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DETERMINATION OF CADMIUM AND LEAD LEVELS IN MEAT, LIVER AND KIDNEY OF COW AND GOAT MARKETED IN ZARIA, NIGERIA

Farouk, M.A.[1], Musa, A.[2] and Yakasai, I.A.[2]
[1]College of Arts, Science and Remedial Studies, Kano, Nigeria
[2]Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmaceutical Sciences, Ahmadu Bello University, Zaria, Nigeria.

ABSTRACT
This study was carried out to determine the levels of Cadmium (Cd) and Lead (Pb) in meat, liver and kidney of cow and goat marketed in Zaria. Samples were purchased from four markets (Sabon Gari, Samaru, Tudun wada and Zaria city) in Zaria. A quantity (10g) of the samples were digested with H_2SO_4 (20 ml) and H_2O_2 (10 ml) in drop wise. Metals were analysed with Varian Atomic Absorption Spectrometer (AA240FS). The result showed that the levels of cadmium range from 0.0021 to0.0097mg/kg and those of lead range from 0.0029 to 0.0169mg/kg. The animal products in Samaru and Tudun wada markets showed high level of lead and cadmium compared to the other markets respectively. A significant difference ($p<0.05$) was found in cadmium concentration between the cow liver and meat and between all the goat samples. Also a significant difference ($p<0.05$) was found in lead concentration between the kidney and meat of both cow and goat. The levels of cadmium and lead in the animal products were found to be below the maximum permissible levels recommended by FAO/WHO, indicating that the foodstuffs are reasonably safe for human consumption in the short term. However, heavy metals are dangerous because they tend to bioaccumulate in living tissues, hence there is the need to assess their long term safety.
Keywords: AAS, Cadmium, Kidney, Lead, Liver, Meat

INTRODUCTION

The significant amount of toxic metals that are able to gain entry in food products increases the concern of the analysts on the study of these substances. There is an increasing concern in relation to human consumption of animal and plant products that are potentially contaminated with these metal. Studies have shown that the increasing level of toxic metals in the food chain is mostly caused by environmental pollution (Seema *et al.,* 2013; Galadima and Garba,2012)

The main factors affecting the accumulation of potentially toxic metals by grazing animals are the presence of the metal, its concentration in herbage and soil surface, and duration of exposure to the contaminated pasture and soil. Contamination of grassland by toxic metals may be due to natural, accidental and anthropogenic activities (Wilkinson *et al*., 2003).The concentration of metals in the top 0.075m of the soil is of particular relevance because the root of most grasses are in that region, and its surface soil that may be ingested along with the herbage by the grazing animals. The grazing animal can ingest the metals either by consuming herbage that is internally or externally contaminated or by consuming contaminated soil (Wilkinson *et al*., 2003).

The target edible body tissues for the accumulation of most toxic metals are the liver and kidney (Teofila *et al.,* 2005). The liver and kidney are the most hazardous raw materials for the consumers of animal product which have been exposed previously to excessive quantities of toxic metals (Agbozu *et al*., 2007). To ensure the safety of food and animal products, it is desirable that the metal concentration in them should not exceed the permissible limit. In Nigeria, fish, chicken meat, the liver, kidney and meat of goat, cow and sheep are a major source of protein to the population and are widely consumed. Mostly habitat of these animals are continually been polluted with cadmium, lead and other metals as a result of indiscriminate dumping of waste materials on the land and water bodies and illegal mining of ores (Bala *et al*., 2012). These waste materials may contain some heavy metals such as cadmium, lead and other metals that are dangerous to human and animal health. Cattle and other ruminants graze freely on such environment and drink water from ponds, streams, rivers and other possible contaminated water sources. Accumulation of heavy metals over large areas and long periods causes damage to living organisms and must be carefully monitored and controlled. Rapid increase in population, urbanization, agriculture, and industrial activities implies a pollutant impact on the environment in cities like Zaria. The presence of high levels of these metals in environmental samples in Zaria have been reported,(Georgina *et al*., 2013; Abolude *et al*., 2013; Musa, 2008; Farouk *et al*., 2006; Farouk*, et al*., 2011;).

The main objective of this study was to determine the levels of cadmium and lead in liver, kidney and meat of some selected slaughtered animals (cow and goat) which are liable to contamination by these metals marketed in Zaria, Nigeria.

MATERIALS AND METHODS

Reagents and solutions

The chemical and reagents used for the analysis were of analytical grade and deionised water was used in preparation and dilution of all solutions. Sulphuric acidand perchloric acid used were of analytical grade. All glassware's and plastics container were washed with deionised water and oven dried.

Sampling sites

The sampling sites are:

1. Sabon Gari market
2. Samaru market
3. Tudun Wada market
4. Zaria city market

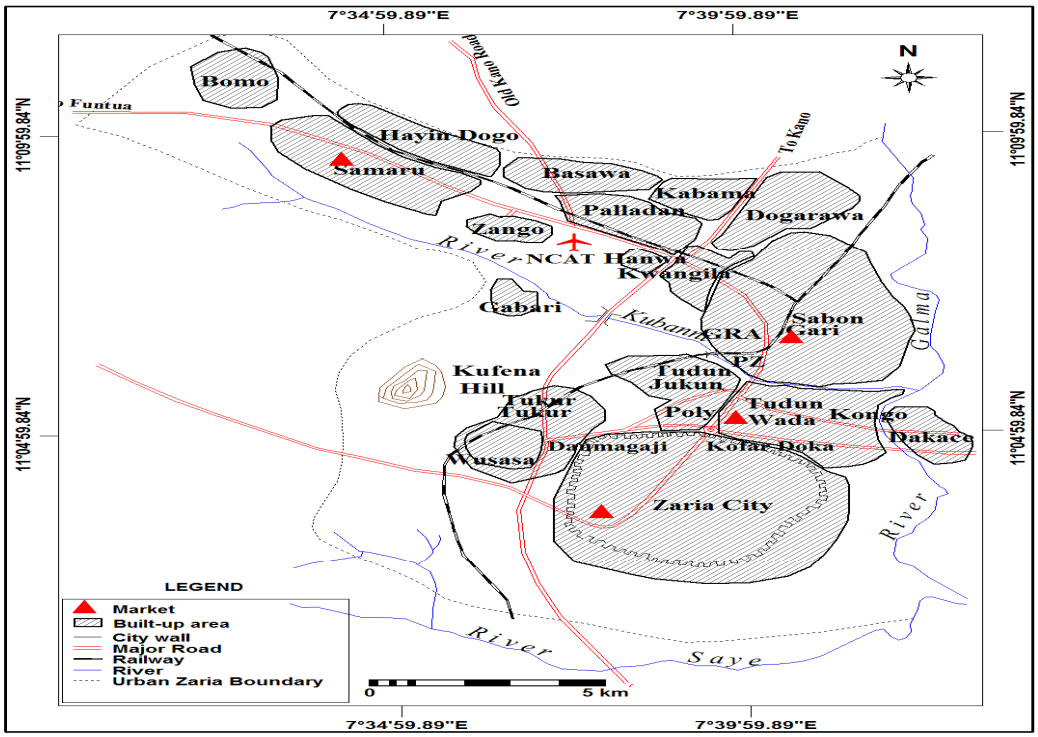

Fig. 1 : Map of Urban Zaria Showing the Sampling Markets
Source: Adapted and Modified from Topographic Map of Zaria

Sample collection

The animal products were purchased directly and randomly from four different markets(Samaru, Sabon Gari, Tudun Wada and Zaria city markets) of Zaria and its environing.

Sample preparation and analysis

The samples were prepared for the analysis according to the method described by Akan, *et al.*,(2010). A quantity (10g) of sample of the selected animal products(liver, kidney or meat) was introduced into the digestion flask. Sulphuric acid (20 ml) was added to the digestion flask and heated for 30minutes. After flocculation, the flask was heated strongly. Hydrogen peroxide (10ml) was also added to the digestion flask drop wise until a clear solution was obtained. The content of the flask was filtered into a 50 mlvolumetric flask and made up to the mark with distilled water.

Analysis of cadmium and lead concentration in the animal products samples were made directly on the final solutions using Atomic Absorption Spectrophotometry (AA240FS) by Varian company at Multi-User Research Laboratory Ahmadu Bello University Zaria.

Statistical Analysis

The data were expressed as mean ± standard deviation and were subjected to One-way analysis of variance (ANOVA) to assess whether the concentration of the metals varied significantly between the sites and the within samples. Analysis was carried out at 95% confidence interval. The data was analysed by the software procedure of SPSS 16.0.

RESULTS

Results for concentrations of cadmium and lead in cow and goat products from the four sampling sites are shown in Tables 1 and 2.

Table 1.Mean Concentration of Cadmium (mg/kg ± SEM) in Meat, Kidney and Liver of Cow and Goat from the four markets in Zaria and its environs

		Sampling Sites			
Samples		Sabon Gari market	Samaru market	Tudun wada market	Zaria market
Cow	Meat	0.0027±0.0015	0.0023±0.0014	0.0034±0.0014	0.0039±0.0016
	Kidney	0.0036±0.0023	0.0095±0.0053	0.0027±0.0077	0.0049±0.0014
	Liver	0.0029±0.0016	0.0025±0.0013	0.0037±0.0016	0.0040±0.0014
Goat	Meat	0.0029±0.0016	0.0023±0.0014	0.0036±0.0015	0.0034±0.0015
	Kidney	0.0021±0.0013	0.0021±0.0013	0.0035±0.0014	0.0042±0.0017
	Liver	0.0026±0.0015	0.0022±0.0013	0.0036±0.0014	0.0038±0.0016

The concentrations of cadmium in cow range from 0.0023 to 0.0097mg/kg and from 0.0021 to 0.0042 mg/kg in goat. The highest level of cadmium concentration (0.0097 mg/kg) was detected in kidney of cow at Tudun Wada market and 0.0095mg/kg at Samaru market. Also cadmium recorded high concentration (0.0042 mg/kg) in the goat products at Zaria city market. Tudun wada market recorded high level of cadmium concentration (0.0034 to 0.0097mg/kg) in cow products. The lowest level was observed in cow meat (0.0023mg/kg) and in goat kidney (0.0021mg/kg) at Samaru market (Tables 1 and 2).

The concentrations of cadmium recorded in this study were found to be within the permissible limit (0.2mg/kg) set by FAO/WHO (2007) and 0.05 to1.0mg/kg set by the E U (2008).

Table 2..Mean Concentration of Lead (mg/kg ± SEM) in Meat, Kidney and Liver of Cow and Goat from the four markets in Zariaand its environs.

		Sampling Sites			
Samples		Sabon Gari market	Samaru market	Tudun wada market	Zaria Market
Cow	Meat	0.0132±0.0066	0.0166±0.0097	0.0099±0.0062	0.0029±0.0015
	Kidney	0.0117±0.0085	0.0162±0.0081	0.0048±0.0026	0.0048±0.0024
	Liver	0.0086±0.0063	0.0113±0.0083	0.0151±0.0108	0.0049±0.0025
Goat	Meat	0.0111±0.0082	0.0169±0.0127	0.0039±0.0019	0.0060±0.0031
	Kidney	0.0090±0.0058	0.0141±0.0117	0.0037±0.0019	0.0075±0.0043
	Liver	0.0075±0.0038	0.0050±0.0026	0.0040±0.0021	0.0050±0.0025

The concentrations of lead in cow ranges from 0.00290 to 0.0162mg/kg and from 0.0037 to 0.0169 mg/kg in goat. High levels of lead concentration (0.0169 mg/kg) was detected in goat meat at Samaru market and in cow meat (0.0162mg/kg) at the same market. Also Samaru market recorded high concentration of lead in both cow (0.0162 mg/kg) and goat kidney (0.0141 mg/kg). Zaria city market recorded lower levels of lead concentration (0.0029-0.0074mg/kg) in both cow and goat products compared to other three sampling sites (Table 1&2). But the concentration of lead in cow liver was higher in Tudun Wada market compared to other animal products. The concentration of lead observed in all the animal products were within the permissible limit set by FAO/WHO (2007) 0.3mg/kg and 0.1, 0.5 and 0.5mg/kg set by the EU (2008).

Statistical analysis ($p > 0.05$) of kidney, liver and meat samples for both cow and goat revealed no significant difference between cadmium and lead concentration across the various sampling sites.

A significant difference ($p < 0.05$) was found between the concentration of cadmium in cow liver and meatwithin the samples andthere is no significant difference ($p > 0.05$) between the kidney of cow and other cow products (liver and meat).Also a significant difference ($p < 0.05$) was found between the concentration of cadmium in kidney of goat and other goat products (liver and meat). A similar significant difference ($p < 0.05$) was found between the goat kidney and liver and between goat liver and meat.

A significant difference ($p < 0.05$) in the lead concentration was found between the cow kidney, liver and meat, and alsoa significant difference ($p < 0.05$) between cowkidney and meat. There was no significant difference ($p > 0.05$) in the lead concentration between the kidney and liver, liver and meat of cow.

There was no significant difference ($p > 0.05$) in the lead concentration between the kidney, liver and meat, kidney and liver, liver and meat of goat. The result revealed a significant difference ($p < 0.05$) in the lead concentration between kidney and meat of the goat.

DISCUSSION

The mean concentrations of cadmium in meat in this study was high when compared to average cadmium content in the muscles of young bovine and cow 0.007 mg/kg and 0.008mg/kg respectively as reported by Drapal *et al.*, 2012. The concentration of cadmium obtained in this work were also lower than 0.352 mg/kg for liver and 0.984 mg/kg for kidney reported by Serpe *et al.,* (2012).

The high concentration of lead in both cow meat and goat meat compared to other animal products obtained in this research work was similar to that reported by Zahurul *et al.* (2011) whose recorded the highest concentration of lead in animal meat of

local cow and local hen of Chittagong that are 24.7 and 41.94 mg/kg respectively and recorded 43.37 and 1.36 mg/kg in the animal meat of Indian cow and local goat of Comilla respectively.

The results also revealed high concentration of lead in kidney of cow and goat 0.0162mg/kg and 0.0141mg/kg respectively, than the concentration of the metal in livers of cow and goat 0.0151mg/kg and 0.0075mg/kg respectively. Also Snezena *et al*; 2010 showed high lead content in kidneys of sheep 0.824mg/kg and goat 0.740mg/kg than in the liver 0.742mg/kg and 0.625 mg/kg respectively and also Bala *et al;* 2013 reported mean concentration of lead in liver, kidney, and muscle samples as 1.887 mg/kg, 1.2790 mg/kg, and 0.6680 mg/kg respectively as recorded in this study.

In general, the results showed higher mean concentration of lead (0.0029-00.0169 mg/kg) in animal products analysed compared to the mean concentration of cadmium (0.00213-0.0097mg/kg) in the same products.

The traditional free ranging management of livestock in Nigeria canbe good indicators of the general environmental pollution status. Toxic heavy metals can betransferred to these animals by inhalation of polluted air, intake of feed or pasture contaminatedwith agricultural chemicals and vehicle emissions; and drinking of polluted water. These heavy metals bio-accumulate increasingly in organs and tissues of these animals and toxicitydepends on dosage and length of time of exposure (Okoye, *et al.,* 2010). Highest cadmium concentration was observed in the kidney and liver of both cow and goat.The high levels of cadmium concentrations in kidneyliver and of cows and goats are likely due to their special functions; liver as storage and metabolic organ and kidney as an excretory organ (Osei*et al*., 2014). There have also been suggestions that animals exposed to cadmium accumulate it in their kidneys because of the presence of free protein-thiol groups which binds the heavy metals strongly to their structures. The concentration of cadmium in the animal products follows the trend kidney > liver > meat. While highest lead concentrations were observed in the meat of cow and that of goat as 0.0166 and 0.0169mg/kg respectively and follows the trend meat > kidney > liver.

CONCLUSION

The present study has been able to determine the concentration of cadmium and lead in some animal products (kidney, liver and meat) of cow and goat purchased directly from four markets (Sabon Gari, Samaru, Tudun wada and Zaria city) within Zaria metropolis.

However, the results obtained for vegetable samples and the animal products were below the stipulated limit given by FAO/WHO (2007) standard and European Union (EU)(2008). Although the toxicological risks for consumers seem apparently low, they could be significant if input from other sources of contamination (water, air etc.) are taken into account. Also the fact that these metals tend to bioaccumulate even when taken in small doses should also be considered. Moreover, concerned authority should take necessary steps for reducing the toxic metal contamination in the food chain.

Recommendations

(i) To establish food safety, it would be advisable to establish maximum residual limit for the various metals, not only for animal products, but for all foods.

(ii) Monitoring and evaluation of levels of toxic metals in soil, water, air, fodder, and any route of toxic metals into the animal is necessary, since reducing exposure is the simplest and most cost-effective way to prevent toxic metal problems.

(iii) There should be a public enlightment on the dangers of toxic metals and how to avoid them.

Contribution of Authors

Farouk, M.A. contributed in sampling and all laboratory work, while I.A.Yakasai and Musa, A. contributed in analysis, supervision and editing of the write up.

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