Determination of Heavy Metals (Cadmium and Lead) From Tilapia Fish in Oguta Lake, Oguta Local Government Area, Imo State

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Abstract
The uptake of heavy metals by fish from the environment, primarily occurs through gills, food, skin and in fresh water.Some aquatic organisms can store heavy metals up to certain amount, which might not be harmful nor toxic, but can reach to human via food chain, which pose as danger to human health (Merlini, 1971).An experiment was carried out on a tilapia fish gotten from Oguta lake in Imo State, to determine the presence of lead (pb) and cadmium (cd);The fish was prepared for analysis by removing the gills and liver, which was dried in an oven at about 90^0c grinded into powdery form, after which 1 gram of the sample was weighed out and was transferred into a digestion flastk. 10mls of $HN0_3$ was added to the sample and was heated to about 95^0c with reflux of 10-15mins without boiling, this action was repeated at intervals till all the brown fumes was given off at a gentle heating of the sample at the temperature of 35^0c.2mls of distilled water and 3mls of 30% of H_20_2 was added aliquotely at intervals until a clean sample of the fish extract was obtained; which was further diluted with 50mls of distilled water, and was filtered out. The filterate was used for the analysis of cadmium (CD) and lead (pb) which was determined through the method of Atomic Absorption spectrometer (AAS), to obtain 0.15 presence of cadmium (cd) and 0.63 of lead (pb); which is within the normal range of FAO/WHO which is (0.04-0-95) of cadmium and (0.00-5.00) of lead respectively.

***Keywords**: Cadmium, Lead, Tilapia Fish*

Introduction

Nigeria is endowed with abundant water-bodies which form excellent environment for numerous fish species and other aquatic fauna and flora. However, these water bodies are subjected to multipurpose usage and therefore prone to various degrees of environmental pollution and degradation that are hazardous to fisheries resources and humans. Anthropogenic sources are usually responsible for a variety of different toxic substances in the environment. The fate for most environmentally persistent chemicals is the water colunm and sediment of aquatic ecosystems. Knechtges (2012). These chemicals go into the food chain through the processes of bioaccumulation and bio-magnification. Heavy metals pollution in aquatic environments and their uptake in the food chain by aquatic organisms put public health at risk. Balogun (2015).

The craving for fish is on the increase in Nigeria because of the touted health benefits of eating fish. Fish contains Omega III fatty acids that are known to reduce cardiovascular diseases, hypertension and arteriosclerosis, thus becoming a preferred source of animal protein for those nearing 50 years of age and above. Ovie and Raji (2006). Fish is widely recognized as an excellent source of protein of very high quality. In spite of the significant role of fish in the diet of Nigerians, one of the challenges facing Nigeria today is that of ensuring sustainable fisheries development and subsequently ensuring seafood safety especially fish. Over last three decades, there has been increasing concern in the problem of accumulation of toxic metals to hazardous levels in aquatic biota (Idodo-Umeh 2002; Anahann 2014). Metals are naturally occurring elements but become contaminants if concentrations in the environment are altered from natural distributions through human activities. According to Mathis and Cumming 2017, excessive pollution of surface waters could lead to health hazards in man, either through drinking water or consumption of fish. Mersch *et al.*, (2003) also stated that fish could accumulate trace metals and act as indicators of pollution.

Tilapia guineensis (Bleeker, 2002) is among the notable and highly demanded fish species for consumption in Nigeria. Balogun (2015). The creek is one of the coastal waters in the Barrier Lagoon Complex (an ecologically important lagoon system), Nigeria. *Tilapia guineensis* is frequently caught and largely eaten in Nigeria rivers and its environs, so their toxic metal content should be of concern to human health. In view of the paucity of information on heavy metals in the edible fish species from this water-body, the present study is being undertaken to determine the extraction of cadmium and lead from fish.

Cadmium and lead are non-essential and toxic metals which are distributed and released into the aquatic environment ‘by industrial sources such as mining, refining of ores (Handy, 1994), plating process, the use of phosphate fertilizers and gasoline containing lead that leaks from fishery boats (Pascoe and Mattery, 2017). Also, heavy metals (include Cd and Pb) enter the aquatic environment naturally from the rocks and soils directly exposed to surface water. These two metals (Cd and Pb) are concentrated from the water and sediments to the different parts of aquatic organisms including fish especially those exposed to the water (Brigham *et al.*, 2018). So, fish might prove a better media than water for detecting heavy metals contamination of freshwater ecosystem (Barak and Mason, 2019). Because many fishes stay in rather confined regions of the river, they will suffer by one way or another if this aquatic system is contaminated by toxic substances, the fish will take those toxic substances through gills and skin and also orally with food (Ikeda et at., 2016).

Pollution of river (water, sediment and fish) by Cd and Pb and other heavy metals has attracted attention for a considerable time. Cd and Pb in fish and shell fish has been studied (Kuroshima, 2017; Kareleeson-Norrgent et al., 2015; Mohamed, 2019; Handy, 2014; Zaky, 2015). The use of Tilapia as a bio-assay organism for sensitivity to toxic effects may be appropriate relative for scale formation (Patin. 2014). Marine bivalves are often used as biological indicators for monitoring marine pollution with trace elements (Ishii et al., 2015). Cadmium, chromium and lead will be studied in aquatic organisms in which the levels of these metals differs from one organism to another (Medina, 2016).

Cadmium and lead were determined in different parts of fish. Cadmium levels in various tissues of fish (kidney, gill, hepatopancreas) show the highest level in kidney than gill (Ikeda *et al*., 2016). Cadmium is observed to be present in higher concentration than Pb in muscle and liver of some marine invertebrates (Ishii *et at*., 2015). Studies of the accumulation and distribution of Cd in fish have shown that gill is one of the primary target organs of fish (Kumada *et al*., 2010). Cadmium accumulation in *Girella* Punctuate during a long term exposure shows that a large amount of Cd was accumulated in the livers and kidneys, followed by lesser amount in gills and intestines (Kuroshima, 2017). Concentration of Cd, Cu, Ag and Zn in fish liver increased in the agricultural areas in the River Basin, U.S.A. (Heing et al., 2007).

Several studies has been carried out in fish pollution by Cd and Pb in Egypt especially those (*Tilapia nilotica*) fish of the River Nile (Awadalla *et al*., 2015; Mohamed *et al*., 2010; Amal, 2013; Khallaf *et al*., 2014; Feshwi, 2014; Zaky, 2015). The High Dam Lake (Nasser lake), which is one of the largest man-made lakes in the world, is the reservoir created as a result of the construction of High Dam in the south of Egypt. There are no studies about the pollution of the High Dam Lake fish (*Tillapia nilotica*) with Cd and Pb. So this study is being conducted to assess the Cd and Pb pollution in the fish and to detect the Lake water pollution through the accumulation of fish scales and the other tissues with Cd and Pb.

Materials and nd Methods

Oguta Lake in Oguta L.G.A of Imo State is located on south Eastern Nigeria. Its coordinate is within longitude 50 43’ 42”N and latitude 6o 48’ 34” E. (world Gazette 2012). Oguta Lake is one of the foremost territories that witnessed western or European expedition during colonization and was used as a gateway by the British to advance into the Igbo hinterland. It is one of the oil and gas producing communities in Imo state. Being the second largest oil producing communities in Oguta L.G.A. It is located in the equatorial rainforest region. (Oguta Lake Wikipedia, a free Encyclopedia 2012)

The climatic condition of Oguta Lake is typically warm all the year round. It is mostly dominated with rainy season from late April to the end of September. This period is usually a farming period for the Orsu people (A close village to the lake). The wet season is obstructed by a short dry spell of one to two weeks in August.

The mean annual rainfall ranges from 2000mm to 2500mm and usually starts from April to October. It has double rainfall intensity. Maximum in March to April and by September to October.The relative humidity of study area changes normally within the periods of the year. It ranges from 65% within April to October (wet season) and 55 to 65% during the dry season (November to February)

The average maximum daily temperature varies from 33°c to 35°c in most times of the year. And men daily minimum temperature range from 19°c to 24°c. (Abu and Egenonu, 2004). Thus, temperature varies daily and seasonally.

The 1991 census in Nigeria brings the population of Oguta Lake to about 14,560. But according to Nigerian population commission NPC (2006) records, the total population of the area is now 22,000 people. The major inhabitances of the study area are petty traders, peasant farmers who trade in finished farm products. Some of the people also engage in fishing activities even though, oil and gas activities are being carried out in the area, it is only few percent that are employed, the rest are either civil servants, students, apprentice and many are unemployed most especially the youth.

Materials and Equipment

i. Beakers

ii. Hotplate,

iii. Volumetric Flask,

iv. Pipettes,

v. Atomic Absorption Spectrometer (AAS).

vi. 100mls measuring cylinder

vii. 10mls measuring cycling

viii. Conical Flask 250ml (2)

ix. Beaker 250ml

x. Volumetric flask 500ml

xi. Motar and pestle

xii. Spatula

xiii. Weighing balance

xiv. Funnel

xv. One (1) Filter paper (watman)

xvi. Improvised stove for reflux

Reagents

i. Hydrogen trioxonitrate v (HNO3),

ii. hydrogen per0xide (H202),

iii. distilled water

Method of f Extraction: Nitric Acid Extraction Method (HNO_3)

Sample Preparation: In the preparation of the fish extract for analysis, the gills and liver was removed from the fish and dried in an oven at about 90°C and therefore grinded into powdery form with blender or motar and pestle. 1 gram of the fish sample was weighed out and transferred into a digestion flask. 10mls of HNO_3will be added to the sample and then heated to 95°C with reflux of l0-l5mins without boiling, then the sample allowed to cool. 5mls of concentrated $HNO_3$was added and reflux for 30mins. If brown fumes occur, the addition of HNO_3 will be repeated until, the brown fumes is given off at gentle heating at 35°C. Then allow to cool. 2mls of distilled water and 3mls of 30% of $H_2O_2$was.then added. 1ml of 30% $H_2O_2$was added aliquotely at intervals until a clear sample is obtained. pipette 5mls of the fish extract and dilute with 50mls of distilled water and then filter the sample then the filtrate was taken to as for the analysis of cadmium(Cd) and lead(Pb) using the hollow cathode lamp.

Results and Discussion

Result

S/N	Species	Investigated heavy metal	Are edible parts appropriate for human consumption	Permissible limits determined by FAO/WHO	Lab result	FAO/WHO range
1.	Tilapia	Cadmium	Yes	FAO/WHO	0.15	0.04-0.95
2.	Tilapia	Lead	Yes	FAO/WHO	0.63	0.00-5.00

Discussion

Some of the aquatic organisms can store heavy metals up to certain amount. Even though these heavy metals are not harmful or toxic, they can reach to humans via food chain and affect human health (Merlini, 1971) As a general rule toxicity occurs when heavy metal concentrations reach above certain levels. Also heavy metals piled in water join to the food chain from many stages and threaten ecosystem safety, fish and human health. (Jain et al., 2008; Sönmez et al., 2013a).

Fish are at the top of the aquatic food chain, and they can accumulate preexisting metals in various tissues and organs (Mansour and Sidky 2002; Sönmez et al., 2012). Aquatic organisms such as fish and shell fish accumulate metals to concentrations many times higher than present in water or sediment (Olaifa et al, 2004, Gumgum et al., 1994; A1-Weher, 2008). Accumulated metals in fish tissues up to toxic concentrations are based on certain environmental conditions such as food chain, predation competition, water chemistry (salinity, pH, water hardness,) and hydrodynamics in the water (Förstner and Wittmann, 1981; Guven et al., 1999; Akgün et al, 2007; Al-Weher, 2008).

Furthermore, interaction between metals may also influence accumulation (Pagenkopf, 1983; Cicik, 2003).

Studies carried out on fish revealed that all heavy metals, despite the fact that some of them are essential for life, have adverse effects on living organisms through metabolic interference and mutagenesis. These adverse effects are decrease in fitness, interference in reproduction that leads to carcinoma and eventually death (Govind and Madhuri, 2014). In addition to reproduction, hypoxic conditions, excessive stocking and starvation heavy metal effects also cause stress in fish (Levesque et al., 2002; Arslan et at., 2006). Stress factors including pollution affect growth, development and reproduction adversely by changing metabolic, physiological and biochemical functions (Heath, 1995; Çiftçi et al., 2017).

Adverse impacts on physiological functions and biochemical parameters both in blood and tissue of the fish living in metal contaminated waters have been observed. It has been reported that fish exposed to metals showed immune system malfunction and thus became vulnerable to contagious diseases and had a greater mortality risk (Larsson and Haux, 1985; Abel and Papoutsouglou, 1986; Sehgal and Saxena, 1986; Nemesok and Huphes, 1988; Çelik, 2006; Akgün et al., 2007; Al-Weher, 2008).

In despite of carcinogenic effects of heavy metals are not known well, several studies suggest genotoxic effects may exist (Snow, 1992). Heavy metals enhance genotoxicity either directly or indirectly by inducing toxicity of other chemical agents (Bolognesi et al., 1999). Heavy metal exposure reduces estrogenic and androgenic secretion and also causes pathological changesi in fish (Ebrahimi and taherianfard, 2011).

Effects of f Cadmium (CD)

Cadmium exhibits high toxicity at even very low concentrations and has acute and chronic effects on fish and environment. Long exposure of cadmium poses various acute and chronic effects on aquatic living beings (Thomas et al., 1983; Kuroshima, 1992). Such effects are enhancement of humoral immune response (Descotes, 1992; Krumschnabel et al., 2010), inducement of structural and functional changes in gill, intestine, liver and kidney (Kumar and Sing, 2010), pathological alterations in liver such as congestion, necrosis of pancreatic cells and fatty changes in the peripancreatic hepatocytes, congestion and engorgement of blood vessels (Rani and Ramamurthi, 1989; Dangre et al., 2010; Kumar and Sing, 2010). It also causes disruption of calcium metabolism, hypercalciuria and leads kidney stones to form. Toxicity varies in fish, salmonids are highly susceptible to cadmium exposure and sublethal effects such as obvious spine malformation were reported. According to Kumarand Singit alters antioxidant defense system and production of free radicals Çiftçi et al. (2017) observed a decrease in hepatosomatic index in north African catfish (*Clarias lazera*) after Cd exposure. In rosy barb (*Puntius conchonius*) short term effect of high concentrations of Cd caused hyperglycemia, whereas long term effect of low concentrations of Cd caused hypoglycaemia and liver glycogen concentrations were enhanced in both situations (Çelik et al, 2008).

Witeska and Jezierska (1994) revealed that red blood cell count and haematocrit levels of Cd exposed common carp (*Cyprinus carpio*) increased. Johansson-Sjobeck and Larsson (1978) showed that red blood cell count, haematocrit and haemoglobin levels of European flounder (*Pleuronectes flesus*) decreased significantly after Cd exposure. Also in Mozambique tilapia (*Oreochromis mossambicus*) Cd caused decrease in haemoglobin levels and red blood cell count (Ruparella et al., 1990; Çelik, 2006).

Tort et al. (1988) found out that Cd exposure caused leucocyte (WBC) concentration of lesser spotted dogfish (*Scyliorhinus canicula*) to reduce. Similar results were obtained in Mozambique tilapia by Ruparella et al. (1990). However Tort and Hernandes-Pascual (1990) observed decrease in WBC count of Mozambique tilapia that exposed to Cd (Çelik, 2006). Cd also effects glucose levels of fish. It has been shown that Cd exposure caused glucose levels in rainbow trout (*Oncorhynchus mykiss*) to increase (Haux and Larsson, 1984), in comon carp (*Cyprinus carpio*) to decrease (Yamawaki et al., 1986). Çelik (2006) showed that Cd in common carp induced glucose levels on 1st and 3rd days whereas glucose levels were not affected on 15th and 30th days after exposure.

Kidney is the main target organ of cadmium toxicity and chronic exposure in almost all animal species and it is characterized by various renal damage degrees (Roméo et al., 2000; Shukla and Gautam, 2004; Kumar et al., 2006; Vesey, 2010; Kumar and Sing, 2010).

Effects of Lead (Pb)

Increase of lead levels in water may cause adverse effects in some aquatic living beings and may lead alterations of blood parameters and nervous system in fish and other animals. Pb is a dangerous environmental pollutant and it has become much thought of due to its considerable danger risks for human health (Afshan et al., 2014).

It has been detected that Pb inhibits Na+/K+-ATPase enzyme and d-aminolevulinic acid dehydratase enzyme that participates in growth and hem synthesis in erythrocytes and affects lipid peroxidation enzyme. It has been shown that Pb also has influence on intercellular communication by changing alanine aminotransferase (ALT) and aspartate aminotransferase (AST) concentrations in tissues and organs (Çogun and Sahin, 2012).

Çiftçi et al. (2017) studied the effects of Pb on nile tilapia (*Oreochromis niloticus*) in terms of HSI and GSI. Çiftçi et al. found out that Pb caused a decrease in HSI of fish whereas it had no effect on GSI. Çiftçi et al. suggested that the decrease in HSI might have occured due to consumption of energy reserves in hepatocytes.

According to the laboratory result gotten, there are traces (presence) of Cadmium Cd and Lead Pd in the Tilapia fish gotten from Oguta lake. Also the laboratory result shows that the concentration of cadmium Cd is 0.15 and that of Lead Pb is 63 which is within the range (Cd - 0.04 - 0.95 and 0.00 - 5.00) as stipulated by the FAO/WHO standard which is healthy for human consumption.

Conclusion

In conclusion, there are traces of Cd and Pd in tilapia fish, also that the concentration of Cd and Pd did not make the fish to be toxic and harmful to human consumption rather it is healthy for human consumption.

Recommendation

After the analysis and findings, the following were recommended

1. The fishes (Tilapia) of Oguta lake is good for human consumption
2. Further research should be carried out on the Fishes (Tilapia) collected from Oguta, so as to check other heavy metals found in fish.

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