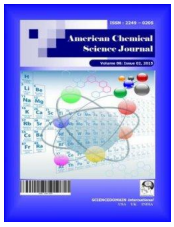

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Determination of Some Heavy Metals in Vital Organs of Cows and Bulls at Jimeta Abattoir, Yola, Adamawa State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author CM designed the study, all authors carried out the laboratory analysis. Authors JEE and BJD managed the literature searches, wrote the first draft of the manuscript and performed the statistical analysis with author ALJ. All authors managed the analysis of study. All authors read and approved the final manuscript.

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ABSTRACT

The recent widespread concern in human health due to the consumption of food product of animal origin has necessitated the need to monitor the level of heavy metal in animal tissues. This study was undertaken to evaluate the concentrations of heavy metals (Cu, Zn, Co, Cd, and Pb) in the heart, intestine, stomach, kidney and liver of cattle from Yola abattoir in Yola Metropolis, Adamawa State, Nigeria, by using Atomic Absorption Spectroscopy (AAS). The levels of heavy metals in the heart, intestine, stomach, kidney and liver 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 lead is deposited more in the kidney and heart. Cadmium was found to be concentrated in the kidney, while cobalt was not detected in most of the tissues. The Analysis of

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Variance (ANOVA) test on the concentrations of all the metals in the heart, intestine, stomach, kidney, and liver resulted in ($p>0.05$), i.e. there is no significant difference in the amount of the elements in this samples. The concentrations of all the metals were low and within the international statutory safe limits.

Keywords: Cow; bull; heavy metal; organ; food safety.

1. INTRODUCTION

Different researchers from many regions across the globe have attempted to assess the degree of Pollution in various environmental media and at times related the results with living organisms in the environment. The need to protect our environment is an important component of sustainable development of a society, with the view of keeping ecological balance, maintaining and improving the natural factors, quality of life and conditions that may affect human and animal health [1].

Pollution of heavy metals is a global threat to the environment as they are widely present in the earth's crust, in air, water and food [2]. The increased in the level of environmental pollutions by toxic metals from various sources call for great concern, because of its impact on human health [3]. Nowadays, it is agreed that, the development of modern agricultural technology and the rapid industrialization are among the foremost factors for environmental pollution [4].

Food items that constitute human diet and even animals are contaminated when they come in contact with polluted environmental media-air, soil and water. Ingestion of these contaminants by animals causes deposition of residues in meat [5]. The effect of heavy metal contamination in meat is of great concern for both food safety and human health because of the toxic nature of these metals even at low concentration when ingested over a long period of time, due to their ability to accumulate in human and animal body [6,7].

Some physico-chemical characteristic and heavy metal prophiles in some Nigeria rivers, streams, and waterways showed high concentration of some heavy metals [8]. High levels of metals were found in beef and mutton as a result of contaminated soil and animal feeds [9,10]. It was observed that metal accumulation in cattle raised in a serpentine-soil area was related to the concentrations of the metals in soils and forage [11]. Apart from being in contact with polluted soil environment and grazing on contaminated plants, exposure to heavy metals can also be as a result of contaminated feeds [10]. Cases of heavy metal contamination in meat products during processing have also been reported [6] [12]. Contamination of meat can also be from dirty slaughter houses.

In Nigeria cattle are free grazing and drink water from ditches, streams, rivers and other possible contaminated water sources. They graze along runways and other sites that might have been contaminated with toxic substances hence the risk to exposure to high levels of contaminant. These metals accumulate in the organs and other tissues. The muscles and other organs are sold in the market for consumption [13].

Heavy metals contamination poses a threat due to their toxicity; bioaccumulation and biomagnifications in the food chain [14]. They are transferred to man and animals through diet and other routes [15]. Although contamination of animal feed by toxic metals cannot be totally avoided given the prevalence of these pollutants in the environment, the contamination needs to be minimized so as to reduce both direct effects on animal health and indirect effects on human health [16].

Exposure of livestock to either high levels of toxic metals (Cadmium and lead) or less than optimal levels of the essential microelements (Copper, Cobalt, and Zinc) can trigger adverse effects such as reproductive impairment, physiological abnormalities, behavioural modification and even death [15]. Depressed appearance, blindness, grinding of teeth, muscular twitching, snapping of eyelids, and convulsive seizures are some of the signs of heavy metal poisoning in cattle caused by lead. Lead has a particular affinity for bones and causes osteoporosis; it also enters the liver and kidney. It interferes with manganese, iron metabolism and may cause anaemia [15,10]. Cadmium, which is a highly toxic metal, causes necrosis by accumulating especially in liver and kidney. Cobalt are also toxic metals at higher levels and is a major constituent of Vitamin B (Cyano Cobalamin) which enhances formation of red blood cells and its deficiency causes

pernicious anaemia [17]. Copper occurs in food in many chemical forms and combinations, which affects its availability to the animal. It is known to be essential at low concentrations for both human and animals but it is toxic at high levels [11,12]. Zinc is an essential element in human diet. Too little Zn can cause problems; however, too much Zinc is harmful to human health [18].

Recently, the increasing demand of food safety has stimulated research regarding the risk associated with consumption of meats contaminated by heavy metals. In this study, a research was carried out to investigate the presence and level of heavy metal in the heart, intestine, stomach, kidney and liver of cattle slaughter at Yola abattoir. This gave an insight on the presence or absence of heavy metals in cattle meat found in our markets. Though meat is a very important human food, there is need to monitor the level of metal in animal tissues so as to assess the effect on animal health and the safety of animal product in human nutrition.

2. MATERIALS AND METHODS

2.1 Sample Collection

The samples consist of heart, intestine, stomach, kidney and liver of cattle from twenty four (24) randomly selected bulls and cows, which were purchased at yola abattoir in yola, Adamawa State, Nigeria. The samples were collected in polyethylene bags and transported to the laboratory for analysis. The sampling was carried out four times, three bulls and three cows (six cattle), twice within the month of August and twice in September 2014.

2.2 Sample Preparation

2.2.1 Digestion

The samples were dried in the oven for three days at temperature 105°C. After which they were grinded in a mortar into fine powder. 2 g of the well grounded samples was weighed into 1000 cm^3 Kjeldahl flasks; 20 cm^3 of distilled water was added followed by 20 cm^3 of concentrated HNO_3. The mixtures were boiled at about 100°C for 60 min, when the samples pass into colloidal solution, the solution was cooled and 10 cm^3 of conc. H_2SO_4 was added. The mixture was heated again and continued at a temperature of 140°C, for 20 min when a dense white fume of the conc. H_2SO_4 is noticed. The solution was allowed to cool and transferred quantitatively into 100 cm^3 volumetric flask and made up to the mark. The solution was then finally transferred into labeled sample bottles [17].

2.3 Metal Analysis

The presence and quantity of Zn, Co, Cu, Cd and Pb were determined using AA240 FS with spectra software Atomic Absorption Spectroscopy (AAS) based on comparison with external standards. The standards were freshly prepared from standard stock metal solutions and were used for initial calibration for each substance.

2.4 Statistical Analysis

Data collected were presented as mean and standard deviation and were subjected to one way analysis of variance (ANOVA) ($p<0.05$) to assess whether heavy metals varied significantly between the organs sample in the study.

3. RESULTS AND DISCUSSION

The mean concentration of heavy metals in the heart, intestine, stomach, kidney and liver in (mg/kg) of cows slaughter at Yola abattoir are presented in Table 1. Zn levels ranged between 1.21±0.26 and 3.19±0.55 mg/kg; 0.14±0.01 and 0.17±0.00 mg/kg Pb; 0.00±0.00 and 0.00±0.00 mg/kg Co; 0.03±0.00 and 0.04±0.01 mg/kg Cd; 0.09±0.04 and 1.32±0.86 mg/kg Cu.

Table 2 shows the mean concentration of heavy metals in the heart, intestine, stomach, kidney and liver in (mg/kg) of bulls slaughter at Yola abattoir. Zn concentration ranged from 1.93±0.46 and 4.9±3.07 mg/kg; 0.15±0.02 and 0.17±0.03 mg/kg Pb; 0.00±0.00 and 0.01±0.01 mg/kg Co; 0.04±0.01 and 0.40±0.38 mg/kg Cd; 0.11±0.05 and 2.66±2.87 mg/kg Cu.

The mean concentrations of heavy metals in the heart, intestine, stomach, kidney and liver of cattle (cows and bulls) are presented in Table 3. Zn levels ranged between 1.91±0.46 and 3.96±3.07 mg/kg; 0.15±0.02 and 0.17±0.02 mg/kg Pb; 0.00±0.00 and 0.00±0.01 mg/kg Co; 0.03±0.01 and 0.3±0.34 mg/kg Cd; 0.20±0.09 and 1.98±02.47 mg/kg Cu.

Highest cadmium concentration was observed in the kidney (0.3±0.34 mg/kg) as seen from Table 3. Cadmium 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 cadmium in the kidney is more than that of the liver of free grazing cattle from abattoirs situated in seven widely spread localities in southern Nigeria [13].

Many researchers have shown that cadmium concentrates more in the kidneys than in the livers [19,20,13]. Once cadmium is absorbed, it accumulates in the body even throughout life [21]. The higher concentration of cadmium in the kidney tissue is due to the detoxification function of the organ where these metals are accumulated. Cadmium showed highest concentration of 0.04±0.01 and 0.40±0.38 in the kidney of cows and bulls respectively (Table 1 and 2). From the results of this study, the concentrations of cadmium in all the samples studied were found to be below the permissible limit of 1.5 mg/kg [22].

Lead showed higher concentration in the kidney and heart from Table 3. Both sample 1 and 2 showed more accumulations of lead in the kidney and heart (0.17±0.05 and 0.17±0.00; 0.17±0.12 and 0.17±0.03) respectively. The monitoring of lead concentration in meat is important for human health. Lead is known to induce reduced cognitive development and intellectual performance in children and increase blood pressure and cardiovascular diseases in adults [7]. Lead toxicity is frequently observed in farm animals, especially in those grazing on pasture in the vicinity of metallurgic complexes and also close to busy roads. Species susceptibility to lead has been described in cattle, particularly the young one.

The milk of dairy cows contains small amount of lead. All the food of animal origin contains lead in higher concentration [23]. So, the contamination of the human consumer can happen by using meat. Studies in cattle showed that lead accumulates in the tissues / organs of cattle but their concentrations were higher in liver and kidneys than the other organs and tissues [24]. Similar studies were conducted on cattle of industrial and rural area of Asturias (northern Spain) to determine the lead concentration. Their observations indicated that samples collected from cattle of industrial area have high concentration of lead especially in liver and kidneys than that of rural area [10]. However, the permissible values of lead have been reported in food stuff as 2.5 mg/kg and the concentration of lead in all the samples studied were found to be below the permissible limit. This result is similar to a finding in Enugu state, Nigeria when the dietary intake of lead and cadmium and health risk from consumption of various parts of cow meat by the urban population was studied. The values indicate that the subjects are not exposed to any significant health risk via cow meat consumption [25].

High concentration of zinc was found in the liver of sample 2 (4.9±3.07 mg/kg), while the least value was in the kidney of sample 1 (1.21±0.26 mg/kg). Zinc is an essential element in human diet. Too little Zn can cause problems; however, too much Zn is harmful to human health [18]. Zinc plays an important role in the enzyme system, in the synthesis of the ribonucleic acid, which points to its role in the development of germ and somatic cells. Studies have shown that Zn is relatively non toxic to animals and has a depressing effect if the amount taken exceeds 700 mg/kg DM and it depends on Cu concentrations.

The highest copper concentration was found in the liver of sample 2 (2.66±2.87 mg/kg) as seen from Table 2. The lowest concentration is observed in the intestine of sample 1 (0.09±0.04). Copper is deposited more in the liver compared to the other organs as observed from the mean result for both cows and bulls from Table 3. A similar study found out that copper is deposited most in the liver of cattle [26]. 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 [18]. Excess accumulation of copper in liver can leds to hepatitis or cirrhosis, but the concentration of copper in all the samples in this study is within the acceptable limit (20 ppm) [5]. The provisional tolerable weekly intakes (PTWI) copper for fresh meat has been proposed as 14 mg/week/ person by food and nutrition board.

Cobalt was not detected in most of the sample. A concentration of 0.01 ±0.01 mg/kg was found in the liver of sample 2 as observed from Table 2. The daily intake is reported to be 3 mg. The concentration obtained from the analysis is [17] however not low, taking into consideration the quantity of the sample used

Table 1. Mean concentration of heavy metal in the organs of the female cattle (cows) slaughter at Yola abattoir in mg/kg

Elements	Samples 1				
(mg/kg)	CH	CI	CS	CK	CL
Zinc	2.14±0.38	2.07±0.31	3.19±0.55	1.21±0.26	2.03±0.35
Lead	0.17±0.00	0.16±0.00	0.15±0.01	0.17±0.05	0.14±0.01
Cobalt	0.00± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00	0.00±0.00
Cadmium	0.03±0.00	0.03±0.01	0.04±0.01	0.04±0.01	0.04±0.01
Copper	0.29±0.07	0.09±0.04	1.32±0.86	0.25±0.25	0.81±0.27

CH..... Cow heart, CI…….Cow intestine, CS……Cow stomach, CK…..…Cow kidney, CL.....Cow liver

Table 2. Mean concentration of heavy metal in the organs of the male cattle (bulls) slaughter at Yola abattoir in mg/kg

Elements	Sample 2				
(mg/kg)	BH	BI	BS	BK	BL
Zinc	2.10±0.45	1.93±0.15	2.92±0.87	2.07±0.48	4.9±3.54
Lead	0.17±0.03	0.15±0.03	0.15±0.03	0.17±0.12	0.15±0.02
Cobalt	0.00± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00	0.01± 0.01
Cadmium	0.04±0.01	0.04±0.02	0.05±0.01	0.40±0.38	0.04±0.01
Copper	0.18±0.07	0.11±0.05	0.32±0.24	0.42±0.60	2.66±2.87

BH... Bull heart, BI… Bull intestine, BS… Bull stomach, BK… Bull kidney, BL….Bull liver

Table 3. Overall mean (±SD) concentration of metals in the organs of cattle (cows and bulls) slaughter at Yola abattoir in mg/kg

Elements	Samples				
(mg/kg)	Heart	Intestine	Stomach	Kidney	Liver
Zn	2.05±0.51	2.35±0.71	2.58±1.02	1.91±0.46	3.96±3.07
Pb	0.17±0.02	0.15±0.03	0.15±0.02	0.17±0.02	0.15±0.02
Co	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.01
Cd	0.04±0.01	0.03±0.12	0.04±0.01	0.30±0.34	0.03±0.01
Cu	0.20±0.09	0.45±0.82	0.40±0.24	0.40±0.50	1.98±2.47

which is 2 grams (2 g). The function of cobalt in humans and animals appears to be a constituent of Vitamin B. The pathway of cobalt from the soil to Vitamin B through ingested food of human beings and non-ruminant animals is sometimes called the cobalt cycle. Plants obtain cobalt from the soil. Ruminant animals, Cattle, Sheep, Goats eat the plants and the bacteria in their rumina use the cobalt to form Vitamin B. The vitamin is absorbed by animals and distributed throughout the whole body tissue. Human beings ingest the meat and milk of these animals and obtain their Vitamin B. Deficiency of cobalt in humans is not known, however if cobalt is ingested in large quantities, the number of red blood cells increases, a condition called polycythemia 4.

CONCLUSION

The Analysis of Variance (ANOVA) test on the concentrations of all the metals in the heart, intestine, stomach, kidney and liver resulted in ($p>0.05$), i.e. there is no significant difference in the amount of the elements in this samples. The various parts of cattle consumed in Yola metropolis in Adamawa State, Nigeria, seem to be safe for consumption, considering the concentrations of Cadmium, lead, zinc, cobalt and copper present in them. It is expected that animals that graze freely will accumulate high concentrations of toxic metals in their organs, but from this findings, the levels of the metals was generally low. This may be due to low levels of industrialization in this part of the country where the animals are raised. The concentrations of these metals seem to be moderate 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 and routine monitoring of heavy metals is necessary for good health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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