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LEVELS OF HEAVY METALS IN PSEUDOTOLITHUS ELONGATUS FROM BADAGRY MARKET, NIGERIA

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Abstract

Fish plays a significant role in food and nutrition security across the world, especially in Nigeria, where the people consume fish as a major supplement to carbohydrate-based diets. Although the fish *Pseudotolithus elongatus* is present in Badagry coastal waters, it is one of the popular imported fish into Nigeria and has a high price in Badagry market because of its characterized good flavor and palatability. However, there are no recent reports on the safety of consuming this fish. In this study, 182 specimens of fresh *P. elongatus* purchased from Badagry market during October 2016 to April 2017 were examined for heavy metal composition (iron, copper, zinc, chromium, and lead) to assess their safety levels for human consumption. Samples were digested using the FAO and APHA procedures, while heavy metal concentrations were determined using an atomic absorption spectrophotometer. Statistical analysis was carried out using ANOVA. The average concentrations of iron (Fe), copper (Cu), zinc (Zn), chromium (Cr), and lead (Pb) detected in the entire content of *P. elongatus* were 14.55±1.17, 0.20±0.02, 3.92±0.61, 0.06±0.02, and 0.35±0.02 mgkg^{-1}, respectively. These concentrations were below the maximum limits recommended in fish and fishery products by the WHO and the FAO. Thus, this study confirms the safety of consumption of this fish from Badagry market. Nevertheless, sellers and processors must embrace hygienic practices to avoid contamination of the fish.

INTRODUCTION

Fish is a fundamental cheapest source of protein and other essential minerals such as omega -3 fatty acids which prevent cardio-related problems (Brawn, 2011). Globally, the concern about the quality of fish has increased. In Nigeria, several studies on heavy metals in fish have been carried out. Also, it has been reported that exposure to heavy metal could result into cancers, retardation in infant development and growth, kidney damage and even death (Ndimele and Kumolu-Johnson, 2012). However, metals such as chromium, zinc and nickel are beneficial in human diet but their concentration needed to be monitored (Abduljaleel and Shuhaimi-Othman, 2011). Although, the maximum permitted levels of metals in fish have been introduced in many parts of the world including Nigeria, however, the necessity to intensify studies on monitoring of heavy metal levels in fish cannot be overemphasized. In Nigeria, over 50% of the population obtained their fish in the market from fish mongers or fish retailer. Many at times, some of these fish are further contaminated by retailer through poor handling and processing. Sequel to the above, the present study aimed to assess heavy metals concentration (iron (Fe), copper (Cu), zinc (Zn), chromium (Cr) and lead (Pb)) in fresh *P.elongatus* from Badagry Market in Nigeria, with a view to ascertain its safety for human consumption.

MATERIAL AND METHOD

Study Area

The study site (Agbalata market) in Badagry, Lagos State, Nigeria is an international market being patronized by Nigerian and Republic of Benin. Badagry is one of the maritime towns of Lagos State, located 57km from Lagos on Longitude $2^0 42^1$ and $3^0 23^1$ E, and Latitude $6^0 23^1$ and $6^0 28^1$ N. It is bounded in the west by Seme-Border, and wholly bounded by the Atlantic Ocean in the south (Lawson et al., 2005).

Collection of Samples

Ten (10) samples of *Pseudotolithus elongatus* (popularly called Brown Croaker in Nigeria) were collected three times monthly from the fish retailers in Badagry market between October, 2016 and April, 2017. The samples were transported in polyethylene bags, previously cleaned and treated with 5% nitric acid and rinsed with distilled water (APHA, 2005). For each month, a total of 30 specimens of *P. elongatus* were sampled except in April, 2017 when 32 specimens were sampled. The ranges of the fish weight and length measured by using weighing balance (Havard trip balance, USA, of capacity 10 kg) and measuring board respectively are 70.90±4.52 g-91.85±4.80 g and 37.50±0.74 cm-40.40±0.65 cm. After length and weight measurement, the fish were washed with tap water and stored in a freezer at -10°C for 96 hours.

Sample Treatment

All frozen samples were allowed to thaw at room temperature (approx. 28°C attained in 5-6 hours). 10 fish samples (in triplicate) were dried monthly, in a laboratory oven at 105 ± 20^0 C for 24 hours to obtain a constant dry weight for each set. Then, dried samples were grounded to powder, using laboratory ceramic mortar and pestle (50mL capacity, Laura Ashley model, UK), and sieved with 2mm mesh sieve to remove coarse material. The powdered fish samples were digested (in triplicate) according to the methods described by American Public Health Association (APHA, 2005) and FAO/WHO (2011).One gram of the fish sample was digested in a mixture containing 70% perchloric acid (Perchloric acid, 69-72% Baker Analyzed® A.C.S. Reagent, USA), concentrated nitric acid (2.5 L Nitric acid, 70-71% Baker Instra-Analysed® Reagent, USA) and concentrated sulphuric acid (Sulphuric acid 95-97% for Analysis, EMSURE® ISO, Germany) in the ratio 1:5:1. The digestion was done at temperature of 80±5°C in a fume chamber (Labconco Fiberglass 30 fume, India) for 2 hours. The digestion continued until a colourless liquid was obtained. Atomic absorption spectrophotometer (Buck scientific 210 VGP model, USA) was used to analyse metal concentration in the digested fish samples. The analytical procedure was checked using reference material (DORM 1, Institute of Environmental Chemistry, NRC Canada). The levels of metal were expressed in mg kg^{-1} dry weight.

Statistical Analysis

Data were expressed as mean±standard deviation while the monthly variation of the metals in the samples was tested by one-way Analysis of Variance (ANOVA) (Statistical Package for the Social Sciences, windows version 17.0, Chicago, USA). Fisher's least significant difference was used to separate the means. The level of significance was set at p=0.05.

RESULTS AND DISCUSSION

The monthly concentrations of heavy metals-iron (Fe), copper (Cu), zinc (Zn), chromium (Cr) and lead (Pb) detected in *Pseudotolithus elongatus* during this study was presented in Table 1, while the permissible limits of heavy metals in fish as recommended by world health organization (WHO) were shown in Table 2.

The highest and lowest concentrations of heavy metals recorded in the sample throughout the months were Fe and Cr respectively. However, there were no significant ($p>0.05$) differences in the monthly mean values of the metals except in Fe ($p<0.05$).There were significant differences ($p<0.05$) in Fe concentrations recorded between the months of November (16.80±1.34) and December (15.80±1.02), December(15.80±1.02) and January (14.90±1.08), and January (14.90±1.08) and February (12.84±0.98) respectively. Also, significant differences ($p<0.05$) existed between November (16.80±1.34) and March (12.62±1.20). In general terms, all the values of Fe(October-January) are significantly higher than values of Fe obtained in February, March and April respectively. This monthly variation in Fe affirmed the report of Ndimele and Kumolu-Johnson (2012) that fish can rapidly bio-accumulate iron in aquatic environment. The concentration of Fe (12.40±1.08mgkg^{-1} - 16.80±1.34mgkg^{-1}) recorded in this study were lower when compared with those detected in *Cynothrissa mento* (Kumolu-Johnson et al., 2010), and *Gadus morhua* (Eze and Ogbuehi, 2015). This present findings could implies that the specimen accumulate little Fe in their body. Iron is an essential component of haemoglobin which is responsible for oxygen transportation in the body. Severe iron deficiency in human causes anaemia (Mekuleyi et al., 2015). The Fe concentration obtained in this study was below 20.0mgkg^{-1}recommended maximum permissible limit in fish (WHO, 1985; FAO/WHO, 2011), but it was higher than those reported in *Clarias gariepinus* (Ugwu et al., 2012) and *Johnius belangeni* (Igwemmar et al., 2013).The Cu contents (0.12±0.04mgkg^{-1}-0.28±0.02mgkg^{-1}) recorded in this study were lower than the values reported in previous studies such as Edet et al., (2014) in *Chrysichthys nigrodigitatus*, Oguzie (2009) in *Parachanna obscura* and Obasohan et al., (2006) in *C. nigrodigitatus*. The Cu content in the present study was lower than 0.40mgkg^{-1}maximum permissible limit of Cu in fish (WHO, 1985, FAO/WHO 2011). However, it was higher than Cu concentration reported in fish by Ugwu et al., (2012) and Igwemmar et al., (2013). The high Cu in this study could have resulted from discharge of untreated wastes into the water bodies from which the specimen are caught, and poor handling, transportation material and storage facilities.

The mean values of Zn (2.98±0.32mgkg^{-1}–4.80±0.65mgkg^{-1}) recorded in this study was below the 5.0mgkg^{-1} WHO recommended maximum limit in fish. However, the values of Zn concentration in the present study is higher than Zn content reported by Ugwu et al., (2012) and Ndimele and Kumolu Johnson (2012). Zinc contamination

Table 1. Monthly levels of heavy metals (mg/kg) in Pseudotolithus elongatus from Badagry market in Nigeria (October 2016-April 2017). (Fe: iron; Cu: copper; Zn: zinc; Cr: chromium; Pb: lead).

Months	Fe	Cu	Zn	Cr	Pb
October	16.50±1.50^{a}	0.12±0.04^{a}	4.08±0.75^{a}	0.05±0.02^{b}	0.40±0.05^{ab}
November	16.80±1.34^{a}	0.19±0.02^{a}	4.22±0.57^{a}	0.07±0.01^{b}	0.42±0.04^{ab}
December	15.80±1.02^{b}	0.28±0.02^{a}	4.80±0.65^{a}	0.06±0.02^{b}	0.45±0.02^{ab}
January	14.90±1.08^{c}	0.26±0.05^{a}	4.02±0.68^{a}	0.09±0.03^{b}	0.36±0.05^{ab}
February	12.84±0.98^{d}	0.25±0.01^{a}	3.86±0.82^{a}	0.06±0.02^{b}	0.34±0.02^{ab}
March	12.62±1.20^{ab}	0.20±0.01^{a}	3.45±0.45^{a}	0.05±0.01^{b}	0.25±0.01^{ab}
April	12.40±1.08^{ab}	0.16±0.01^{a}	2.98±0.32^{a}	0.04±0.02^{b}	0.20±0.01^{ab}

Results are expressed as mean±standard deviation (n=182).

Mean values bearing different superscripts within the column are significantly different ($p<0.05$).

Table 2. FAO/WHO (2011) Recommended Permissible limits of heavy metals in Fish (mg/kg). (Fe: iron; Cu: copper; Zn: zinc; Cr: chromium; Pb: lead).

WHO limits	Fe	Cu	Zn	Cr	Pb
Minimum	3.0	0.004	0.5	0.05	0.01
Maximum	20.0	0.40	5.0	0.10	0.48

has effect on the hepatic distribution of other trace metals in fish. The mean range of Cr (0.04±0.02 $mgkg^{-1}$-0.09±0.03 $mgkg^{-1}$) in the present study was within the WHO and FAO recommended limit of 0.1 $mgkg^{-1}$.It was also lower than those reported by Ugwu et al. (2012), Oguzie (2009) and Ndimele and Kumolu-Johnson (2012). The low level of Cr in the sample could suggest that the samples might have been caught farther from industrial areas.

Pb (0.20±0.01 $mgkg^{-1}$- 0.45±0.02 $mgkg^{-1}$) concentration in this study did not exceed 0.48 $mgkg^{-1}$ recommended permissible limits (FAO/WHO, 2011). The low level content of lead in this study implies that the fish has no harmful lead effect. However, the Pb level in this study was higher than those reported by Jenyo-Oni and Oladele (2016) in *Oreochromis niloticus*. On the contrary, Pb content in the present study was lower than those recorded in *Scomber scombrus* by Abubakar et al., (2014) and Kareem et al., (2016). The presence of heavy metals in the fish samples is an indication that the fish is exposed to pollution whose sources could be either point or non-point sources.

CONCLUSION

It is evident from the study that fresh *P. elongatus* from Badagry market contained all the heavy metals (Fe, Cu, Zn, Cr and Pb) examined in this study, although their concentrations are still within the permissible limits. Therefore, it could be concluded that consumption of the fish samples from Badagry market is safe at present. However, sellers and processors should embrace hygienic practices to avert further contamination of the fish.

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