Evaluation of Two Named Heavy Metal Residue in Tissues of Cattle from Three Selected Slaughter Slabs in Akure Metropolis

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Abstract: **This study was carried out to determine the levels of lead and cadmium in the liver, kidney and muscle of cattle slaughtered in three slaughter slabs in Akure, Ondo state, Nigeria. Heavy metals (HM) as well known through scientific knowledge can build up in the soil, leading to severe environmental pollution and contamination of the food chain which is of global public health importance. This study therefore emphasized on the need for continuous monitoring and control of heavy metal residues in cattle slaughtered for human consumption. Five animals each were sampled from Shasha (SH), Onyarugbulem (ON) and Ilara mokin (IM), collecting their liver, kidney and muscle. The samples were assessed for lead (Pb) and cadmium (Cd) levels using the Atomic Absorption Spectrophotometer (AAS). Results obtained showed that lead and cadmium levels in samples from SH were in the order kidney > muscle > liver and liver > muscle > kidney respectively. Levels in IM samples appeared in the order kidney > muscle >liver for lead and kidney > liver > muscle for cadmium. While ON samples presented the order; kidney > liver > muscle and liver > muscle /kidney for lead and cadmium respectively. However, significant difference was not observed in lead and cadmium concentrations in all the samples (p > 0.05). Summarily, levels of the assessed metals in this study were within the limits adjudged safe by two International Organizations viz; Food and Agriculture Organization together with World Health Organization (FAO / WHO).**

Keywords: **Heavy metals, Cattle, Muscle, Liver, Kidney**

I. INTRODUCTION

Environmental pollution by heavy metals has been a major challenge globally. Of great concern is occurrence in developing countries where little or no strict preventive measures or regulations of production of food of animal origin are conducted [1], [2]. Although, these heavy metals may be useful to living organisms up to certain requirements and if undue bio-accumulation develops it may snowball to numerous disadvantageous manifestations on their health. As a result of urban development leading to increased industrialization and environmental exposure of toxic metals from the use of industrial waste and drain water for irrigation of farmlands, heavy metals might accumulate to concentrations that are toxic and risky to the food chain [3], [4]. Animals become victims of heavy metal toxicity/residues accumulating in their tissues and organs upon grazing on pastures that are hyper-metal accumulators [5], [6], [7], [8]. As a result of bioaccumulation and bio magnification in the food chain, meat contaminated with highly toxic heavy metal can pose a threat to human health [9], [10], [11], [12], [13]. Vehicular emissions, unkempt slaughter slabs and houses as well as unhygienic meat stalls particularly roadside and open market meat merchants have been implicated as potential sources of heavy metal contamination to meat [14]. This is typical of the scenario in most of the developing African countries. There is need to provide wholesome environment for the rearing, processing and production of animal foods to avoid heavy metal contamination. However, for food safety and public health reasons, there is need for heavy metal assessment of meat before being pronounced fit for consumption because, one of the best methods of assessing humans' health risk is through the food consumed by them [15]. In subsequent to the above, this study was conceptualized and conducted to evaluate the levels of the lead and cadmium residues in the muscle, kidney and liver of cattle slaughtered in three slaughter slabs in Akure metropolis, Ondo state, Nigeria.

II. MATERIALS AND METHODS

A. Experimental site

The study was carried out within three geo-political zones in Akure metropolis namely; Shasha, Onyarugbulem and Ilaramokin. Five cattle were randomly sampled from three slaughter slabs (Shasha, Onyarugbulem and Ilaramokin), 10 g each of the liver, kidney and muscle was collected immediately after slaughter (n = 45). The collections as coded per abattoir are as shown in Table 1.

B. Laboratory analyses

Well preserved samples in sterile cellophane bags were transported to the Analytical Laboratory of the Department of Animal Production and Health, Federal University of Technology, Akure for analyses. Assessment of the concentrations of heavy metals in each of the samples began by weighing 0.5 g into digestion tubes. The samples were thereafter digested with concentrated nitric acid (70% HNO_3), (65 % $HClO_4$) in ratio 3:1 v/v together with the addition of distilled water. Mounting of the digestion tubes on the digestion block followed at a controlled temperature (120^oC) for two hours. After which the digestion had been perfected, the samples were cooled down to room temperature and then mixed with ultra-pure water to make a volume of 50 mL. Homogenization and centrifugation were carried out for 10 minutes and 4500 rpm for 5 minutes respectively before decanting the supernatants into another set of test tubes for the determination of lead (Pb) and cadmium (Cd) levels using an Atomic Absorption Spectrophotometer (AAS Perkin Elmer Analyst, USA) as described by [16]. The atomic absorption spectrophotometer was adjusted to specific wavelength corresponding to each of the metals to be measured. Measurements were done using the hollow cathode lamps at the wavelength of 283.3 nm and 228.8 nm for Pb and Cd respectively. The analyses were carried out in triplicate.

C. Statistical analysis

Data collected were carefully arranged and subjected to analysis of variance (ANOVA) using IBM SPSS (Version 23.0). Post hoc was done and Duncan Multiple Range Test was employed in comparing means before the allocation of superscript where necessary to the means from the different slaughter slabs [17].

Table 1: Meat Samples Collected From Three Selected Abattoirs, Labeling Codes and Interpretations

Serial number	Code	Interpretation	Serial number	Code	Interpretation	Serial number	Code	Interpretation
1	S_{C1M}	Shasha cattle1 muscle	16	O_{C1M}	Onyarugbulem cattle1 muscle	31	I_{C1M}	Ilara cattle1 muscle
2	S_{C1L}	Shasha cattle1 liver	17	O_{C1L}	Onyarugbulem cattle1 liver	32	I_{C1L}	Ilara cattle1 liver
3	S_{C1K}	Shasha cattle1 kidney	18	O_{C1K}	Onyarugbulem cattle1 kidney	33	I_{C1K}	Ilara cattle1 kidney
4	S_{C2M}	Shasha cattle2 muscle	19	O_{C2M}	Onyarugbulem cattle2 muscle	34	I_{C2M}	Ilara cattle2 muscle
5	S_{C2L}	Shasha cattle2 liver	20	O_{C2M}	Onyarugbulem cattle2 muscle	35	I_{C2L}	Ilara cattle2 liver
6	S_{C2K}	Shasha cattle2 kidney	21	O_{C2K}	Onyarugbulem cattle2 kidney	36	I_{C2K}	Ilara cattle2 kidney
7	S_{C3M}	Shasha cattle3 muscle	22	O_{C3M}	Onyarugbulem cattle3 muscle	37	I_{C3M}	Ilara cattle3 muscle
8	S_{C3L}	Shasha cattle3 liver	23	O_{C3L}	Onyarugbulem cattle3 liver	38	I_{C3L}	Ilara cattle3 liver
9	S_{C3K}	Shasha cattle3 kidney	24	O_{C3K}	Onyarugbulem cattle3 kidney	39	I_{C3K}	Ilara cattle3 kidney
10	S_{C4M}	Shasha, cattle4 muscle	25	O_{C4M}	Onyarugbulem cattle4 muscle	40	I_{C4M}	Ilara cattle4 muscle
11	S_{C4L}	Shasha cattle4 liver	26	O_{C4L}	Onyarugbulem cattle4 liver	41	I_{C4L}	Ilara cattle4 liver
12	S_{C4K}	Shasha cattle4 kidney	27	O_{C4K}	Onyarugbulem cattle4 kidney	42	I_{C4K}	Ilara cattle4 kidney
13	S_{C5M}	Shasha cattle5 muscle	28	O_{C5M}	Onyarugbulem cattle5 muscle	43	I_{C5M}	Ilara cattle5 muscle
14	S_{C5L}	Shasha cattle5 liver	29	O_{C5L}	Onyarugbulem cattle5 liver	44	I_{C5L}	Ilara cattle5 liver
15	S_{C5K}	Shasha cattle5 kidney	30	O_{C5K}	Onyarugbulem cattle5 kidney	45	I_{C5K}	Ilara cattle5 kidney

III. RESULTS AND DISCUSSION

The mean lead and cadmium concentration in samples collected (muscle, liver and kidney) from the various abattoirs as well as the overall average of the heavy metals concentrations in cattle tissues from all the slaughter slabs are shown in Tables 2 to 4 and 5 respectively.

Table 2: Concentrations of Lead and Cadmium in Meat from Shasha Slaughter Slab

Tissue	Lead	Cadmium
Muscle	0.06 ± 0.09^b	0.06 ± 0.01^a
Liver	0.04 ± 0.03^b	0.07 ± 0.01^a
Kidney	0.16 ± 0.09^a	0.04 ± 0.04^{ab}
Significance	*	*

Table 3: Concentrations of Lead and Cadmium in Meat from Onyarugbulem Slaughter Slab

Tissue	Lead	Cadmium
Muscle	0.01 ± 0.01^b	0.06 ± 0.01
Liver	0.04 ± 0.06^b	0.07 ± 0.01
Kidney	0.12 ± 0.11^a	0.06 ± 0.04
Significance	*	NS

Table 4: Concentrations of Lead and Cadmium in Meat from Ilaramokin Slaughter Slab

Tissue	Lead	Cadmium
Muscle	0.05 ± 0.10^b	0.05 ± 0.01
Liver	0.04 ± 0.08^b	0.06 ± 0.01
Kidney	0.11 ± 0.11^a	0.07 ± 0.03
Significance	*	NS

For all the Tables: Values are presented as Mean ± standard deviation (ppm) of heavy metal residues in triplicate**s.** Means with different superscripts along the same column are significantly different ($p < 0.05$) from one another, NS = not significant and * = significant

Table 5: Pooled Mean Concentrations (Ppm) Of Lead and Cadmium in Cattle Slaughtered In the Three Abattoirs

Tissues	Lead	Cadmium
Muscle	0.04^b	0.05
Liver	0.04^b	0.07
Kidney	0.13^a	0.06
Significance	*	NS

Values are presented as Mean (ppm) of heavy metal residues in cattle. Means with different superscripts along the same column are significantly different ($p < 0.05$) from one another, NS = not significant and * = significant

Lead and cadmium are two heavy metals whose levels in food deserve proper monitoring in order to prevent their untold negative health hazards. This study recorded significant differences ($p < 0.05$) in the values of lead (0.04 ± 0.03 - 0.16 ± 0.09) and cadmium (0.04 ± 0.04 - 0.07 ± 0.01) from Shasha slaughter slab (Table 2) with the highest obtained value for lead in the kidney, followed by the muscle and lastly the liver. In the case of Onyarugbulem abattoir (Table 3), significant difference ($p < 0.05$) was observed in the values of lead (0.01 ± 0.01 - 0.12 ± 0.11) but contrariwise for cadmium (0.06 ± 0.04 - 0.07 ± 0.01). Lead concentrations in the tissues from this abattoir was in the order kidney > liver > muscle. Cadmium had the highest value recorded in the liver while kidney and muscle values were at par. Significant difference ($p < 0.05$) in lead (0.04 ± 0.08 - 0.11 ± 0.11) values was noticed in the samples from Ilaramokin abattoir (Table 4) with the order Kidney > muscle > liver. Cadmium levels (0.05 ± 0.01 - 0.07 ± 0.03) from this same location were not significant ($p > 0.05$) but followed the order Kidney > liver > muscle. The overall mean concentrations of lead and cadmium in the tissues of the cattle slaughtered from the three abattoirs (Table 5) showed significant difference ($p < 0.05$) in lead levels with the highest recorded value from the kidney while the same value was obtained for the muscle and the liver. In case of cadmium, there were no observed significant differences in all the tissues. The presence and identification of the two metals from the tissues in this study agrees with the reports of several authors concerning the availability of metals in many foodstuffs including meat in Nigeria [18], [19], [20], [21], [22]. Also, the pattern followed by the levels of lead in the kidney being highest in the tissues of the cattle in all the abattoirs agrees with the reports of [23, 24] that found high concentration of lead in the kidney of cattle. According to them, this does not constitute a risk for the animals and human health because it was within the tolerance limits. All the liver samples from the three locations contained 0.04 ppm lead level which is still below the tolerance limits similar to the reports by the European Commission (EC) [25]. Cadmium in all the samples was found below 0.2 ppm recommended for meat of animal and poultry [26]. Generally, the cadmium and lead levels in all the tissues from the three abattoirs were below the recommended permissible limits of 0.3 ppm and 0.2 ppm respectively by Food and Agriculture Organization/World Health Organization [27]. This actually agrees with the findings of earlier authors in which the levels of cadmium and lead were within the acceptable limits.

IV. CONCLUSION

Beef from the three abattoirs evaluated in this study are being viewed as wholesome for human consumption, due to the fact that the concentrations of the analyzed metals were within the tolerance limits of 0.3 ppm and 0.2 ppm for cadmium and lead respectively. However, close monitoring and regular laboratory assessment of meat being consumed by the teeming population of humans for heavy metals and other sound health-hampering substances is highly recommended.

REFERENCES

[1] Varsha, M., Nidhi, M., Anurag, M., Singh, R. B. and Sanjay, M. (2010). Effect of toxic metals on human health. *Open Nutr. J.* **3**(10): 94 – 99.

[2] Adetunji, V. O., Popoola, A. F. and Odetokun, I. A. (2012). Heavy metal (lead, cadmium) and antibiotic (tetracycline, chloramphenicol) residues in fresh and frozen fish types (*Clarias gariepinus*, *Oreochromis niloticus*) in Ibadan Oyo State, Nigeria. *Pakistan Journal of Biological Sciences* **15**(18): 895 – 899.

[3] Kennish, M. J. (1992). Ecology of Estuaries Anthropogenic Effects. CRC Press, Boca Raton. pp. 494. 1992.

[4] Felagha, I., Monanu, M. O. and Amadi, B. A. (2020). Human Health Risk Assessment of Heavy Metals in Three Species of Mollusks (*Egeria radiata, Limicolaria flammea* and *Viviparus contectus*) from Yenagoa, Bayelsa State, Nigeria. *Asian Journal of Advanced Research and Reports* **10**(3): 21-26; Article no. AJARR.56780 ISSN: 2582-3248.

[5] Sedki, A., Lekouch, N., Gamon, S and Pineau, A. (2003). Toxic and essential trace metals in muscle, liver and kidney of bovines from a polluted area of Morocco. *The Science of the Total Environment,* **317**: 201–205.

[6] Ugwu, J. N. (2010). Assessment of levels of some heavy metals in the muscles and internal organs of cows consumed in Enugu and Nsukka, Enugu State, Nigeria". Unpublished PhD Thesis of the Department of Pure and Industrial Chemistry, University of Nigeria Nsukka.

[7] Nawaz, R. and Rehman, S. (2015). Analysis of heavy metals in red meat in District Peshawar Khyber Pakhtunkhawa. 23: 166-71.

[8] Arogbodo, J. O., Ajayi, O. A. and Adebayo, I. A. (2020). Phytochemical Screening and Analyses of Eight Selected Heavy Metals in an Air-dried and Sun-dried Leaf of Alternanthera brasiliana (L.) O Kuntze. *International Journal of Scientific Research in Biological Sciences* Vol.7, Issue 2, pp 146-150.

[9] Demirezen, O. and Uruc, K. (2006). Comparative study of trace elements in certain fish, meat and meat products. Meat Science. 74: 255-60.

[10] Oluyemi, E. A., Feuyit, G., Oyekunle, J. A. O. and Ogunfowokan, A. O. (2008). Seasonal variations in heavy metal concentrations in soil and some selected crops at a landfill in Nigeria. *African Journal of Environmental Science and Technology* **2** (5): pp 089-096.

[11] Jalil, H. (2013). Determination of Heavy Metals in Exposed Corned Beef and Chicken Luncheon That Sold in Sulaymaniah Markets. *Afr J Food Sci*. 7: 178-825.

[12] Hillary-Frances, L. G. and Emmanuel, T. T. (2019). Appraisal of heavy metals (lead and cadmium) in the muscle and intestinal organs of cattle slaughtered in Ibadan. *American Journal of Zoology*, **2**(1): 1 – 5.

[13] Nwineewii, J. D., Edori, O. S. and Marcus, A. C. (2019). Heavy metal content of surface water and crab (*Potamon fluviatile*) from the New Calabar River, Rivers State, Nigeria. *J. Chem. Soc. Nigeria*. **44**(6): 1035 – 1043.

[14] Umer, Z., Wasif, M., Saif-ur-Rehman, K., Saman, S. and Fariha, A. (2017). Assessment of heavy metal contaminants from protein sources. Short commentary, *J Food Technol Pres* 2017 Volume 1 Issue 2 pp 7 – 11.

[15] Onuoha, S. C., Anelo, P. C. and Nkpaa, K. W. (2016). Human health risk assessment of heavy metals in snail (*Archachatina marginat*a) from four contaminated regions in Rivers State, Nigeria. *Amer. Chem. Sci. J.* **11**(2): 1 – 8.

[16] Iwegbue, C. M. A., Nweje, G. E. and Iyoha, E. H. (2008). Heavy metal residues of chicken meat and gizzard and turkey meat consumed in Southern Nigeria. *Bulgar J. Veterin. Med*., **11**: 275 – 280.

[17] SPSS: Statistical Package for Social Sciences (2015). SPSS 23 Statistics Premium for Windows. IBM Corporation computer software package, version 23, 32 and 64 bit, Jordan.

[18] Onianwa, P. C., Adetola, C., Iwegbue, C. M. and Tella, O. (1999). Trace heavy metal composition of some Nigerian beverages and food drinks. *Food Chemistry*, **66**: 275 – 279.

[19] Yusuf, A. A., Arowolo, T. A. and Bamgbose, O. (2003). Cadmiun, Copper and nickel levels in vegetable from industrial and residential areas of Lagos city, Nigeria. *Food and Chemical Toxicology*, **41**: 375 – 378.

[20] Adekunle, I. M. and Akinyemi, M. F. (2004). Lead levels of certain consumer products in Nigeria: a case study of smoked fish foods from Abeokuta. *Food and Chemical Toxicology*, **42**: 1463 – 1468.

[21] Nnorom, I. C., Osibanjo, O. and Ogugua, O. (2007). Trace heavy metal levels of some bouillon cubes and food condiments readily consumed in Nigeria. *Pakistan Journal of Nutrition*, **6**(2): 122 – 127.

[22] Lanre-Iyanda, T. Y. and Adekunle, I. M. (2012). Assessment of heavy metals and their estimated daily intakes from two commonly consumed foods (Kulikuli and Robo) found in Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*, **12**(3): 6156 – 6169.

[23] Jukna, C., Jukna, V. and Siugzdaite, J. (2006). Determination of heavy metals in viscera and muscles of cattle. *Bulg. J. Vet. Med*., **9**: 35-41.

[24] Alonso, M. L., Benedito, L. J., Miranda, M., Castillo, C., Hernandez, J. and Shore, F. R. (2002). Arsenic, cadmium, lead, copper and zinc in cattle from Galicia, NW Spain. *Science Total Environ*., **246**(2): 237-248.

[25] Rahimi, E. and Rokni, N. (2008). Measurement of cadmium residues in muscle, liver and kidney of cattle slaughtered in Isfahan abattoir using grafite furnace atomic absorption spectrometry (GFAAS): A preliminary study. Iran. *J. Vet. Res*., **9**: 174-177.

[26] Choi, Y. Y. (2011). International/National Standards for Heavy Metals in Food". Power Point Presentation by a Chemist in Government Laboratory. Pp 1 – 12.

[27] FAO/WHO (2019). Food Standard Programme. Codex Alimentarius Commission. 42nd session, Geneva, Switzerland 8 – 12 July, 2019. Pp 42 – 60.