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Research

Proximate and Elemental Analysis of Catfish Reared in River and Pond Systems in Ogun State, Nigeria.

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Abstract

Catfish was obtained from Ewekoro River, Wagunna River, fish ponds A and B for proximate and the quantification of the presence of lead, cadmium, manganese and chromium in the fish muscle which was achieved using Atomic Absorption Spectroscopy. The levels of cadmium, lead, manganese and chromium in the muscle of catfish from Ewekoro River were 1.34, 0.31, 1.62 and 0.24 mg/kg and 1.01, 0.22, 1.56 and 0.12 mg/kg for Wagunna River respectively. Cadmium was not detected in the water samples of the fish ponds A and B as well as in the muscles of catfish. In most of the fish samples, the concentrations of the selected metals in the muscle of the fish raised in Rivers were found to be higher than the minimum values recommended by standard organizations.

KEY WORDS: Catfish, Heavy Metals, River and Fish Pond

Introduction

In the aquatic system such as river and ponds, marine organisms especially fish had been exposed to several pollutants such as oil spillage, pesticides and fungicide, industrial discharge etc. Many of these sources contain metals as part of their constituents which has a direct consequence of biomagnifications. Among these metals however are heavy metals that even at low concentrations in fish and water have a particular significance in ecotoxicology and their toxic effects to man as a result of consumption of aquatic organisms contaminated with toxic metals have been widely reported (Storelli *et al*., 2005; Agatha, 2010; Oronsaye *et al.*, 2010; Jared and Usman, 2011; Muiruru *et al*., 2012). The risks (such as damage or reduced mental and central nervous functions, damage to blood composition, lungs, liver and kidney, lowering of energy level and skin, teeth or bones etc) of the consumption of marine organisms contaminated with toxic metals such as cadmium, lead, chromium, manganese, nickel and zinc had been raised by many (Ozmen, 2004; Alaa and Werner, 2010; Kumar *et al*., 2012; Olowoyo *et al.*, 2012). These metals are not only toxic to fish and other marine organisms but they are also indestructible and tend to bioaccumulate in living tissues which can be passed through the food chain into human body.

Fish is highly consumed all over the world mostly for its valuable sources of high protein contents and also serves as source of vitamins. Fish can form very nutritious components of most diet and is rich in most of vitamins consumed, containing a good number of mineral elements as well as essential amino acid obtained from proteins. Fish are excellent sentinels of environmental health as they are sensitive to wide range of xenobiotic chemicals. The presence of metal pollutants in fresh water system posed great danger to the marine organism and fish is known to posed great ability to accumulate heavy metals in their muscles, and since the same is very essential in human diet, it is necessary therefore to carefully examined them for toxic metal contamination before being supply for human consumption (Adeniyi and Yusuf, 2007; Ekeayanwu *et al.*, 2010). To this end, catfish obtained from two ponds and two rivers were deployed for chemical analysis of mineral contents and proximate analysis such as percent of protein contents, moisture contents, ash contents and carbohydrate contents.

Materials and Methods

Study Locations

Ewekoro is one of the fastest growing Local Governments in Ogun State South West of Nigeria. It is the chief host community to one of the famous cement factories **'ELEPHANT CEMENT'** and many other cement factories due to large deposit of $CaCO_3$ in the area. Due to high industrial activities, the rivers located in this area are not being used as source of drinking water but majorly for industrial and irrigation purposes. Itori, is the largest community under Ewekoro Local Government and is about 1km away from the Elephant Cement factory. Wagunna river and fish ponds A and B are located in Itori and it's environ, while Ewekoro river is located within the premises of elephant cement factory.

Collection and Preparation of Water and Fish Sample

500 ml of water samples were obtained each from the two rivers and the fish ponds and filtered through Whatman No. 1 filter paper and kept inside 1000 ml polypropylene bottles and few drops of HNO_3 were added to acidify it. Samples of Catfish (*clarias gariepinus*) were collected from two fish ponds and two rivers namely Wagunna River in Itori and Ewekoro river all in Ewekoro Local Government of Ogun State, Nigeria and they were kept in plastic bags containing iced cooler for transportation into the laboratory and stored at a temperature below -20^{o}C to prevent spoilage. The average weight of the catfish from the fish ponds was 800 g, while that of the river was 500 g respectively. The fish samples were defreeze and dried in an electric oven. The belly flap and the lateral line were cut out and split open and it was then oven dried. Samples were then ground with the aid of mechanical grinder into a fine homogeneous powder and stored in well labeled plastic bags before digestion.

Metal Analysis

Both the fish and water samples were digested following the method described by APHA, (2005). About 10 ml of the treated water sample was digested with 5 ml of nitric acid at 100^{o}C with drop wise addition of hydrogen peroxide until there was no evolution of brown fumes. This was then filtered using Whatman No. 1 filter paper and transferred into a 100 ml volumetric flask and made up to the mark. For the fish samples, about 0.5 g of the dried powdered portion was mixed with 10 ml of nitric acid and digested with

the addition of few drops of hydrogen peroxide until there were no brown fumes. The mixture was filtered and then transferred into a 100 ml volumetric flask and made up to the mark. Metal contents analysis was performed by using Atomic Absorption Spectrophotometer (Buck Scientific Model).

Moisture Content Determination

Clean and dried crucible was placed in an oven for about 30 minutes, cooled in desiccators and weighed. About 3 g of the powdery fish sample was weighed into the pre-weighed crucible and this was placed in an oven for 2 hour at 80^{o}C after which it was cooled in desiccators and re-weighed until the weight remained fixed. Loss of weight was equated to the moisture content.

Ash Content Determination

About 10 g of the fish sample was weighed into previously ignited, cooled and weighed crucible and pre-ashed to eliminate fumes that may deposit in the furnace. This was then transferred into Muffle furnace at 650^{o}C for 4 hours. The ash was removed from the furnace, cooled and re-weighed.

Protein Content Determination

About 7 g of the fish sample was weighed into the digestion tube (kjeldahl tube). Two kjaldahl tablets and concentrated tetraoxosulphate (VI) acid were added and the tube was placed in the pre-heated digester at 400^{o}C for about 30 minutes until a clear solution was obtained. The conical flask containing 25 ml of 2% boric acid was placed under the condenser outlet and 25 ml of 40% sodium hydroxide was added and distilled for 4 minutes in the distillation unit. The ammonium borate solution formed was titrated with 0.02M hydrochloric acid to purple grey end point.

Statistical Analysis

Statistical analysis was performed to determine the different between multiple range tests and means and it was done using ANOVA at a significant level of $p \leq 0.05$.

Results

Table 1: Proximate analysis of the catfish.

	Ewekoro River	**Wagunna River**	**Fish Pond A**	**Fish Pond B**
% Protein	10.10	8.40	19.80	22.40
% Moisture	76.60	71.20	89.20	80.00
% Carbohydrate	0.67	0.38	5.42	6.44
% Ash	0.13	2.02	4.66	3.27

Table 1 shows the results of the proximate analysis of the catfish obtained from Wagunna River, Ewekoro River, fish ponds A and B. The mean protein content of catfish raised in the fish pond was higher than the one reared in the river. The protein content of the catfish was 10.10, 8.40, 19.80 and 22.40% for Ewekoro River, Wagunna River, fish ponds A and B respectively. The percentage of the moisture content of catfish was 76.60, 71.20, 89.20 and 80.00% respectively. The value of the carbohydrate contents in the muscle of the catfish was 0.67, 0.38, 5.42 and 6.44% in Ewekoro River, Wagunna River, fish ponds A and B respectively. Contrary to the results obtained for the protein analysis, the values of the carbohydrate contents of the catfish which were obtained from the two fish ponds A and B were found to be higher than those raised in the two Rivers with the catfish fishes pond B having the highest value, while the least values was observed in Ewekoro River. For the ash contents, values of 0.13, 2.02, 4.66 and 3.27% was obtained in that order for the four water systems as described earlier.

Table 2 shows the results of the elemental analysis of water samples of Wagunna River, Ewekoro River, fish ponds A and B. The results indicated that the concentration of Pb obtained was 0.78, 0.43, 0.06 and 0.03 mg/kg for Ewekoro River, Wagunna River, fish ponds A and B respectively. The highest concentration of lead was observed in Ewekoro River and the least value was observed in fish pond B. For Cd, the detected concentration was 2.31 and 1.94 mg/kg in Ewekoro and Wagunna Rivers. Cadmium was not detected in the water samples of the two fish ponds A and B analyzed. The concentration of Mn obtained was 2.13, 1.91, 0.64 and 0.92 mg/kg in Ewekoro River, Wagunna River, fish ponds A and B, while that

of chromium was obtained to be 0.83, 0.68, 0.03 and 0.06 mg/kg respectively.

Table 2: Elemental analysis of water samples.

	Pb (mg/kg)	Cd (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	References
Ewekoro river	0.78	2.31	2.13	0.83	This study
Wagunna river	0.43	1.94	1.91	0.68	This study
Fish pond A	0.06	ND	0.64	0.03	This study
Fish pond B	0.03	ND	0.92	0.06	This study
WHO	0.05	0.01	0.5	0.05	WHO, 2003
SON	0.01	0.05	0.2	0.05	Ekeayanwu *et al*., 2010.

Note: ND stands for not detected.

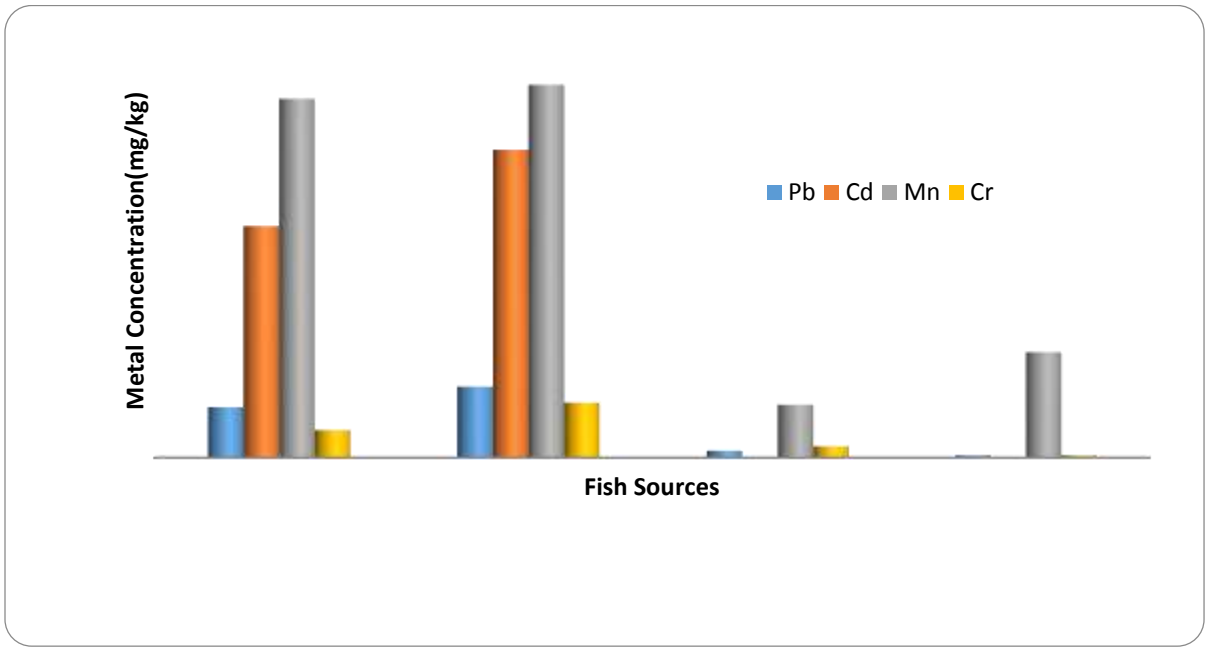

Figure 1: Metal concentrations in the muscles of catfish.

Figure 1 shows the results of the trace metal concentrations in the muscles of catfish at Ewekoro River, Wagunna River, fish ponds A and B. The results showed that in Ewekoro River, Mn had the highest concentration of 1.62 mg/kg, followed by Cd(1.34 mg/kg), then Pb(0.31 mg/kg) and Cr had the least value of 0.24 mg/kg. For Wagunna River, the increasing order of the metal is given as Cr(0.12 mg/kg) > Pb(0.22 mg/kg) > Cd(1.01 mg/kg) > Mn(1.56mg/kg). It is worthy of note that cadmium was not detected in the muscle of the catfish which were gotten from the two fish ponds analyzed.

Discussion

The protein contents of the catfishes which were obtained from the two rivers were lower than 15-28% recommended by FAO 2012, while that of the two fish ponds A and B fall within this range. Proteins are the building blocks of amino acids and certain of them are important in human diet for the maintenance of good living. The values of the carbohydrate contents obtained in the two fish ponds were however higher than 1.65±0.495 mg/kg reported by Okonji and Enoma, 2007; while those from the two river sources were lower than 2.13±0.035 mg/kg reported by Okonji and Enoma, 2007. According to FAO 2012, the composition of a particular species often appears to vary from one fishing ground to another, and from

season to season, but the basic causes of changes in composition are usually variation in the amount and quantity of food that the fish eats and the amount of movement it takes. It further stressed that when fish are overcrowded, there may not be enough food to go round, thus intake will be low and composition will change accordingly. This may however explain the large differences observed in the chemical composition of the fish reared in river and those reared in fish ponds as indicated by this study. Also, Lovell, 1981 as well as Okonji and Enoma, 2007 suggested that the differences in the percentage protein contents between the fish raised in pond and those raised in the river could be as a result of the fact that fishes raised in fish ponds are constantly being fed with highly quality food in addition to the presence of zooplankton in ponds which is natural source of protein. They further opined that most of these foods contain protein as part of their ingredient which may include groundnut cake, bones, soya beans, grounded fish to mention but a few. On the other hand, fish raised in River system often rely on the protein from natural zooplankton for their survival.

Metals can produce harmful effects on tissues of marine organisms such as fish. At relatively lower concentrations, fish may suffer from various kinds of unpleasant effects but still survive. However, at high concentrations, symptoms due to interference with the fish neurological system, changes in histological pattern may occurs in the digestive tubular tracks, gills or epithelial tissues and death of the fish may be observed. These symptoms may be as a results of changes in enzymal or hormonal activities resulting in that the fish become weak and ecologically vulnerable to death. Also, lethal or sub-lethal toxicity occurring as a result of accumulation of low-level contaminants over an extended period of time, delayed in growth or reproduction rates and changes in respiration may all occur, though may be difficult to detect.

Among the sample analyzed, of great concern however is the fact that the concentrations of Pb, Cd, Mn and Cr in the two river samples were found to exceed the limit values of 0.05, 0.01, 0.5 and 0.05 mg/kg and 0.01, 0.05, 0.2 and 0.05 mg/kg as recommended by World Health Organization and Standard organization of Nigeria for each of the metals. It was also observed that the water samples obtained from Ewekoro had the highest metal concentration for all the metal analysed in this study. The concentration of trace metals in catfish from this study were lower than those reported by Indrajit *et al.*, 2011. According to Muiruri *et al*., 2013 and Agatha, 2010, the low levels of Pb may as well pose fear of poisoning since low levels are also known to be toxic. It is obvious that fish muscles are capable of bioaccumulation of heavy metals which may pose danger to fish consumers. Generally, the concentrations of the selected heavy metals in catfish which were raised in fish pond were lower than the values observed in the two river samples. This could be as a result of the proper and regular monitoring of the fish ponds and partly to the fact that effluents from industries can't flow directly into these fish ponds. This could also be as a result of the released of industrial effluents into the water system as well as the continuous mining activities which is as a result of the search for the deposit of $CaCO_3$ in Ewekoro. According to Muiruri *et al*., 2013, weatherings of soil and rocks as well as a variety of anthropogenic activities are two independent factors that result into the presence of heavy metals in water.

Conclusion

Proximate and elemental analysis of water samples and catfish muscles raised in two Rivers and two fish ponds in Itori and Ewekoro community all in Ogun state, Nigeria were analyzed. The results revealed that the catfish raised in the fish ponds contain more proteins than their River counterpart which may be as a result of their diet composition. High level of metal concentrations was observed in the water samples as well as the muscles of catfish obtained from the two rivers when compare with the values obtained in fish pond samples. It is therefore necessary to carry out a regular routine analysis of the contents of metal concentrations in Ewekoro and Wagunna Rivers if fish from these sources will serve as components of diet for human consumption.

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