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Health Risk Assessment of Some Offal of Selected Domestic Animals Slaughtered at Fagge Abattoir, Kano State, Nigeria

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***Abstract**: All heavy metals are toxic at certain levels of intake and cause harm to animals and human health. Humans feed on animal's meats and organs as a source of protein and proper diet where they can be contaminated either through food chain or web. This work determined the concentrations of some heavy metals (Cd, Cr, Cu, Pb, Ni and Zn) using Atomic Absorption Spectrophotometer (AAS) in selected offal samples (liver, intestine, lungs, tripe and kidney) of some domestic animals (cow, ram and goat) slaughtered at Kano abattoir. The health risks of consuming these metals from the offal were calculated based on the Estimated Daily Intake (EDI), Target Hazard Quotients (THQ), Health Index (HI) and Target Cancer Risk (TCR). The results showed the mean concentration ± standard deviation values ranged from 0.223±0.020mg/kg - 0.555±0.020mg/kg for Cd, 0.437±0.172mg/kg - 1.528±0.130mg/kg for Cr, 5.4±0.44mg/kg - 100.2±2.75mg/kg for Cu, 0.193±0.077mg/kg - 0.649±0.175mg/kg for Ni, 0.074±0.084mg/kg - 0.576±0.043mg/kg for Pb and 39.68±1.20mg/kg - 80.25±0.35mg/kg for Zn and there was no significant difference at p>0.05 using one-way ANOVA. Some EDI and THQ calculated values of Cd, Cr, Pb and Ni were above the Provisional Tolerable Daily Intake and greater than Unity respectively. Evaluated health index were all above 1 for each offal. Some of the TCR of these metals were also above the acceptable value of 1.0×10^{-4}. This revealed that an adult in Kano consuming these offal will experience a significant risk to health associated with the studied heavy metals.*

Keywords: *Heavy Metals, Offal, Health Risk, Cow, Ram, Goat.*

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1.0 INTRODUCTION

Meat and offal obtained from cattle are consumed daily as source of protein, but consumers' knowledge on the possible exposure to heavy metals in meat and its associated health risk is generally low (Okareh and Oladipo, 2015). 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 (Milam *et al.,* 2015).

Meat contamination is a problem that must be addressed since it can affect consumers' health. Standard acceptable limits for heavy metals in meat and organs have been established by many international organizations. Livestock including sheep, cattle, camels, and goats' side by side with other poultry species are the most significant sources of meat for protein (Morshdy *et al.,* 2023).

Heavy metal contamination in animal products may be harmful to people's health. The earth's crust naturally contains heavy metals, but uncontrolled human activity has significantly changed their geochemical cycles and biological equilibrium. This causes a buildup of metals in animal tissue that contain secondary metabolites, which gives rise to a specific pharmacological action. Humans can have negative health effects from prolonged exposure to heavy metals as lead, cadmium, arsenic, and mercury (Morshdy *et al.,* 2023)

Heavy metal pollution has become one of the most important threats that can endanger the health of animals, the environment, and humans (Hamid *et al.,* 2022). It was observed that most people that consume offal containing heavy metals from animals such as cow, ram and goat do not know the health implication on the body system. Therefore, this study is aimed to assess the health risk associated with the consumption of some offal of cow, ram and goat slaughtered at Fagge abbatoir, Kano Metropolis, Nigeria.

2.0 MATERIALS AND METHODS

2.1 Sample Collection

Five Offal samples each from Goat, Ram and Cow were obtained from fagge abattoir, in Kano city. They include liver, intestine, lungs, tripe and kidneys. The samples obtained from the study area were transported to Analytical Chemistry Laboratory of Department of Pure and Industrial Chemistry in Bayero University Kano (old campus) inside polyethylene bags and ice box to avoid early spoilage.

2.2 Sample Preparation

The fifteen samples were cut into pieces using a sterile stainless steel knife on cutting board. Then washed with water and rinsed with distilled water. The samples were oven dried for three days at 105℃ until they were properly dried. After which they were grinded in a wooden mortar and pestle into fine powder, and then stored in a well labeled sample containers for further analysis.

2.3 Digestion

The digestion of the samples was done using a mixture of HNO_3, H_2SO_4 and $HClO_4$. 1g of the well-ground sample was introduced into a digestion flask a 125 cm^3 flask that was washed with dilute nitric acid and rinsed with distilled water. Acid digestion with concentrated Per-chloric acid (4 cm^3), concentrated Nitric acid (10 cm^3) and Sulphuric acid (2 cm^3) was carried out. The content was thoroughly mixed and digested on a hot plate and heated gently at low temperature of 55℃. Heating was continued until white dense fume was observed. The digested sample was diluted with distilled water and filtered using What man filter paper, in 100ml volumetric flask and filled up to the mark. It was then transferred into a sample bottle and taken for analysis using Atomic Absorption Spectrophotometer (Usman *et al.,* 2022). Each sample was analyzed in triplicate.

2.4 Heavy Metal Analysis

A total of six (6) heavy metals (Cadmium, Chromium, Copper, Lead, Nickel and Zinc) were determined in each offal sample of the animals using Atomic Absorption Spectrophotometer (Perklin Elmer PinAAcle 900H).

2.5 Health Risk Assessment

2.5.1 Estimated Daily Intake (EDI)

Estimated daily intake (EDI) is the initial investigation of food contaminant potential risk based on its consumption rate. The EDI was calculated according to the United States Environment Protection Agency (USEPA) (2010) as in the following equation:

$$EDI = \frac{IR \times C}{BW} \quad \textbf{(1.1)}$$

Where: C is the concentration of the heavy metal;
IR is the ingestion rate = 227g or 0.227 kg (meal size) for adult with body weight (BW) of 70 kg;
(Yahaya *et al.,* 2020) (USEPA, 2000a and 2000b)
BW is the average body weight of an adult (60kg)

2.5.2 Target Hazard Quotients (THQ)

Target Hazard Quotient (THQ), is defined as the ratio of exposure to the reference dose. It is evaluated using an integrate US-EPA risk analysis. Target Hazard Quotient (THQ), implies the ratio of exposure rate to the reference dose and can be expressed as;

$$THQ = \frac{EF \times \mathrm{ED} \times \mathrm{IR} \times \mathrm{C}}{RfDo \times \mathrm{BW} \times \mathrm{AT}} \quad \textbf{(1.2)}$$

Where: EF is the exposure frequency = 365days/year;
ED is exposure duration = 60 years for adult.
IR is the food ingestion rate 0.227 kg in adult 0.114 kg in children (Yahaya *et al.,* 2020).
C is the concentration of metal in offal (mg/kg);
RfDo oral reference dose (mg/kg/day), Pb = 0.004, Cd = 0.001, Cr = 0.003, Cu = 0.04, Ni = 0.02 and Zn = 0.3 (USEPA 2010, 2000);
Body weight (BW) is 60kg,
AT is the Averaging Time = EF (365days) × ED (60years)
This method of risk assessment has recently been used by many researchers and has been validated. A heavy metal THQ >1 indicates a health risk from consumption of food contaminated with that toxic metal, whereas values <1 indicate an insignificant health risk (Wang *et al.,* 2005).

2.5.3 Hazard Index (HI)

The HI can be expressed as the sum of the
THQ values: (Abd-Elghanay *et al*; 2020)

$$HI = THQ_{Cd} + THQ_{Cr} + THQ_{Pb} + THQ_{Cu} + THQ_{Ni} + THQ_{Zn} \quad \textbf{(1.3)}$$

2.5.4 Total Cancer Risk (TCR)

The target cancer risk (TCR) which assesses the potential carcinogenic risks associated with lifetime exposure to carcinogens, was calculated as described by (Muktar *et al.,* 2022), using the formula:

$$TCR = CSF \times EDI \quad \textbf{(1.4)}$$

CSF is cancer slope Factor (ug/g/day) for Pb = 0.0085mg/kg/day, Ni = 3.0mg/kg/day, Cr = 0.5mg/kg/day (Muktar *et al;* 2022).
Cd = 6.3 mg/kg/day (Chowdhury & Alam 2024)
EDI is the estimated daily intake.
TCR value below 1.0 E-06 are regarded as negligible.
With 1.0E-06 and 1.0E-04 falling within an acceptable range
Above 1.0E-04 unacceptable

3.0 RESULTS

Table 1: Mean Concentration Standard deviation of the heavy metals in the samples analyzed (mg/kg).

Offal	Cd	Cr	Cu	Ni	Pb	Zn
C1	0.228±0.010	0.747±0.090	16.6±0.23	0.542±0.031	0.396±0.042	80.25±0.35
C2	0.544±0.030	0.692±0.180	5.4±0.44	0.649±0.007	0.576±0.043	49.82±1.89
C3	0.354±0.050	1.333±0.101	7.95±0.74	0.459±0.046	0.386±0.030	50.25±2.33
C4	0.314±0.090	1.528±0.130	8.45±0.4	0.258±0.081	0.074±0.084	65.23±2.33
C5	0.440±0.030	0.717±0.073	14.43±1.13	0.443±0.045	0.580±0.057	46.47±1.12
R1	0.384±0.028	0.875±0.080	100.2±2.75	0.313±0.014	0.330±0.031	57.77±1.42
R2	0.400±0.060	0.512±0.160	7.45±1.78	0.649±0.175	0.360±0.076	55.65±2.09
R3	0.396±0.076	1.350±0.312	24.45±1.09	0.499±0.085	0.417±0.046	44.97±2.78
R4	0.386±0.092	1.162±0.385	10.72±0.73	0.493±0.090	0.397±0.101	58.97±2.74
R5	0.366±0.068	0.762±0.118	11.95±0.35	0.436±0.061	0.232±0.041	48.65±0.94
G1	0.300±0.072	0.638±0.147	81.15±3.25	0.370±0.093	0.168±0.058	48.70±0.86
G2	0.555±0.020	0.762±0.118	7.52±0.21	0.535±0.030	0.462±0.014	47.48±2.08
G3	0.223±0.020	1.303±0.180	10.57±0.12	0.570±0.061	0.466±0.045	39.68±1.20
G4	0.380±0.096	0.437±0.172	6.13±0.08	0.193±0.077	0.193±0.058	58.23±1.19
G5	0.440±0.066	0.662±0.120	10.42±1.71	0.496±0.065	0.474±0.068	41.15±2.69
WHO/FAO	0.5	1.0	200	0.5	0.5	150

C = Cow R = Ram G= Goat 1= liver 2= Intestine 3=lungs 4= Tripe 5= Kidney

Statistical Analysis

Data collected were presented as mean and standard deviation and were subjected to one way analysis of variance (ANOVA) and showed no significant difference at p>0.05 between the offal samples analyzed in the study.

Table 2: Estimated Daily Intake (EDI) (mg/kg/day) values of the offal samples analyzed.

Offal	Cd	Cr	Cu	Ni	Pb	Zn
C1	0.0009	0.0028	**0.0628**	0.0021	0.0015	0.3036
C2	**0.0021**	0.0026	0.0204	0.0025	0.0022	0.1885
C3	**0.0013**	**0.0050**	0.0301	0.0017	0.0015	0.1902
C4	**0.0012**	**0.0058**	0.0320	0.0010	0.0003	0.2468
C5	**0.0017**	0.0027	**0.0546**	0.0017	0.0022	0.1758
R1	**0.0015**	**0.0033**	**0.3791**	0.0012	0.0012	0.2186
R2	**0.0015**	0.0019	0.0282	0.0025	0.0014	0.2105

R3	**0.0015**	**0.0051**	**0.0925**	0.0019	0.0016	0.1701
R4	**0.0015**	**0.0044**	**0.0406**	0.0019	0.0015	0.2231
R5	**0.0014**	0.0029	**0.0452**	0.0016	0.0009	0.1841
G1	**0.0011**	0.0026	**0.3070**	0.0014	0.0006	0.1826
G2	**0.0021**	0.0029	0.0285	0.0020	0.0017	0.1796
G3	0.0008	**0.0049**	0.0400	0.0022	0.0018	0.1501
G4	**0.0014**	0.0016	0.0232	0.0070	0.0007	0.2203
G5	**0.0017**	0.0025	0.0394	0.0019	0.0018	0.1557
RfD	0.001	0.003	0.04	0.02	0.004	0.3

RfD: Oral Reference Daily Dose. **EDI values:** exceeded the RfD value.

Table 3: Target Hazard Quotient **(THQ)** and Health Index **(HI)** of the offal samples analyzed

Offal	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**	**Zn**	**HI**
C1	**0.90**	**0.93**	1.57	**0.11**	**0.38**	1.01	4.90
C2	2.10	**0.87**	**0.51**	**0.13**	**0.55**	**0.63**	4.78
C3	1.30	1.67	**0.75**	**0.09**	**0.38**	**0.63**	4.82
C4	1.20	1.93	**0.80**	**0.05**	**0.08**	**0.82**	4.06
C5	1.70	**0.90**	1.37	**0.09**	**0.55**	**0.59**	5.20
R1	1.50	1.10	8.23	**0.06**	**0.30**	**0.73**	11.92
R2	1.50	6.30	**0.71**	1.30	**0.35**	**0.70**	10.86
R3	1.50	1.70	2.31	**0.10**	**0.40**	**0.57**	4.58
R4	1.50	1.47	1.02	**0.10**	**0.38**	**0.74**	5.21
R5	1.40	**0.97**	1.13	**0.08**	**0.23**	**0.61**	4.42
G1	1.10	**0.87**	7.68	**0.07**	**0.15**	**0.61**	10.48
G2	2.10	**0.97**	**0.71**	**0.10**	**0.43**	**0.60**	4.91
G3	**0.80**	1.63	1.00	**0.11**	**0.45**	**0.50**	4.49
G4	1.40	**0.53**	**0.58**	**0.04**	**0.18**	**0.73**	3.46
G5	1.70	**0.83**	**0.99**	**0.10**	**0.45**	**0.52**	4.59

THQ < 1: insignificant health risk. THQ > 1: significant health risk

Table 4: Target Cancer Risk (TCR) of the offal samples analyzed.

Offal	**Cd**	**Cr**	**Ni**	**Pb**
C1	$5.7x10^{-3}$	$1.4x10^{-3}$	$6.3x10^{-3}$	$1.3x10^{-5}$
C2	$1.3x10^{-2}$	$1.3x10^{-3}$	$7.5x10^{-3}$	$1.9x10^{-5}$
C3	$8.2x10^{-3}$	$2.5x10^{-3}$	$5.1x10^{-3}$	$1.3x10^{-5}$
C4	$7.7x10^{-3}$	$2.9x10^{-3}$	$3.0x10^{-3}$	$2.6x10^{-6}$
C5	$1.1x10^{-2}$	$1.4x10^{-3}$	$5.1x10^{-3}$	$1.9x10^{-5}$
R1	$9.5x10^{-3}$	$1.7x10^{-3}$	$5.6x10^{-3}$	$1.0x10^{-5}$
R2	$9.5x10^{-3}$	$1.0x10^{-3}$	$7.5x10^{-3}$	$1.2x10^{-5}$

R3	$9.5x10^{-3}$	$2.6x10^{-3}$	$5.7x10^{-3}$	$1.4x10^{-5}$
R4	$9.5x10^{-3}$	$2.2x10^{-3}$	$5.7x10^{-3}$	$1.3x10^{-5}$
R5	$8.8x10^{-3}$	$1.5x10^{-3}$	$4.8x10^{-3}$	$7.7x10^{-5}$
G1	$6.9x10^{-3}$	$1.3x10^{-3}$	$4.3x10^{-3}$	$5.1x10^{-6}$
G2	$1.3x10^{-2}$	$1.5x10^{-3}$	$6.0x10^{-3}$	$1.4x10^{-5}$
G3	$5.0x10^{-3}$	$2.5x10^{-3}$	$6.6x10^{-3}$	$1.5x10^{-5}$
G4	$8.8x10^{-3}$	$8.0x10^{-4}$	$2.1x10^{-3}$	$5.9x10^{-6}$
G5	$1.1x10^{-2}$	$1.3x10^{-3}$	$5.7x10^{-3}$	$1.5x10^{-5}$

TCR < $1.0x10^{-6}$ Negligible. $1.0x10^{-6}$ – TCR- $1x10^{-4}$ Acceptable. TCR > $1x10^{-4}$ significant health risk.

3.1 DISCUSSION

Table 1 shows the mean concentrations ± standard deviation of cadmium, chromium, copper, nickel, lead and zinc respectively in the five offal samples analyzed (liver, intestine, lungs, tripe and kidneys) of the three selected domestic animals (cow, ram and goat).

3.1.1 CADMIUM (Cd)

Cadmium was detected in all the analyzed samples. The values ranged from 0.223 ± 0.02mg/kg to 0.555±0.02mg/kg which are below the FAO/WHO (2006) maximum permissible limit of 1.0mg/kg in kidney and 0.5mg/kg in other samples with the exception of cow's and goat's intestines. This was in agreement with Usman *et al.,* (2022) who reported the mean concentration of cadmium in liver, intestine and tripe samples of cow as 0.31mg/kg, 0.22mg/kg and 0.16mg/kg respectively. But Okareh and Oladipo (2015) reported a higher cadmium concentration levels of 5.24mg/kg and 5.71mg/kg in liver and kidney of cattle samples which is similar to that of Olamide *et al.,* (2020) that obtained 2.50±1.18mg/kg in goat kidney from Akure.

3.1.2 CHROMIUM (Cr)

The composition of Chromium Cr in the samples as shown in figure 4.2 varied from 0.437mg/kg to 1.528mg/kg. The highest and the lowest concentrations were found in goat tripe and cow tripe respectively. Some of the samples analyzed were higher than the 1.0mg/kg maximum permissible limit set by FAO/WHO (2006). Okareh and Oladipo (2015) reported a higher residual levels of chromium in liver and kidney of cattle with 1.28 ± 0.93mg/kg and 2.33±2.99mg/kg respectively. Values of 17.48mg/kg, 13.12mg/kg and 15.80mg/kg in liver, intestine and tripe samples were reported by Usman *et al.,* (2022) which are also higher than the result obtained by this study.

3.1.3 COPPER (Cu)

Copper is an essential component of various enzymes and it plays a key role in the bone formation and in maintaining good health, which causes health problem such as liver and kidney damage when consumed in very high concentration (ATSDR 2004) and public health hazard in high concentrations (Brito *et al.,* 2005). The highest concentration was found in liver of Ram 100.2 ± 2.75mg/kg and the lowest value was observed in cow intestine 5.4 ±

0.44mg/kg. The copper concentration in the liver, intestine, lungs, tripe and kidney of cow, ram and goat were all below the permissible limit of 200mg/kg as set by FAO/WHO (2006). This is higher than 0.31mg/kg, 0.18mg/kg and 0.46mg/kg of intestines of cow, sheep and goat analyzed by Bristone *et al.,* (2018). Also the obtained results are lower than 149.100 ±0.03mg/kg, 538.425 ±0.018 mg/kg and 144.350 ±0.018mg/kg of liver samples from cow, sheep and goat respectively as reported by Birnin-yauri *et al.,* (2018).

3.1.4 NICKEL (Ni)

The results for Nickel showed the mean concentration range of 0.193 ±0.077mg/kg to 0.649 ± 0.175mg/kg. The FAO/WHO (2000) maximum permissible limit is 0.5mg/kg, hence establishing that some offal samples were higher than the limit. The result obtained by Sabuwa and Nafarnda (2020) in liver, intestine and kidney of cattle (0.0153mg/kg, 0.1090mg/kg and 0.0044mg/kg) were lower than that obtained by this study from cow's liver, intestine and kidney respectively likewise Yetude et al., (2019) reported 0.01±0.002mg/kg in goat's liver.

3.1.5 LEAD (Pb)

Lead was found to be higher than the standard permissible limit of 0.5mg/kg set by FAO (2006) in cow's intestine and kidney samples only. Lead as observed in the kidney of cow showed the highest concentration of 0.580 ± 0.057mg/kg and the lowest concentration of 0.168 ± 0.058mg/kg in the liver of goat. 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 (Milam *et al.,* 2015). Lead is known to cause reduced cognitive development and intellectual activity in children and high blood pressure and cardiovascular diseases in adults (Badis *et al.,* 2014). Therefore, these samples containing higher lead limit are not safe for human consumption due to contamination of lead.

3.1.6 ZINC (Zn)

Intake of Zinc is essential in human diet. The study showed a lowest zinc concentration in goat's lungs (39.68mg/kg) and the highest in cow liver (80.25mg/kg).The results obtained were lower than the values of 619.86mg/kg, 395.18mg/kg and 428.31mg/kg for liver, intestine and tripe of cow respectively reported by Usman *et al.,* (2022) while Olamide *et al.,* (2020) found a higher value of 65.00 ±10.40mg/kg in intestine of goat from Owena than the one obtained in this study as 47.48±2.08mg/kg in goat's intestine. The concentrations of zinc in all the samples studied were below the permissible limit of 150mg/kg as set by ANZFA (2001). Exposure to very high concentration of zinc cause arteriosclerosis, damage to the pancreas and disturb protein metabolism (Ihedioha *et al.,* 2014).

3.2 Health Risk Assessment

The EDI (Figure 4.13, 4.14, 4.15, 4.16, 4.17 and 4.18) of the trace elements (Cd, Cr, Cu, Pb, Ni and Zn respectively) of adult for consuming different animal organs (offal) ranged from 0.0003 – 0.0058. Muktar *et al.,* (2022) obtained an EDI values higher than the one found in this study. The EDI values for Cd, Pb and Ni in all samples analyzed in this study were above the PTDI (Provisional Tolerable Daily Intake) values set by WHO (2000) (0.001mg/kg/day for Cd, 0.002mg/kg/day for Pb, 0.003mg/kg/day for Ni). The level of toxicity of heavy metals depends on rate of daily intake in human beings (Khan *et al.,* 2008).

The estimated THQ value of Cd, Cr, Cu and Ni some were found to be greater than 1 as shown from figures 4.13 – 4.18, whereas all the THQ values of Zn and Pb were less than 1. Furthermore, the THQ values in cow offal were at a range of 0.05Ni in tripe to 2.10Cd of liver,

while ram and goat offal had a trend of Cu>Cd>Cr>Zn>Pb>Ni and Cu>Cr>Cd>Ni>Zn>Pb respectively.
The Calculated THQ values of copper in Cow's (intestine, lungs and tripe), Ram (intestine) and goat's (intestine, lungs, tripe and kidney) were found to be less than 1 which implies that the observed concentrations may not have potential health risk. In contrast to the values obtained from this study, Darwish *et al.,* (2015) reported the THQ values for both Cd and Pb in liver, and kidney samples from young and aged sheep carcasses in Zagazig City, Egypt were less than 1.0, indicating an insignificant health risk or no carcinogenic risk from consumption of such foods. The health index was calculated to determine the non-carcinogenic risk of multiple elements by consuming the animal's offal as shown in figure 4.25 ranged from 3.46 (goat's tripe) to 11.92 (ram's liver). All the values were found to be greater than Unity, therefore, it can be concluded that all the analyzed animal's offal were at a health risk of consumption. Our findings are a little similar to those previously reported in Kuwait (Abd-Elghany *et al.,* 2020), where HI values estimated from sheep samples in the present study were 1.34 for liver, and 2.012 for kidney. Because all values were >1, a significant health risk from the intake of heavy metals is associated with the consumption of these sheep tissues marketed in Kuwait.

Target Cancer risk (TCR) of Cd, Cr, Pb and Ni for adult at 60kg through the consumption of offal from cow, goat and ram were presented in a chart 4.26 -4.29 respectively. The TCR for Cadmium (Cd) ranged values of 5.0E-3 in goat's lungs to 1.3E-2 in goat's intestine, 8.0E-4 in goat's tripe to 2.9E-3 in cow's tripe for Chromium (Cr), 2.55E-6 in cow's tripe to 1.87E-5 in cow's kidney for Lead (Pb) and 2.1E-3 in goat's tripe to 7.5E-3 in ram's intestine for Nickel (Ni). The values that were found to be higher than 1.0E-4 might pose a cancer risk health hazard on adults of 60kg who consumes these offal from Kano metropolis.

4.0 CONCLUSION

One of the principal objectives of this study was to investigate the Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), Health Index (HI) and the Target Cancer Risk (TCR) in offal of selected domestic animals slaughtered from Kano abattoir by determining the levels of some heavy metals contamination. Six heavy metals; Cd, Cr, Cu, Pb, Ni and Zn were detected. The result obtained from this study revealed that estimated daily intake (EDI) value varied from 0.0057 – 0.3791 indicating a level of daily intake of all the analyzed metals. Some evaluated values of Target Hazard Quotient (THQ) of Cd, Cr, Pb and Ni were greater than 1, therefore indicates a potential risk associated with consumption of these metals in the analyzed offal samples. Furthermore, Health Index confirmed the health risk by obtaining a HI value greater than 1 for each offal sample. The pollution could be associated with the food the animals grazed on, drinking contaminated water, exposure during transportation, and living in a highly polluted environment with more anthropogenic activities.
The analysis of variance (ANOVA) on the concentrations of the heavy metals in the offal; liver, intestine, lungs, tripe and kidney resulted in ($p>0.05$) i.e there is no significant difference in the amount of the elements in the samples.
It is recommended that Follow up studies are recommended to safeguard consumers from possible exposure to health hazard and when cooking offal, it is advisable to cut the tissues and organs into smaller sizes and it should thoroughly be washed and boiled so as to reduce the contamination level of these metals.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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