkin Ladi Market, Plateau State", an unpublished research work.

Gale, N.L; Adams, C.D; Wixson B. G; Loftin, K. A and Huang, Y. W. (2002); "Lead concentrations in fish and river sediments in the old 4262 – 4268.

World Health Organization (WHO) in U.S Environmental Protection Agency (EPA) Report, 2002.

Popoola, R.O., Akinsola, R.O; and Goodwoli, I.A, (2005); "Selected Heavy Metal Concentrations in Fishes from Gashua Township of River Yobe", proceeding of the 28th International Conference of the Chemical Society of Nigeria, Sept; 2005. Ray,S.; McLeese,D. and Pezzack D. (1980). "Accumulation of Cadmium", by Neries virnes. Archivesa of Environmental Contamination and Toxicology, 9: Pg 1-8.

Hayton, W.L and Barron, M.G.(1990); "Rate Limiting Barriers to Xenobiotic Uptake by the Gill", Environmental Toxicology and Chemistry, 9 Pg 151 – 156.

The Australian, New Zealand food Authority (ANZFA).