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ASSESSMENT OF SOME METALS CONCENTRATIONS IN SOME VITAL ORGANS OF SHEEP SLAUGHTERED AT GBOGOBIRI, CALABAR, CROSS RIVER STATE, NIGERIA

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ABSTRACT

The concentrations of some metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) in the liver, kidney, lungs and intestines of sheep slaughtered at Gbogobiri slaughter, Calabar, Cross River State were assessed for safety for four Months (October, 2015 to January, 2016) using Atomic Absorption Spectrophotometer. The result showed that there was no significant difference in levels of exposure to heavy metals between the four organs. The highest value of cadmium was recorded in the lungs (0.034±0.001) mg/kg while the kidneys and intestines recorded the lowest values (0.00 ± 0.00) mg/kg respectively. Cobalt was below detectable limits in the lungs and intestines but had its highest value (0.030 ± 0.003) mg/kg in the kidneys. Chromium was detected in all the organs with its highest value (0.071 ± 0.009) mg/kg recorded in the kidneys while the lowest value (0.030 ±0.003) mg/kg was recorded in the liver. The highest value of copper (0.059 ± 0.002) mg/kg was recorded in the liver while the lowest value (0.038 ± 0.001) mg/kg was recorded in the intestines. The liver also recorded the highest values of Iron (0.092 ± 0.002) mg/kg, manganese (0.052 ± 0.009) mg/kg, Nickel (0.022 ± 0.003) mg/kg, Lead (0.041 ± 0.005) mg/kg and Zinc (0.11 ± 0.002) mg/kg. Nickel was not detected in the lungs and intestines. Iron (0.041 ± 0.001) mg/kg and Manganese (0.036 ± 0.001) mg/kg was lowest in the intestines while the lungs recorded the lowest values of Lead (0.015 ± 0.001) mg/kg and Zinc (0.046±0.001) mg/kg. The concentrations of metals in the four organs of sheep did not show any statistical significant difference ($p>0.05$). The values were within the tolerable limits accepted by WHO and FAO. Consumption of meat from sheep sold at Gbogobiri is considered safe from the study but since metals do accumulate in biological systems over time, there should therefore be continuous monitoring of metals in sheep slaughtered at Gbogobiri.

Keywords: Assessment, Metals, Liver, Kidneys, Lungs, Intestines, Sheep, Gbogobiri, Calabar, Nigeria

1. INTRODUCTION

Contamination with heavy metals is a serious threat to man because of their toxicity, bioaccumulation and bio-magnification in the food chain (Damirezen and Uruc, 2006). Although contamination of animal feed by toxic metal cannot be entirely avoided given the prevalence of these pollutants in the environment, there is need for such contamination to be minimized with the aim of reducing both direct effect on animal health and indirect effects on the health of human consumers (SCAN, 2003).

One of the serious health threats to animals and humans in our today society is environmental pollution. Pollution resulting from our daily activities like transportation, industrialization, indiscriminate exploitation of natural resources etc. has been on the increase over the years.

Recent studies have shown that contaminating the environment and food with toxic metals had reached unprecedented levels over the past decade and pose serious risk to humans on the continent (Yabe *et al.*, 2010).

The risk associated with the exposure to metals present in food products has aroused widespread concern about human health. Therefore monitoring of the levels of heavy metals in the food chain is of great importance for the well-being of all life forms (Akoto *et al.*, 2014). Although some metals such as Zn and Cu are essential at low concentrations, the excessive concentrations in food are of great concern because of their toxicity to humans and animals at relatively higher concentrations. According to Baykov *et. al.*, (1996), heavy metals often have direct physiologically toxic effects and are stored or incorporated in living tissue.

A study carried out by John and Jeane (2005) showed that levels of arsenic, cadmium, mercury and lead were detected in several tissues of sheep at very high concentrations above the permissible level. In another study the distribution and localization of some heavy metals in the tissue of some sheep were detected, the most affected organs, which showed higher levels of trace metals, were livers, kidneys and small intestines (Horky *et. al.*, 2006). Lead is a metabolic poison and a neurotoxin that binds to essential enzymes and several other cellular components and inactivates them (Cunningham and Saigo, 1997). Food is one of the principal environmental sources of Cadmium (Baykov *et. al.*, 1996). As cadmium moves through the food chain, it becomes more and more concentrated as it reaches the carnivores where it increases in concentration by a factor of 50 to 60 times (Daniel and Edward, 2007). Toxic effects of cadmium are kidney dysfunction, hypertension, hepatic injury and lung damage (John and Jeanne, 2005).

Improvements in the food production and processing technology have increased the chances of contamination of food with various environmental pollutants, especially heavy metals. Ingestions of these contaminants by animals cause deposition of residues in meat. Due to the grazing of sheep on contaminated soils, higher levels of metals have been found in ram (Sabir *et. al.*, 2003). Gonza *et al.*, (2006) also recorded the levels of toxic metals, (lead and cadmium) in meat products exceeding recommended limits. Meat is a very rich and convenient source of nutrients including, to a large extent, micro elements. Chemical composition of meat depends on both the kind and degree of the feeding animal. The need for mineral compounds depends on the age, physiological state and feed intake as well as on living condition (Baykov *et al.*, 2009). Toxic effects on metals have been described in animals under relatively low level of metal exposure (Kostial, 1986); one of the earliest effects is the disruption of trace element metabolism (Goyer, 1997). The risk of heavy metal contamination in livers and kidneys of sheep is of great concern for both food safety and human health because of the toxic nature of these metals at relatively minute concentrations of metal (Santhi *et. al.*, 2008). Instances of heavy metal contamination in meat products during processing have been reported (Santhi *et. al.*, 2008; Brito *et. al.*, 2005). In other cases, contaminated animal feed and rearing of livestock in proximity to polluted environment were reportedly responsible for heavy metal contamination of meat (Miranda *et. al.*, 2005). In Nigeria, the meat, the liver and kidney of sheep are a major source of protein to the population and are widely consumed. The main source of metal in meat from sheep is contaminated feed and drinking water. Meat from sheep composes mainly of protein, fat and some important essential elements. It is essential for growth and maintenance of good health. Contaminants gain access into the animals through direct sewage water and industrial effluent that they take in. Contamination of meat from sheep can also be caused by vehicular emissions and from dirty slaughter environment.

2. MATERIALS AND METHODS

2.1 Sampling area

Gbogobiri is a Hausa settlement in Calabar. It is located within the bounds of Goldie Street, Barracks Road, and traversed by Mary Slessor Avenue in Calabar Municipality. Calabar is located at the extreme of South Eastern Nigeria between latitude 4.95000N and 8.32500E. Calabar is considered as the most preferred destination due to its serene climate with 24.5°C to 27.5°C and warm weather conditions. Rainy season spans from April to October and dry season from November to March.

2.2 Duration of study

The study was carried out within a period of four (4) months, from October, 2015 to January, 2016).

2.3 Sample collection and Preparation

Fresh samples of liver, kidneys, lungs and intestines of sheep slaughtered at Gbogobiri were collected from Gbogobiri slaughter house. The samples were kept in labeled polyethylene bags and stored in cooler boxes containing ice blocks before being conveyed to the Laboratory of the Department of Chemistry, University of Calabar for analysis. Samples were kept frozen prior to the period of analysis.

2.4 Laboratory analysis

One gram (1g) of dried sample was weighed into a beaker and 5ml of perchloric acid with 10ml of nitric acid added. The mixture was then heated until the whole sample was digested to a clear solution which was then diluted to 100ml with deionized water. The diluted sample was then analyzed in Atomic Absorption

Spectrophotometer (AAS) for the following metals, Mn – 279.5nm, Cu – 324.8nm, Fe – 248.0nm, Zn – 213.1nm, Cd – 228.9nm, Co – 240.7nm, Ni – 232.0nm, Pb – 283.3nm, Hg – 253.7nm.

2.5 Statistical analysis

Data were subjected to analysis of variance (ANOVA) and presented as mean ± standard errors.

3. RESULTS AND DISCUSSION

The mean values of the concentrations of heavy metals Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn in liver, kidneys, lungs and intestines of sheep slaughtered at Gbogobiri are presented in Table 1. The result showed that there was no significant difference in levels of exposure to heavy metals between the four organs.

The highest value of cadmium was recorded in the lungs (0.034±0.001) mg/kg while the kidneys and intestines recorded the lowest values (0.00 ± 0.00) mg/kg respectively. Cobalt was below detectable limits in the lungs and intestines but had its highest value (0.030 ± 0.003) mg/kg in the kidneys. Chromium was detected in all the organs with its highest value (0.071 ± 0.009) mg/kg recorded in the kidneys while the lowest value (0.030 ±0.003) mg/kg was recorded in the liver. The highest value of copper (0.059 ± 0.002) mg/kg was recorded in the liver while the lowest value (0.038 ± 0.001) mg/kg was recorded in the intestines. The liver also recorded the highest values of Iron (0.092 ± 0.002) mg/kg, manganese (0.052 ± 0.009) mg/kg, Nickel (0.022 ± 0.003) mg/kg, Lead (0.041 ± 0.005) mg/kg and Zinc (0.11 ± 0.002) mg/kg. Nickel was not detected in the lungs and intestines. Iron (0.041 ± 0.001) mg/kg and Manganese (0.036 ± 0.001) mg/kg was lowest in the intestines while the lungs recorded the lowest values of Lead (0.015 ± 0.001) mg/kg and Zinc (0.046±0.001) mg/kg.

Concentrations of Cadmium in all the organs of the sheep were lower than the acceptable limits by WHO and FAO. Cadmium is very toxic to animals and according to Mclaughlin *et al.*, (1999), cadmium can accumulate in kidneys and liver over a long time and can interact with a number of minerals such as Zn, Fe, Cu and Se due to chemical similarities and competition of binding sites. Miranda *et al.*, (2005) reported that the mean detectable concentration of Cd in the meat part of calves from polluted industrialized areas of Northern Spain was 0.161mg/kg and higher than 0.096mg/kg obtained for those in the rural areas. Falandysz, (1994) reported mean values higher than 0.038mg/kg in the liver of poultry from polluted areas of Poland while Tahvonen and Kumpulainen (1994) reported 0.021mg/kg in Finland. Akan, *et al.*, (2010) reported high concentrations (1.22 ± 0.21) mg/g of Cr in Caprine liver and low level (0.23mg/g) was reported in meat of beef. High Cd level (0.35mg/kg) has been reported by Okoye and Ugwu, (2010) in liver and 0.83mg/kg in kidneys of goats from Nigeria. The high levels of Cd in the liver and kidneys were ascribed largely to atmospheric deposition and free range grazing.

Chromium concentrations in all the samples were lower than the acceptable limits by WHO and FAO. Although chromium is an essential element which helps the body to use protein, sugar and fat, it is also known to be carcinogenic (Institute of Medicine, 2002). Excessive amounts of chromium in the body can cause adverse health effects (ATSDR, 2004). The copper content detected in the samples did not exceed the permissible limits set out by WHO and FAO. High levels of Cu were reported by Korenekova *et al.*, (2002) in muscles (4.57mg/kg) and liver (31.07mg/kg) of cattles. Miranda *et al.*, (2005) also reported high concentration of Cu to the tune of 26.6mg/kg 3.04mg/kg and 3.94mg/kg in muscle, liver and kidneys respectively of calves. Copper is essential for good health; it is an essential component of various enzymes and can play a key role in bone formation, skeletal mineralization and maintaining the integrity of the connective tissue (ATSDR, 2004). Although Cu has all the aforementioned benefits, very high intake can cause liver and kidney damage.

Iron concentration was below detectable limits. Okorafor and Amadiali, (2015) reported high concentration of Fe (0.107 ± 0.015) mg/kg in the liver of goats slaughtered at Atakpa Abattoir, Calabar, Nigeria. Akan, *et al.*, (2010) also reported high concentration (4.65 ± 0.30) mg/kg of Fe in the liver of chicken and low concentration 0.98mg/kg in beef. Fe is an important element within the haemoglobin molecule, which carries oxygen in every red blood cell. It is also an essential trace element which can occur naturally in plants and animal tissues.

Deficiency of Mn can cause nervous system problem, therefore daily intake of small amounts is needed for growth and good health in humans (Demirezen and Uruc, 2006). Okorafor and Amadiali, (2015) reported higher levels of Mn in the liver and lower levels in the kidneys. But both the higher and lower levels of this element observed were lower than the permissible limits set by WHO and FAO.

Nickel concentration was higher in the liver and lower in the kidneys. Okorafor and Amadiali, (2015) reported low Ni concentration in the liver and kidneys of goats slaughtered at Atakpa abattoir in Calabar, Nigeria. Ni is a micro nutrient and present in a number of enzymes in plants and micro-organisms. Khurshid and Igbal (1984) reported that Ni regulates prolactin and stabilizes RNA and DNA structures in humans. However, excessive intake of Ni can cause severe allergic reactions (Mutric and Viswanathan, 1998). Sabir *et al.*, (2003) reported Ni concentrations up to 2ppm and 1ppm in mutton and beef, respectively.

Zinc was highest in the liver. Mukhacheva and Bezel, (1995) found high levels of copper and Zinc in the liver and kidneys of mutton and beef. Although Zn is an essential metal, when present in excessively high concentrations in organs of animals (sheep), it can pose significant health risk to consumers of their meat. ATSDR (2004) reported that excess consumption of Zn in diets can result in heaematological defects such as anaemia and induction of copper deficiency by hindering its absorption. Concentrations of Zn in all the organs were below the permissible limits by WHO and FAO.

Among all the organs examined, the liver accumulated the highest levels of metals. This could be attributed to the role it plays in the body. The liver has the function of keeping the body pure of toxins and harmful substances. It detoxifies the blood to rid it of harmful substances and therefore can accumulate such harmful substances. Stoyke, *et al.*, (1995) reported that the liver is a storage and metabolic organ.

4. CONCLUSION

The concentrations of all the metals in the organs (liver, kidneys, lungs and intestines) of sheep slaughtered at Gbogobiri were similar. However, the liver accumulated higher levels of metals than any other organ of the body examined. In order to prevent human exposure to these metals, preventive measures should be taken to avoid accumulation of the metals beyond acceptable limits in sheep. Pesticides and fungicides use as well as phosphates and sewage sludge fertilizers should be in check in order to reduce the pollution with metals. Feeds for sheep should not be harvested from polluted sites such as industrial drainages and oil spilled areas. Heavy metals in the organs of the sheep may be traced to industrial and municipal effluent discharges on the environment where fodder is harvested as well as other anthropogenic activities. Efforts should be made to scale down on anthropogenic activities that encourage injection of heavy metals into the environment and accumulation in grasses and other useful plants. Sanitary and health officers should be employed and trained by the government on the requisite techniques of detecting heavy metals in meat sold to the public not only slaughtered at Gbogobiri but in other slaughter houses. Periodic monitoring and evaluation of the outcome should be analyzed to assess impact on the health of the populace.

REFERENCES

Akan J. C, Abdulrahman, F,I, Sodipo OA, Chiroma, Y.A. (2010). Distribution of heavy metals in the Liver, Kidney and Meat of Beef, Mutton, Caprine and Chicken from Kasuwan Shanu Market in Maiduguri Metropolis, Borno State, Nigeria. *Res. J. App. Sci. Engin. and Tech.*. 2(8):743-748.

Akoto O, Bortey Sam N, Nakayama SMM, Ikenaka Y, Baidoo E. Yahones YB, Mizukawa H, Ishizuka M. (2014). Distribution of heavy metals in organs of Sheep and Goat Reared in Obuasi, a Gold Mining Town in Ghana. *Int. J. Environ Sci. and Toxic. Res.* 2 (2): 81-89.

ANZFA (2001). Australia New Zealand Food Authority. Wellington NZ 6036. Retrieved from: URL: http://www.anzfa.gov.au.

ATSDR (2004). Agency for Toxic Substances and Disease Registry. Division of Toxicology, Clifton Road, NE, Atlanta, GA, Retrieved from: http://www.at.Cdc.gov/toxprofiles/.

Baykov, B. D, Stoyanor M. P, Grugora M. L. (1996) *Cadmium and Lead bioaccumulation in male chickens for high food concentrations. Toxial. Environ. Chem*., 54: 155 – 159.

Baykov, B. D., Stoyanor M. P., Grugora, M. L. Cadmium and lead bioaccumulation in male Chicken for high food concentrations. *Toxial. Environ. Chem*. 1996; 54: 155 – 159.

Brito G, Diaz C, Galindo L, Hardisson A, Santiago, D., Carcia, M. F. (2005). Levels of metals in canned meat products: intermetallic correlations. *Bull. Environ. Contam. Toxicol.* 44 (2): 309 – 316.

Cunningham, W. P.and Saigo, B. W. (1997). Environmental Science a Global concern. 4th edn. WMcBrawn Publisher, New York. pp 389.

Daniel, B. and Edward, A. K. (2007) Environmental Science, Earth as a living Planet. John Wiley and sons, Inc. New York, 278-279.

Demirezen, D. and Uruc, K. (2006). Comparative study of trace elements in certain fish, meat and meat products. *Meat Science.* 7(4): 255-260.

Falandysz, J. (1994) Some toxic and trace metals in big game hunted in Northern Part of Poland in 1987-1991. *Sci. Total Environ.* 141: 59-79.

GonzaLez, W. D, Karlsson, L., Caballero, A, Henandez, F., Gutierrez, A, Gonzalez-Igatesias T., Marino, M. and Hardission, A. (2006) Lead and cadmium in meat and meat products consumed by the population in Tenerife Island, Spain. *Food Addit. Contamin.* 2(3): 757-763.

Goyer, R. A. (1997) Toxic and essential metal interactions. *Annu. Rev. Nutr.* 1(7): 37-50.

Horky D, Ilek J, Pechova A. (2006) .Distribution of heavy metals in Sheep organs. *Vet Med.* 4(3): 331-342.

Institute of Medicine. (2002) Dietary reference takes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickle, silicon, vanadium and zinc. Institute of medicine of the National Academic. The National Academy press. Washington D.C USA.

John, H. H. and Jeanne, I. R. (2005) Food additives, contaminants and natural toxins. In: Maurice E. S., A. O. James., S. L. Moshe and Febiger, (Eds), *Modern Nutrition in health and disease.* 8th Edn. part II. pp: 1507 – 1598.

Khurshid, J. S. and Igbal, H. Q. (1984) The role of inorganic elements in the human body. Nucleus. 21:3-23.

Korenekova B, Skalicka M, Nadu P. (2002) Concentration of some heavy metals in Cattle reared in the vicinity of Merallurgic Industry. *Veterinary Archive.* 72(5):259-267.

Kostial, K. (1986) Trace elements in human and animal nutrition. 5th Edn. Hertz, W. (Ed), Academic Press, Orlando. 2: 319 – 345.

McLanghlin, M. J., Parker, D. R. and Clark, J. M. (1999) Metals and micro nutrients food safety issues. *Field Crops Res.* 60: 143 – 63.

Miranda, M., Lopez-Alonso, M., Castillo, J., Hernandez, J, Benedicto, L.(2005) Effects of moderate pollution on toxic and trace metal levels in sheep from a polluted area of northern Spain. *Environ. Int.* 3(1): 543 – 548.

Mukhacheva, S. V. and Bezel, V. S. (1995) Levels of toxic elements and functional structure in populations of small mammals under conditions of technogenic pollution (with reference to the bank vole). *Ekologiya.* 3: 237-240.

Mutric, C. R. K. and Viswanathan P. (1989) Toxic metals in the Indian Environment. Wiley Eastern ltd; New Dalhi.

Okorafor, K. A. and Amadiali, P. (2015) Concentrations of some metals in kidneys and liver of Goats slaughtered at Atakpa Abattoir, Calabar South, Cross River State, Nigeria. *Biosciences Research in Today's World.* 1(1): 90-96.

Okoye, C. O. B. and Ugwu, J. N. (2010) Impact of environmental cadmium, lead, copper and zinc on quality of Goat meat in Nigeria. *Bull. Chem. Soc. Ethiop.* 24 (1):133-138.

Sabir, S. M., Khan, S. W. and Hayat, I. (2003) Effect of environmental pollution on quality of meat in district Bagh, Azad Kashmir. *Pak. J. Nutr.*; 2(2):98-101.

Sansinanae, A. S., Carore, S. I., Streitenberger, S. A, Garcia, C. and Auza, N. (1997) Superoxide dismutase activity and reduced glutathione levels in cu-overlaod liver from steep. *Nutrition Research.* 17: 115 – 123.

Santhi, D., Balakrishnan, V., Kalaikannan, A. and Radhakrishnan, K. T. (2008) Presence of heavy metals in Pork products in Channai (Indai). *Am. J. Food Technol.* 3(3): 192 – 199.

SCAN (2003). Scientific Committee on Animal Nutrition: Opinion of the undesirable substances in feed,. Retrieved from: http://europe.ev.int/comm/food/fs/sc/scan/out126bisen.pdf.

Stoyke, M., Doberschutz, K. O. and Lusky, K. (1995) Heavy mental contents (cadmium, lead and mercury) in selected food stuffs, organs and tissue in cattle from different sites of Brandenburg. *Mengenspurenelemente Arbeit stag.* 15: 269-279.

Tahvonen, R. and Kumpulainen, J. (1994) Lead and cadmium content in Pork, Beef and Chicken and in Pig and Cow liver in Finland. *Food Add. Contam.* 11:415-419.

WHO (2006) Report of the 2nd Session of the codex committee of the food additives

contaminants. Beijing People's Republic of China. March, 2006, pp 20-24.
Yabe, J., Ishizaka, M. and Umemura, T. (2010) Current levels of heavy metal pollution in Africa. *J. Vet. Med. Sci.*, 72: 1257 – 1263.

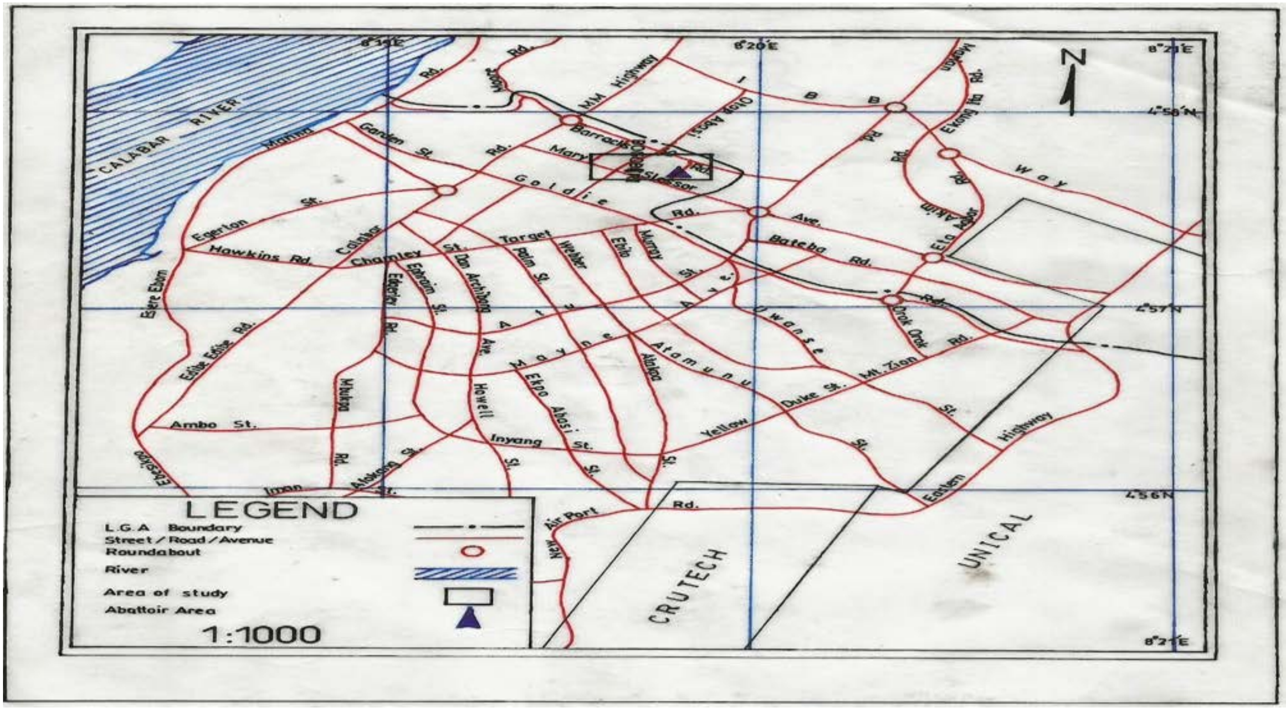

Fig. 1: Map of Calabar Municipality showing sampling area

Table 1: Mean value of metals concentrations in the Liver, Kidneys, lungs and intestines of sheep slaughtered at Gbogobiri, Calabar.

Metals (mg/kg)	Organs of sheep				FAO (ppm/mg/kg)	WHO (ppm/mg/kg)	ANZFA (ppm/mg/kg)
	Liver	Kidneys	Lungs (Mean±SD)	Intestines (Mean±SD)			
Cadmium (Cd)	0.011±0.002	0.00±0.00	0.034±0.001	0.00±0.00	>1	1	-
Cobalt (Co)	0.027±0.003	0.030±0.003	0.00±0.00	0.00±0.00	-	-	0.10
Chromium (Cr)	0.030±0.004	0.071±0.009	0.046±0.003	0.045±0.003	-	-	0.10
Copper (Cu)	0.059±0.002	0.055±0.002	0.053±0.001	0.038±0.001	-	-	200
Iron (Fe)	0.092±0.002	0.080±0.003	0.062±0.001	0.041±0.001	-	-	0.10
Manganese (Mn)	0.052±0.009	0.041±0.004	0.048±0.001	0.036±0.001	-	-	0.10
Nickel (Ni)	0.022±0.003	0.016±0.003	0.00±0.00	0.00±0.00	-	0.2	-
Lead (Pb)	0.041±0.005	0.016±0.003	0.015±0.001	0.016±0.001	-	-	>1
Zinc (Zn)	0.11±0.002	0.097±0.008	0.046±0.001	0.078±0.001	0.5	0.5	50

Where: SD = Standard Deviation; NS = Not significant; FAO = Food Agricultural Organisation; WHO = World Health Organization; ANZFA = Australia New Zealand Food Authority.

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