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Comparison between Mean Concentrations of Heavy Metals in Male and Female Cane Rats (*Thryonomys Swinderianus)* in Gyawana Ecosystem, Adamawa State, Nigeria

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Abstract

Many terrestrial ecosystems which include wild populations of small mammals are usually contaminated with potentially toxic trace elements from the accumulation of agricultural pesticide, fertilizers, industrial effluents and wastes disposal. This study was carried out in Gyawana ecosystem, Adamawa State, Nigeria, for a period of twelve months (December 2017 to November, 2018). A total of four hundred and eighty (480) male and female adult cane rats (Thryonomys swinderianus) were used, to compare the concentration of heavy metals (As, Cd, Co, Cr, Cu, Ni, Pb and Zn) in male and female T. swinderianus. The T. swinderianus were dissected separately to obtain the organs and flesh. The samples were dried at 105^{o}C and digested with tri-acid mixture (HNO_3: HCO_4: H_2SO_4). Determination of the heavy metals was done using a Buck Scientific 200A Model, Atomic Absorption Spectrophotometer. The result shows that, the mean concentrations of As (0.032±0.000mg/g) and Cd (0.306±0.004mg/g) was the same in both male and female T. swinderianus respectively, but higher mean concentration of Co, Cu, Pb and Zn was found in female (0.282±0.004mg/g, 18.827±0.050mg/g, 0.493±0.007mg/g and 8.395±0.098mg/g)Respectively, than male rats (0.0281±0.004mg/g, 17.757±0.049Mg/g, 0.364±0.004mg/g and 8.377±0.098mg/g) respectively, even though there was no significant difference since ($p < 0.05$). Ni was significantly higher in male rats (0.040±0.001mg/g) than the females (0.036±0.0001mg/g), $p > 0.05$. In conclusion the heavy metal concentrations in male and female T. swinderianus sampled, female had higher concentrations level of most of the heavy metals studied with exception of arsenic which has the same mean concentration in male and female. The concentration level of nickel was higher in male than female, while chromium was not dictated in both sexes. Both male and female cane rats (T. swinderianus) of Gyawana Ecosystem are safe for consumption since the concentration level were within the permissible limit. Regular monitoring of heavy metals in Gyawana ecosystem should be carried out to ascertain the level of toxicants in wild populations of small mammals.

Keywords: Comparison; Heavy Metals; Cane rat (Thryonomys swinderianus); Gyawana; Ecosystem

Introduction

Many terrestrial ecosystems which include wild populations of small mammals are usually contaminated with potentially toxic trace elements from the disposal of agricultural waste, pesticide, fertilizers, industrial effluents and other wastes disposal. These wastes are usually high in heavy metals which can be absorbed by plants and later found in high concentrations in animal's tissues and finally humans (Durojaye *et al.* 2014). Rats are widely distributed and valuable animal and good source of protein supplements in West and Central Africa. Rats can be found in cultivated areas, sugar cane plantations and fields where groundnut, maize, rice and cassava are grown. They are monogastric herbivores, make good use of roughages, very fond of sweet and salty foods, but are wasteful feeders. They readily adapt to a variety of diets which includes grasses, leguminous fodder, roots, fruits, tubers and food crops (Wilkie and Godoy, 2001; Durojaye *et al*. 2014). The presence of heavy metals in terrestrial animals like rats is becoming a threat, thereby making them unfit for human consumption. For this reason, the investigation of heavy metals in rat (*T. swinderianus)* is essential. Any changes in concentration of heavy metal above the acceptable levels may alter the metabolic process in rat. Heavy metals enter the body system through food, air and water and bioaccumulation over a period of time (Cobelo-Garcia *et al*. 2003; Lenntech, 2004; Yahaya *et al.* 2009). When agricultural soils are polluted, these metals are taken up by plants and consequently accumulate in their tissues (Trueby, 2003). Animals that graze on such contaminated plants and drink from polluted waters also accumulate such metals in their tissues and milk (Peplow, 2000). Contamination

of the environment by heavy metals is viewed as an international problem because of the effects on the ecosystem in most countries. The situation is even more worrisome in the developing countries where research efforts towards monitoring the environment have not been given the desired attention by the stake holders. In areas such as Gyawana, the situation is no better because of the industrial activities at the Savannah Sugar Company and the immediate community in terms of waste disposal which could lead to increasing levels of pollutant in the ecosystem. In order to effectively control and manage ecosystem pollution, it is imperative to have a clear identification of the heavy metals and their concentration levels in an ecosystem; hence the need for this research. This study was carried out mainly to compare by sex the concentrations of heavy metals in the cane rat (*T. swinderianus),* in Gyawana Ecosystem.

Materials and Methods

Sampling Area

The study was carried out in Gyawana ecosystem, Lamurde Local Government Area, Adamawa State of Nigeria. Gyawana is located at latitude 9˚.35' N and longitude 11˚.55' E and is 135 meters above Sea level. Lamurde Local Government Area lies between longitude 9˚.36' 03.92"N and latitude 11˚.47' 36.25"E at an elevation of 137 meters above sea level (Adebayo and Tukur, 2004). Adamawa State is located in the North Eastern part of Nigeria, and lies between latitudes 7˚ and 11˚ N and between longitudes 11˚ and 14˚ E. It is on an altitude of 185 meters above Sea level and covers a land area of about 39,741km^2 (Fig.1).

The study was conducted for a period of twelve (12) months (December 2017 to November, 2018). Cane rats (*T. swinderianus)* were collected once every first week of a month from various locations (Gokumbo, Italiah, Nguro Bemun and sugar cane farms of the Savanna Sugar Company); in Gyawana ecosystem, Lamurde local Government Area, Adamawa State, Nigeria.

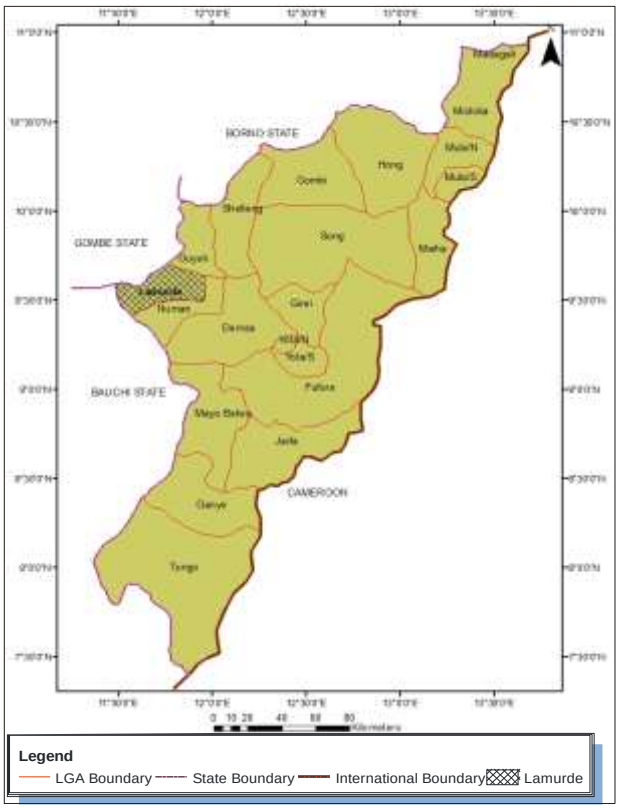

Figure1: Map of Adamawa State Showing Lamurde Local Government as the study Area

Sampling and Sample Preparation

A total of four hundred and eighty (480) adult male and female cane rats (*T. swinderianus)* were collected making a sub total of forty (40) per month sampled from cultivated areas near streams and rivers side which may be a potential source of contamination due to the use of pesticides and agro-chemicals. The *T. swinderianus* were trapped using mouse glue traps (Plate 1). Blood samples were collected from the lower limb vein of trapped rats using micro-capillary tube. Each blood sample was then dropped on a Whatman No.1 filter paper to air dry. The rats were then sacrificed immediately by suffocation using 2mls of 5% chloroform in air tight transparent plastic containers adopting the method of (Iyanda and Adeomi, 2013) with ethical considerations. The length of each *T. swinderianus* was measured using a meter rule and the weight was measured using a Pesola Spring Balance. The *T. swinderianus* were washed with de-ionized water to remove any attached heavy metals on their body surface and dissected using dissecting instruments as soon as they were sacrificed. The brain, liver and flesh were removed separately for the different sexes and transferred into sterile sample bottles which were labeled and taken to the Animal Production Laboratory of Adamawa State University, Mubi, Adamawa State, Nigeria, for digestion.

Sample, Digestion and Heavy Metal Analysis

Each organ of *T. swinderianus* was dried in a furnace equipped with circulation system at 105^{o}C until it reached a constant weight, and properly homogenized using porcelain mortar and pestle before 5.0gram was taken for digestion. The ground *T. swinderianus* organs were transferred to a porcelain basin and put into a muffle furnace, whose temperature was gradually increased to a maximum of 550^{o}C. The samples were digested with tri-acid mixture (HNO_3: HCO_4: H_2SO_4) in the ratio of 10:4:1, respectively at the rate of 5mls per 5.0gram of sample and placed on a hot plate of 100^{o}C temperature. Digestion was allowed to continue until the liquor became clear. All the digested liquor was filtered through Whatman 541 filter paper and diluted with 25mls of distilled water. Determination of the heavy metals was done directly on each final solution using a Buck Scientific 210A Model, Atomic Absorption Spectrophotometer (AAS) and the values obtained were expressed in milligram per gram (mg/g) (APHA, 1995; AOAC, 2000; APHA, 2005).

Data Analysis

Student t-test was used to test for difference of heavy metals levels between the male and female cane rat (*T. swinderianus*) using a statistical software package (SPSS for Windows). The results were presented as mean±standard error and $P > 0.05$ was regarded as not statistically different.

Results

The result of this analysis shows that, the mean concentrations of As (0.032±0.000mg/g) and Cd (0.306±0.004mg/g) was observed to have the same level in both male and female *T. swinderianus*. But higher concentration of Co was found in female (0.282±0.004mg/g) than male rats (0.0281±0.004mg/g), statistically there was no significant difference since $p > 0.05$.

Cu was found to be higher in female (18.827±0.050mg/g) than male (17.757±0.049Mg/g) *T. swinderianus* and Ni was significantly higher in male *T. swinderianus* (0.040±0.001mg/g) than the females (0.036±0.0001mg/g), $p > 0.05$. The concentration of Pb was significantly higher in female *T. swinderianus* (0.493±0.007mg/g) than males (0.364±0.004mg/g). Also a similar trend obtains for Zn, being higher in female *T. swinderianus* (8.395±0.098mg/g) than male (8.377±0.098mg/g). There was significant difference in the mean concentration of Zn since $p < 0.05$.

Table 1: Mean Concentrations (mg/g) of Some Heavy Metals in Male and Female Cane rats (*T. swinderianus)*

Metals	Male Cane rats	Female Cane rats	
As	0.032 ± 0.000^{a}	0.032 ± 0.000^{a}	ns
Cd	0.306 ± 0.004^{b}	0.306 ± 0.004^{b}	ns
Co	0.281 ± 0.004^{b}	0.282 ± 0.004^{b}	ns
Cr	ND	ND	
Cu	17.757 ± 0.049^{b}	18.827 ± 0.050^{b}	ns
Ni	0.040 ± 0.001^{a}	0.037 ± 0.001^{a}	ns
Pb	0.365 ± 0.004^{b}	0.493 ± 0.007^{a}	*
Zn	8.377 ± 0.098^{a}	8.395 ± 0.098^{b}	*

NB: Means with the same superscripts in each row are not significantly different at $p > 0.05$.

Key: ns = not significant, * = significant, ND = Not Detected

Discussion

The analysis of cane rat shows that, the mean concentrations of arsenic and cadmium were the same in both male and female cane rats (*T. swinderianus),* but male rats had higher concentrations of nickel, while the female had higher concentrations of cobalt, copper, lead and zinc. Bio-accumulation of heavy metals in animals varies according to their sex, size and age (Damek-Poprawa and Sawicka-Kapusta, 2004; Nesta *et al.* 2016). Although, the ages of rats in this study was not determined, the results of sex differences in the accumulation of heavy metals in cane rats in this study showed no statistical variation ($p > 0.05$) except in lead and zinc. However, the level of Ni was higher in the male cane rats (*T. swinderianus)* compared to females. In the female rats; Co, Cu, Pb and Zn were higher than in male *T. swinderianus*. The results of this study is in line with that of Blagojevic *et al.* (2012) who reported that, in the skull of mice from two localities in Serbia no gender dependent variation was detected for Fe, Mn, Co, Cd, Zn, Ni, Pb and Cu ($p > 0.05$). The results of this study is also similar with the findings of Nesta *et al*. (2016), who stated that the average Cd levels in the liver (0.12 mg/g dw) and kidneys (0.65 mg/g dw) of females were two times higher than in male liver (0.07 mg/g dw) and kidneys (0.29 mg/g dw), respectively. Absorption of some heavy metals is through the gastrointestinal tract (GIT), however this can be affected by several factors, such as age, sex, nutritional status, and preceding metal burden. Among these, young age, iron deficiency, and being female are reported to accelerate the absorption of metals through the GIT in both humans and animals (Nesta *et al*. 2016).These could be the reasons why Co, Cu, Pb and Zn concentrations were higher in females than males. Exposure of wild cane rats (*T. swinderianus)* to heavy metals in Gyawana could have resulted from municipal waste, the use and sometimes abuse of phosphate fertilizers and organic manures. Other sources may include leachates from Ni-Cd based batteries and Cd plated items which are carelessly discarded into the environment by battery chargers and users in Nigeria, a similar scenario has been reported by Bortey-Sam *et al*. (2015) in Ghana. Recently, electronic wastes are disposed and often burnt at refuse dumps; excess of these heavy metals may cause neurotoxicity, production of reactive oxygen species and disturbance of mitochondrial dynamics in rats and humans (Barhoumi *et al.* 2004; Martinez-Finley *et al*. 2013).

Conclusion

The result obtained in this study shows that, female cane rats (*T. swinderianus)* had higher concentrations of most of the heavy metals studied with the exception of As and Cd which has the same mean concentration level in both sexes. The concentration of the studied heavy metals in cane rats (*T. swinderianus)* were within the permissible limit in both sexes of (*T. swinderianus)* studied. Therefore, both sexes of cane rats (*T. swinderianus)* are safe for consumption. Regular monitoring of heavy metals in the cane rats (*T. swinderianus)* of Gyawana ecosystem should be carried out to ascertain the level of toxicants.

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