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EVALUATION OF HEAVY METALS IN THE KIDNEY, LIVER, AND MUSCLE TISSUES OF *Tragelaphus scriptus, Hystrix cristata,* and *Thryonomys swinderianus* IN TARABA STATE, NIGERIA

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ABSTRACT

Heavy metals are dangerous elements of the earth crust and they tend to bioaccumulate, increasing concentration level in biological organism over the time. This study evaluates heavy metal concentrations (Fe, Cu, Mn, Cd and Pb) in the kidney, liver, and muscles tissues of Antelope (Tragelaphus scriptus), Grasscutter (Thryonomys swinderianus) and Porcupine (Hystrix cristata) in Taraba State, Nigeria. A total of 18 smoked samples from the kidney, liver, and muscles tissues of Antelope (Tragelaphus scriptus), Grasscutter (Thryonomys swinderianus) and Porcupine (Hystrix cristata) were used for the study. The samples were digested and analyzed using Atomic Absorption Spectrometer (AAS). Results obtained from the heavy metal analysis revealed that the concentration of Pb in Antelope's liver and kidney (0.780±0.107ppm, 0.775±0.19ppm), Grass cutter's muscle and liver (0.584±0.085ppm, 0.434±0.010ppm), and Porcupine's liver (0.430±0.01ppm) were higher than the safe limits recommended by WHO (0.01-0.38ppm) for human consumption. While the heavy metal concentrations (Fe, Cu, Mn, and Cd) were within the safe limits. The high level of Pb in the samples is a matter of concern for bush meat consumption from that area. Therefore, the study recommends the need for continuous education of hunters and farmers on the detrimental effects of using guns for hunting and the use of chemicals for agricultural activities mostly around the reserves where game animals are found.

Keywords: Heavy metals, safe limits, hunting, game animals

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INTRODUCTION

Consumers often consider bush meat a wholesome, safe alternative to commercially produced meat on sale at grocery stores. In some regions, it is preferred to farm-raised meats for its taste or based on the perception that industrial meats contain chemicals and additives (van Vliet and Mbazza, 2011). Moreover, bushmeat also plays a special role in the cultural and spiritual identity of indigenous peoples (Siren, 2012). Cawthorn and Hoffman (2015) have provided an extensive review of the nexus between bush meat and livelihoods, emphasizing the contributions of bush meat to food security, nutrition and well-being. In some communities, human ailments are treated with products derived from animals, also known as zoo therapy (Alves *et al*. 2013a). Such animal-based preparations constitute a plethora of medicinal solutions employed by numerous cultures since ancient times, and are still being used in different parts of the world as primary or complementary treatments (Alves and Rosa, 2013). Bushmeat has developed a widespread acceptance in the trade network which involves

hunters, wholesalers, retail traders, butchers and chop bar owners as well as the general public (Falconer, 1992). The demand for bush meat has been met through hunting from the wild by the use of guns, cutlasses, chase dogs, baiting with chemicals, and bush burning (Oduro and Kankam, 2002).

Hunting practices such as the use of guns and baits used for killing wild animals could be a great threat to human life due to the presence of harmful chemicals or heavy metals such as Lead (Pb), Cadmium (Cd), Manganese (Mn), Iron (Fe), Zinc (Zn) and Copper (Cu) (Hunt *et al*., 2009). The toxicity of heavy metals is one of the major environmental problems and its danger to animal and human health is as a result of bioaccumulation of these metals through food chain (Aschner, 2002, Aycicek *et al*., 2008) and the resultant effect on brain cells calls for concern.

Bush meat is consumed in Africa and other parts of the world, it becomes imperative to ascertain the levels of some of these heavy metals and make appropriate recommendations. This information will also guide prospective marketers, processors and consumers as to where they buy this game meat from, what to observe and possibly how best to process them. The broad objective of this study therefore is to evaluate the levels of (Fe, Cu, Mn, Cd and Pb) in the liver, muscle and kidney of smoke-dried bush meat samples obtain from wild sources.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out in Baissa, the headquarters of Kurmi Local Government Area, Taraba State, Nigeria. it is located on latitude 7° 15' 23.11" North and longitudes 10° 37' 4.51" East. The area is within the rain forest zone of Nigeria characterized by high rainfall patterns. The maximum rainfall occurs between August and September while November marks the start of the dry season, which lasts until early March. Average annual rainfall ranges between 1,200mm^3 to 2,500mm^3 with a mean annual temperature of 28^{o}C. It is a Guinea Savannah which is marked by forest and tall grasses.

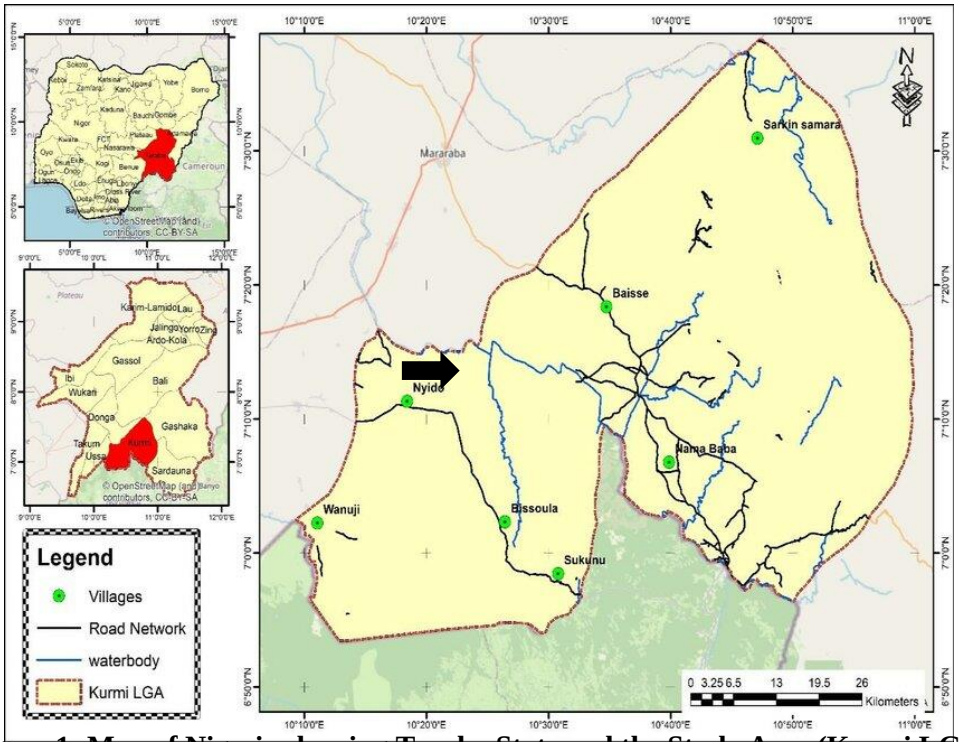

Figure 1: Map of Nigeria showing Taraba State and the Study Area (Kurmi LGA)
Source: Taraba Geographic Information System

Sample Collection

Fresh samples (18) of kidney, liver and muscles tissue were obtained from Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* which were then smoked in an ideal condition excluding contamination.

Digestion of Bush Meat Samples

Samples were digested according to Akan *et al.,* (2012). The laboratory analysis of the samples comprised of protein digestion of the meat samples, which was carried out in the wildlife laboratory of the Department of forestry and wildlife management, Taraba State University. 1g of each sample was weighed into a glass beaker for the digestion process. 10mls of nitric acid were added and kept for 24 hours after which a minimum time frame of one to two hours were used to boiled the samples on the cooking gas and allowed to cool down for five to ten minutes. Digested samples were filtered using 50 ml volumetric flasks, filter paper and a funnel and then topped up to 50 ml with distilled water.

Heavy Metal Analysis

The digested meat samples were transported to the University of Ibadan Central Laboratory for analysis. Determination of the heavy metals (Fe, Cu, Mn, Cd and Pb) was done using Atomic Absorption Spectroscopy (AAS).

Data Analysis

Results obtained for the heavy metal analysis were subjected to descriptive statistics using Statistical Package for Social Science (SPSS) to find out the prevalence and abundance of heavy metals concentration in Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata).*

RESULTS

Recorded mean value of the different heavy metals (Fe, Cu, Mn, Cd and Pb) in the smoked muscles of Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* respectively are as follows: Fe (0.337 ± 0.000), (0.756 ± 0.009), and (1.100 ± 0.126), Cu (0.654 ± 0.023), (0.118 ± 0.002), and (0.224 ± 0.006), Mn (0.039 ± 0.002), (0.537 ± 0.005), and (0.311 ± 0.004), Cd (0.003 ± 0.001), (0.003 ± 0.006), and (0.004 ± 0.000) and Pb (0.255 ± 0.043), (0.584 ± 0.085), (0.317 ± 0.048) (Table 1).

Table1. Heavy Metals Concentration in the muscles

Heavy metals	Antelope (ppm) (Mean ± S.D)	Grass cutter (ppm) (Mean ± S.D)	Porcupine (ppm) (Mean ± S.D)	Safe Unit (ppm)
Fe	0.337 ± 0.000	0.756 ± 0.009	1.1000 ± 0.126	4.49-15.0
Cu	0.654 ± 0.023	0.118 ± 0.002	0.224 ± 0.006	0.87.5.0
Mn	0.039 ± 0.002	0.537 ± 0.005	0.311 ± 0.004	NYC
Cd	0.003 ±0.001	0.003 ±0.006	0.004 ±0.000	0.33
Pb	0.255 ± 0.043	0.584 ± 0.085	0.317 ± 0.048	0.01-0.38

NYC- Not Yet Confirmed

Table 2 shows the mean value of the different heavy metals (Fe, Cu, Mn, Cd and Pb) in the smoked Liver of Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* respectively; Fe (0.780 ± 0.010), (2.450 ± 0.063), and (2.055 ± 0.013), Cu (1.481 ± 0.060), (0.541 ± 0.011), and (0.293 ± 0.006), Mn (0.332 ± 0.031), (1.177 ± 0.022), and (1.177 ± 0.022), Cd (0.001 ±0.000), (0.027 ±0.001), and (0.010 ± 0.001) and Pb (0.780 ± 0.107), (0.434 ± 0.010), and (0.430 ± 0.001).

The concentrations of the different heavy metals (Fe, Cu, Mn, Cd and Pb) in the smoked kidney of Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* respectively are also as follows; Fe (1.706 ± 0.036), (1.076 ± 0.013), and (1.045 ± 0.009), Cu (0.128 ± 0.002), (0.314 ± 0.006), and (0.348 ± 0.006), Mn (0.229 ± 0.03), (0.277 ± 0.008), and (0.358 ± 0.004), Cd (0.004 ±0.000), (0.034 ±0.002), and (0.054 ± 0.000) and Pb (0.775 ± 0.19), (0.357 ± 0.028), and (0.252 ± 0.041) (Table 3).

Table 2: Heavy Metals Concentration in the liver

Heavy metals	Antelope (ppm) (Mean ± S.D)	Grasscutter (ppm) (Mean ± S.D)	Porcupine (ppm) (Mean ± S.D)	Safe Unit (ppm)
Fe	0.780 ± 0.0108	2.450 ± 0.063	2.055 ± 0.013	4.49-15.0
Cu	1.481 ± 0.06	0.541 ± 0.011	0.293 ± 0.006	0.87.5.0
Mn	0.332 ± 0.031	1.177 ± 0.022	0.448 ± 0.005	NYC
Cd	0.001 ±0.000	0.027 ±0.001	0.010 ± 0.001	0.33
Pb	0.780 ± 0.107	0.434 ± 0.010	0.430 ± 0.01	0.01-0.38

NYC- Not Yet Confirmed

Table 3: **Heavy Metals Concentration in the kidney**

Heavy metals	Antelope (ppm) (Mean ± S.D)	Grasscutter (ppm) (Mean ± S.D)	Porcupine (ppm) (Mean ± S.D)	Safe Unit (ppm)
Fe	1.706 ± 0.036	1.076 ± 0.013	1.045 ± 0.009	4.49-15.0
Cu	0.128 ± 0.002	0.314 ± 0.006	0.348 ± 0.006	0.87.5.0
Mn	0.229 ± 0.03	0.277 ± 0.008	0.358 ± 0.004	NYC
Cd	0.004 ±0.000	0.034 ±0.002	0.054 ± 0.000	0.33
Pb	0.775 ± 0.19	0.357 ± 0.028	0.252 ± 0.041	0.01-0.38

NYC- Not Yet Confirmed

The heavy metal concentration for (Fe, Cu, Mn, Cd and Pb) in the smoked tissues (muscle, liver and kidney) of Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* were within the safe limits recommended for human consumption. While the heavy metal concentration for Pb in Antelope's liver and kidney, Grass cutter's muscles and liver, and Porcupines's liver were seen to be higher than the safe limits. (Table 1-3)

DISCUSSION

Heavy metal bioaccumulation in tissues of animals should be of great concern due to the detrimental effects of causing organ dysfunction and interrupting enzymes activities. In the present study, the heavy metal concentration for Pb in Antelope's liver and kidney, Grass cutter's muscles and liver, and Porcupine's liver were seen to be higher than the safe limits (Table 1-3). This is in contrast to the findings of Ampofo *et al.,* 2017 in which the Pb concentration was relatively high in the fresh bush meat and within the recommended limits in the smoked bush meat. Eboh *et al.,* 2006, Okoro *et al.,* 2015 also explain that the loss of moisture in fresh bush meat resulting from smoking goes concurrently with the reduction in Pb concentration as it is mostly found in the cytoplasm of cells. However, the higher concentration of Pb in the smoked tissues of bush meat as seen in the present study affirms a higher deposit of Pb from environmental contamination through anthropogenic activities. Also hunting practices involving the use of gun, causes the deposition of Pb in tissues as the bullet shots contain dispersion of heavy metals including Pb fragments (Hunt *et al.,* 2009). High concentration of Pb above the safe limits may pose serious health ailments to consumers as Pb is a toxic metal and non-biodegradable in nature (Agah *et al.,* 2009, Binkowski, 2012).

The heavy metal concentration for Fe, Cu, Cd and Mn in the smoked tissues (muscle, liver and kidney) of Antelope (*Tragelaphus scriptus)*, Grasscutter (*Thryonomys swinderianus)* and Porcupine (*Hystrix cristata)* as seen in the present study, were within the safe limits for human consumption as recommended by WHO. This is in agreement with the findings of Ampofo *et al.,* 2017 in which the mean concentrations of Mn, Cu, Fe and Cd in both the fresh and smoked bush meat were within the safe limits for human consumption.

CONCLUSION

The present study evaluates the concentration of heavy metals (Fe, Cu, Mn, Cd and Pb) in smoked

bush meat samples from Antelope, Grass cutter and Porcupine which are the game animals that are commonly hunted for bush meat. Previous literatures revealed that smoking which is one of the methods of bush meat processing and preservation reduces the concentration of heavy metals. The concentration of Pb in the present study, seen to be above the safe limits recommended for human consumption, which implies that there is a higher deposition of Pb in the environment as a result of anthropogenic activities. However, there is need for continuous education of farmers on the detrimental effects of using chemicals for agricultural activities mostly around the reserves where these game animals are found.

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