Original Research Article

ASSESSMENT OF HEAVY METAL CONTENT IN AFRICAN GIANT RAT (*Cricetomys gambianus)*

ABSTRACT

This study was undertaken to evaluate the concentrations of heavy metals in the liver, kidney and tissue of Africa giant rat (*Cricetomys gambianus)* in three (3) processing centers in Abeokuta, Ogun State with a view to determine its safeness for consumption. Atomic Absorption Spectroscopy was used to determine the concentrations of heavy metals in the liver, tissue and kidney of Africa giant rat. Data collected were analyzed using descriptive and inferential statistics. The study found out that Mn, Zn and Cu are the heavy metals present in liver, tissue and kidney of giant rat while cobalt, cadmium, chromium, lead and nickel are below detection limit. Mn levels ranged between 0.015 ± 0.002^{a}, 0.01 ± 0.002^{b} and 0.005 ± 0.003^{c} for liver, tissue and kidney respectively. Zn levels ranged between 0.070 ± 0.016^{a}, 0.032 ± 0.013^{b} and0.044 ± 0.006^{bc} for liver, tissue and kidney respectively. Cu levels ranged between 0.0087 ± 0.0061^{a}, 0.000 ± 0.000^{b} and 0.0057 ± 0.0001^{bc} for liver, tissue and kidney respectively. Highest manganese concentration was observed in the liver (0.015 ± 0.002^{a} mg/kg), highest copper concentration was found in the liver (0.0087 ± 0.0061^{a} mg/kg). The levels of heavy metals in the liver, tissue and kidney ranged from 1.91±0.00 to 3.96±0.00 mg/kg Zn; 0.15±0.00 to 0.17±0.00 mg/kg Pb; 0.20±0.00 to 1.98±0.00 mg/kg Cu; 0.03±0.00 to 0.27±0.00 mg/kg Cd; and 0.00±0.02 to 0.00±0.00 mg/kg Co; on average. The highest concentration of zinc and copper were found in the liver while manganese was also deposited more in the liver. The Analysis of Variance (ANOVA) test on the distribution and concentrations of all the metals in the liver, tissue and kidney shows that ($p<0.05$), i.e. there is significant difference in the amount of the elements in this samples and therefore not safe for human consumption.

KEYWORDS: Assessment, Consumption, Giant Rat, Health and Heavy Metals

1. INTRODUCTION

The African giant rat (*Cricetomys gambianus*) is a member of the order, *Rodentia,* subfamily, *Cricetomyinae*, and genus, *Cricetomys* [1]. This rat weighs up to 1200gm at adult life and grows up to 38cm long with a 45cm tail which has a characteristic white tip [1]. They are omnivorous animals feeding on vegetables, insects, crabs, snails and other items but apparently preferring palm fruits and palm kernels. The rats are distributed in all parts of Nigeria. In the rain forest zone, they are restricted to farmlands, grasslands and human habitations. Bush meat is a general term applied to meat obtained

from any wild terrestrial mammal, bird, reptile or amphibian harvested for subsistence or trade, mostly illegally. Since the beginning of civilization, game meat has been a main source of meat for humans and the main activity was hunting, particularly in developing countries [2, 3]. It is popular with a lower concentration of lipid than farm animals. The meat obtained from Africa giant rat is regarded as a delicacy in a number of West African countries [3]. There is a general wide acceptability of Africa giant rat regardless of religious faith and social status [4]. Meat and meat products form an important part of the human diet as well as an important source of a wide range of nutrients, but they may also contain certain toxic substances. Although the level of these toxic substances in muscle is generally low, offal, such as liver and kidney, showed higher concentration of toxic substances than most other foods [5]. Studies on the level of heavy metals in organs of various wild animal species particularly Giant rat in Nigeria are largely unavailable. The consumers of Giant rat meat are unaware of the level of heavy metal occurrence. Moreover, heavy metal concentrations in Giant rat are a critical issue for consumer safety.

This research work is to ensure safe consumption of Giant rat in minimizing the toxic effects of these metals on human health. The need for a better understanding of heavy metal composition in this animal is essential if human communities are to be safe from these metals and its adverse effects.

2. Materials and Method

2.1 Study Area

The study area is Abeokuta south and Odeda local government area of Ogun State. Abeokuta South is a Local Government Area in Ogun State, Nigeria. The headquarters of the LGA are at Ake Abeokuta 7°09′00″N 3°21′00″E. It has an area of 71 km² and a population of 250,278 at the 2006 census. Odeda is a Local Government Area and town in Ogun State, Nigeria. The headquarters of the LGA are at Odeda on the A5 highway 7°13′00″N 3°31′00″E. It has an area of 1,560 km² and a population of 109,449 at the 2006 census. Ogun State is situated in rainforest zone with annual rainfall of 100 - 150cm [6, 7]. The state has estimated population of 3,486,683 people for the year 2005. It is located in the southwest zone of Nigeria with a total land area of 16,409.26 km^2 [8]. It is bounded on the west by the Benin Republic, on the south by Lagos State and the Atlantic Ocean, on the east by Ondo State and on the north by Oyo and Osun States. Olomore bushmeat market is located in Abeokuta North local government area, Itoku bushmeat market is located in Abeokuta South local government while Alabata bushmeat market is located in Odeda local government area of the state.

2.2 Sample Collection and Heavy Metal Analysis

Six (6) samples of African giant rat were selected for this study in order to test the level of heavy metals in the liver, kidney and tissue of the animal in which 2 samples each were purchased from three bushmeat market in Abeokuta Ogun state.

The selected bushmeat markets are; Olomore, Itoku and Alabata. In each fresh-kill of the animal, the organs were removed immediately so as to avoid autolysis and the abdominal part of the samples was carefully macerated to remove the kidneys and liver, while lung were removed from the thoracic cavity. Internal tissue was then cut. Each set of organs were put in a separate glass container and labeled accordingly. This procedure was repeated for all the samples that were collected in the three bush meat markets.

The collected samples were decomposed by wet chemical digestion method for determination of various metals. In the laboratory, 1 g of the samples (liver, kidney and tissue) was weighed into the digestion flask. To each portion of sample in the flask, 5 ml of perchloric acid and 15 ml of 0.1 N concentrated HNO3 in a ratio 1:3 were added and then heated in an electric plate until sample became clear [9]. After digestion, 5 ml of 20% HCl (0.1 N) was added to the content. The content of the flask was filtered using Whatman filter NO42 paper into a 100 ml volumetric flask and was made up to the mark with a distilled water and then stored in a plastic reagent bottle, ready for Atomic Absorption Spectroscopy (AAS) analysis to determine Cu, Fe, Se, Zn [10] which was done at the laboratory of College of Veterinary Medicine University of Agriculture Abeokuta. In the laboratory, 5 g of the fresh and dried samples (liver, kidney and tissue) were also weighed in separate beakers and oven dried at 100°C.

2.3 Method of Data Analysis

The collected data were analyzed using descriptive and inferential statistics. One way Analysis of Variance (ANOVA) at 5% significant level was used to determine the association between the heavy metals and the organs in the animals. Mean values were separated using Duncan Multiple Range Test (DMRT) to determine variations due to sampling errors and differences in mean values were determined and accepted as being significantly different if $P< 0.05$.

3. RESULTS

3.1 Metal analysis

The result in table (1) shows the mean concentration of heavy metal content found in liver, tissue and kidney of giant rat. The result shows that the three heavy metals present in the organs are manganese, zinc and copper while cobalt, cadmium, chromium, lead and nickel are below detection limit. Mn levels ranged between 0.015 ± 0.002^{a}, 0.01 ± 0.002^{b} and 0.005 ± 0.003^{c} for liver, tissue and kidney respectively. Zn levels ranged between 0.070 ± 0.016^{a}, 0.032 ± 0.013^{b} and0.044 ± 0.006^{bc} for liver, tissue and kidney respectively. Cu levels ranged between 0.0087 ± 0.0061^{a}, 0.000 ± 0.000^{b} and 0.0057 ± 0.0001^{bc} for liver, tissue and kidney respectively.

The result shows that there is significant difference in manganese concentration in liver, tissue and kidney, while there is significant difference between zinc and manganese concentration in liver and kidney, liver and tissue, but there is no significant difference in tissue and kidney.

Table 1: Mean concentration of heavy metals in liver, kidney and skin

1	Liver	0.015 ± 0.002^{a}	0.070 ± 0.016^{a}	0.0087 ± 0.0061^{a}	BLD	BLD	BLD	BLD	BLD
2	Tissue	0.01 ± 0.002^{b}	0.032 ± 0.013^{b}	0.000 ± 0.000^{b}	BLD	BLD	BLD	BLD	BLD
3	Kidney	0.005 ± 0.003^{c}	0.044 ± 0.006^{bc}	0.0057 ± 0.0001^{bc}	BLD	BLD	BLD	BLD	BLD

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Concentration with same superscript is not significantly different and vice versa

BLD- Below Detection Limit

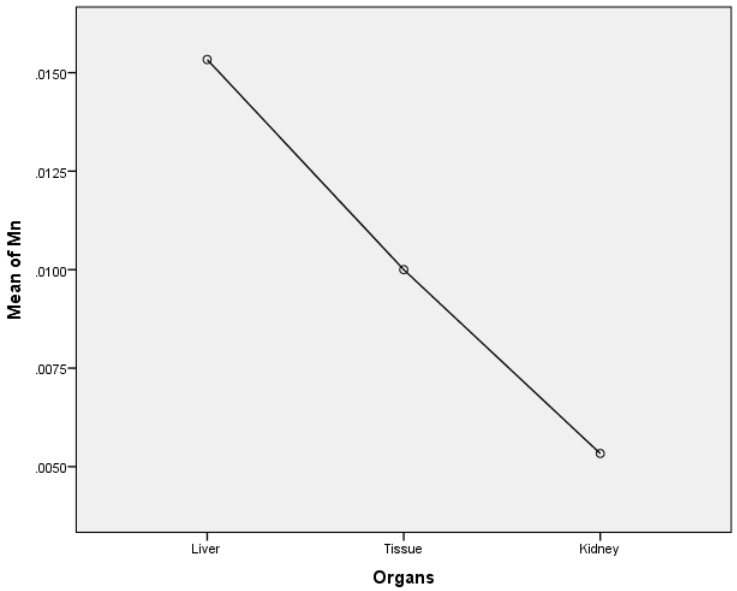

Figure 1: Mean manganese concentration

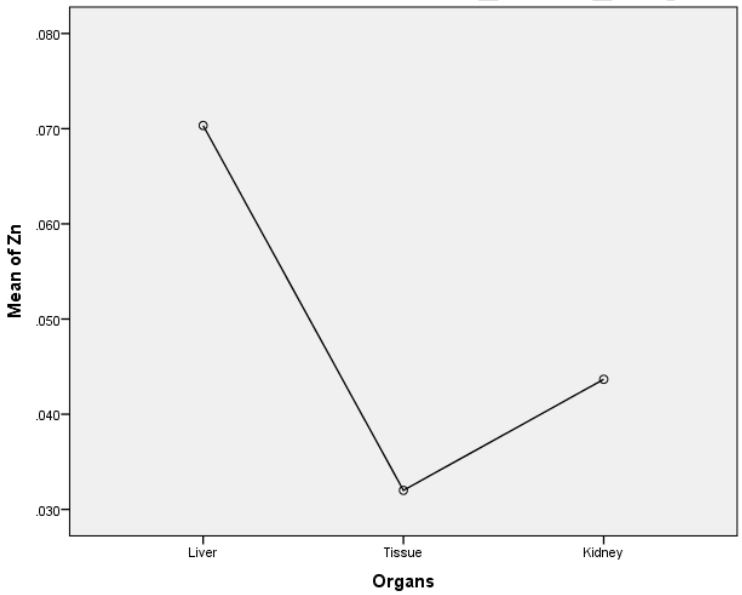

Figure 2: Mean zinc concentration

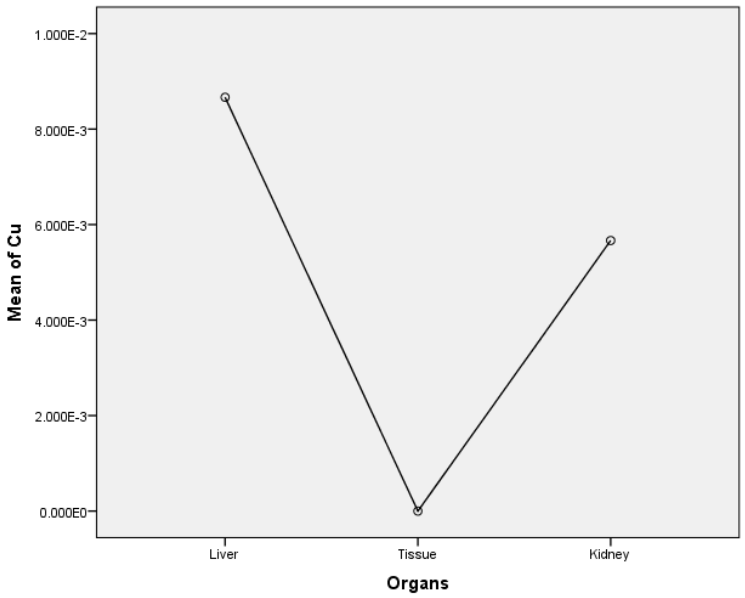

Figure 3: Mean copper concentration

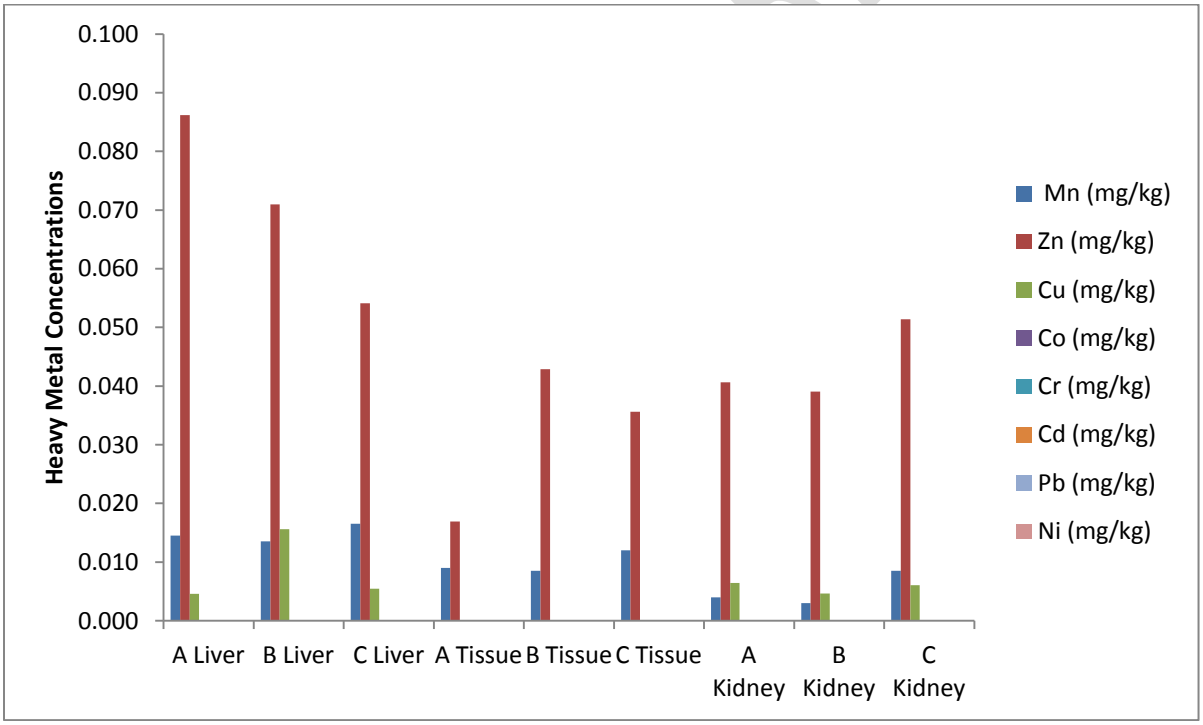

Figure 4: Heavy metal concentrations in each organ

3.2 Distribution of heavy metal content in various part of Giant rat

Table (2) shows the comparison of distribution of heavy metals concentration in Giant rat. It revealed that there is significant difference in manganese distribution in liver compare to tissue and kidney, while manganese distribution in skin compared to liver and kidney is also significantly different at ($p<0.05$). The kidney manganese distribution also shows significant difference when compared to liver and tissue. The result also shows that there is significant difference in zinc concentration in liver compared to tissue and kidney. Significant difference exists between zinc concentration in tissue compare to liver but not with kidney. Zinc concentration in kidney also shows significant difference with liver but not in tissue. The result of copper distribution shows that significant difference only occurs in liver compared to tissue.

Table 2: Distribution of heavy metal content in various part of Giant rat

Multiple Comparisons								
Dependent Variable		(I) Organ	(J) Organ	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Mn	LSD	Liver	Tissue	.00533*	.00187	.029	.0008	.0099
			Kidney	.01000*	.00187	.002	.0054	.0146
		Tissue	Liver	-.00533*	.00187	.029	-.0099	-.0008
			Kidney	.00467*	.00187	.046	.0001	.0092
		Kidney	Liver	-.01000*	.00187	.002	-.0146	-.0054
			Tissue	-.00467*	.00187	.046	-.0092	-.0001
Zn	LSD	Liver	Tissue	.03833*	.01031	.010	.0131	.0636
			Kidney	.02667*	.01031	.041	.0014	.0519
		Tissue	Liver	-.03833*	.01031	.010	-.0636	-.0131
			Kidney	-.01167	.01031	.301	-.0369	.0136
		Kidney	Liver	-.02667*	.01031	.041	-.0519	-.0014
			Tissue	.01167	.01031	.301	-.0136	.0369
Cu	LSD	Liver	Tissue	.00867*	.00301	.028	.0013	.0160
			Kidney	.00300	.00301	.357	-.0044	.0104
		Tissue	Liver	-.00867*	.00301	.028	-.0160	-.0013
			Kidney	-.00567	.00301	.108	-.0130	.0017
		Kidney	Liver	-.00300	.00301	.357	-.0104	.0044
			Tissue	.00567	.00301	.108	-.0017	.0130
*. The mean difference is significant at the 0.05 level.								

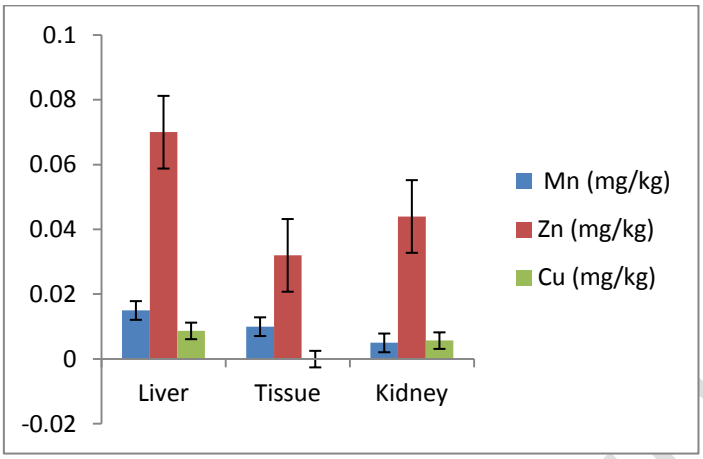

FIGURE 5: Mean Error Bar of Metal Concentration

4. DISCUSSION

The study observed the presence of three heavy metals found in Africa giant rat meat which are manganese (Mn), zinc (Zn), and copper (Cu) while cobalt, cadmium, chromium, lead and nickel are below detection limit. Highest manganese concentration was observed in the liver (0.015 ± 0.002^{a} mg/kg). Manganese is toxic to virtually every system in the animal body. It is almost absent in the human body at birth, however accumulates with age. This result is similar to a finding, where the concentration of manganese in the liver is more than that of the kidney of free grazing cattle from abattoirs situated in seven widely spread localities in southern Nigeria [11]. Many researchers have shown that manganese concentrates more in the liver than in the kidney [12]. Once manganese is absorbed, it accumulates in the body even throughout life [13]. Zinc also shows higher concentration in the liver and the kidney. The monitoring of zinc concentration in meat is important for human health. Excessive high level of zinc may enhance susceptibility to carcinogens [14]. The highest copper concentration was found in the liver (0.0087 ± 0.0061^{a} mg/kg) as seen from Table 1. The lowest concentration was observed in the skin (0.000 ± 0.000^{b} mg/kg). Copper is deposited more in the liver compared to the other organs as observed from the mean result from Table 1. A similar study found out that copper is deposited most in the liver of cattle [15]. Copper is an essential component of various enzymes and it plays a key role in bone formation, skeletal mineralization and in maintaining the integrity of the connective tissues. Copper is essential for good health, but very high intake can cause health problems such as liver and kidney damage [16]. The trend of mean manganese concentrations were liver > tissue > kidney, the trend of mean zinc concentrations were liver > kidney > tissue while the trend of mean copper concentrations were liver > kidney > tissue.

CONCLUSION

The study found out that various parts of giant rats consumed in Abeokuta metropolis in Ogun State, Nigeria seems not to be safe for consumption considering the concentrations of manganese, zinc, and copper present in them. This may be due to high levels of industrialization in the part of the country where the animals are found. The concentrations of these metals seem to be toxic for the body. However, since there can be accumulation of these elements resulting in toxicity, it is advisable to limit their consumption most especially the liver and kidney.

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