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Full Length Research Paper

Metal quantification in cattle: A case of cattle at slaughter at Ota Abattoir, Nigeria

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In this study, cattle were assessed for the levels of metals in some organs. Six metals, Arsenic (As), Cadmium (Cd), Cobalt (Co), Chromium (Cr), Nickel (Ni) and Lead (Pb) were determined in twenty samples comprising four different parts (liver, kidney, muscle tissue and blood) from five cows at slaughter in a major abattoir in Ota, using flame atomic absorption spectrophotometer (S-series 712354v1.27), following digestion. The heavy metal concentrations ranged from 12.864 to 18.475 mg/kg for As; 0.522 to 2.131 mg/kg, Cr; ND-1.227mg/kg, Pb; 0.463 to 0.844 mg/kg, Cd; ND-0.112 mg/kg, Co; and ND-1.075 mg/kg, Ni. Since these observed levels were higher than the WHO standards, gross contamination of the cattle could be inferred; and the levels of metals in cattle parts could be used as biomarkers of metal pollution, though highly influenced by several factors.

Key words: Cattle, biomarker, heavy metal, metal pollution.

INTRODUCTION

Pollution is currently a global problem that exists in various dimensions (Adekola et al., 2002; Asonye et al., 2007). The type and degree of pollution varies with time and space. The sources of heavy metal pollution include natural sources (Miranda et al., 2009; Hobbelen et al., 2006), ore mining or metal smelting (Uhlig et al., 2001; Haimi and Mätäsniemi, 2002), municipal waste, industrial effluents, application of sewage sludge and animal manure on agricultural land (del Val, 1999; Blanco-Penedo et al., 2006; Salehi and Tabari, 2008), and aerial deposition of particulates from vehicular emission (Ward and Savage, 1994). The problem becomes worse when it becomes difficult to determine when, how and to what extent is the level of pollution in a particular environment. Several researchers far back in history have used various objects as markers of environmental pollution. Such markers could be changes in availability, levels and characteristics of the objects under consideration. Recently, biological indicators have become very common and have been found very useful. This is because living organisms have high sensitivity to changes in environmental components and conditions that constitute their living. However, different organisms respond at different degree to changes in some environmental parameters. Therefore, the biodiversity needs to be well understood when considering biomarkers of environmental pollution.

Several researchers have investigated levels of pollutants in microbes, invertebrates, mammals, apes, plants and even human tissues as biomarkers of pollution. The use of moss (Acar, 2006), earthworm (Wang et al., 2009a; Elaigwu et al., 2007), fishes (Azmat et al., 2008), great tits (Geens et al., 2010), some gastropod and bivalve species (Liang et al., 2004), horse (Maia et al., 2006), microbial biomass carbon (Zhang et al., 2010; Wang et al., 2009a; Kizilkaya et al., 2004), human scalp hair (Wang et al 2009b), human nails (Were et al., 2008), blood and wool or hair from sheep, horses and alpacas (Ward and Savage, 1994), buffalo (Abou-Arab, 2001), and forest reindeer (Medvedev, 1995) have been reported.

The effectiveness and reliability of using the levels of metals in living organisms as biomarker of pollution are functions of several factors such as species, age of the organism and sex (Parker and Hamr, 2001), animal parts and tissues considered (Miranda et al., 2009; Nwude et al., 2010a), feeding habit, animal management system,

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Table 1. Variation of metal concentrations (mg/kg) in the Liver of the cows.

Cow	As	Cd	Co	Cr	Pb	Ni
A	12.864	0.698	0.03	0.522	0.417	0.446
B	16.564	0.581	ND	1.036	0.994	0.093
C	16.007	0.762	ND	1.515	0.882	0.061
D	16.635	0.776	ND	1.306	0.318	0.196
E	18.441	0.844	ND	1.305	0.276	ND

ND = Not detectable range.

Table 2. Variation of metal concentrations (mg/kg) in the kidney of the cows.

Cow	As	Cd	Co	Cr	Pb	Ni
A	17.39	0.739	0.021	1.256	0.276	0.573
B	15.334	0.869	ND	1.71	0.419	0.561
C	17.346	0.888	ND	1.311	1.227	0.394
D	18.475	0.996	ND	1.378	0.378	0.306
E	16.767	1.342	ND	1.151	ND	0.316

ND = Not detectable range.

Table 3. Variation of metal concentrations (mg/kg) in the muscle tissue of the cows.

COW	As	Cd	Co	Cr	Pb	Ni
A	15.931	0.463	ND	1.242	0.994	0.272
B	17.803	0.764	ND	2.131	0.981	1.075
C	17.221	0.715	ND	1.261	ND	0.216
D	17.034	0.733	ND	1.34	0.349	0.24
E	17.062	0.831	ND	0.955	0.18	0.378

ND = Not detectable range.

animal physiology, season, level of pollution, type and chemistry of the metal, metal uptake potential of the dominant plant species the animals feed on (Guala et al., 2010a; 2010b; Weis and Weis, 2004) in the environment under consideration, nature of the soil at the polluted site, leaching potentials of the metals (Chen et al., 2006), influence of the presence and /or level of the a metal on the other in the living organism (Blanco-Penedo et al., 2006) and in the concerned environmental media. Assessing the levels of metals in some organs of cattle as biomarker should put into consideration which cattle organ is to be analyzed. Examining investigations by Miranda et al. (2005), kidney had the highest accumulation of some metals, Cd, Pb and As, in the industrialized area; and Cd as well in the rural area. The trends were followed by the levels in the liver for all the metals, except in the rural area where Pb and As were highest in the liver. Cattle, in addition to being the most common source of meat in South-West Nigeria, are grazing animals which are constantly in contact with the polluted environment; hence the need to assess the levels of pollutants, especially heavy metals in cow parts. This study therefore aimed at assessing the levels of metals which could be toxic at higher concentrations in cattle parts, since the most common source of meat in Nigeria, especially in the South-West, is cow; and to see if the levels in cattle could reflect pollution.

MATERIALS AND METHODS

Four different parts (Liver, kidney, muscle tissue and blood) from five different cows (A, B, C, D and E) were collected randomly in polythene bags immediately as the cattle were slaughtered in an abattoir located at Toll Gate, Ota, Ogun state. Since the cows were meant for consumption as meat (beef), and there was no law against that in the country, approval from animal ethical committee then became unnecessary. The samples were transferred to the laboratory and were stored in the refrigerator for about two weeks pending the time of analysis. 5 g of each sample (Liver, kidney, muscle tissue and blood) were introduced into the digestion flask. 5 mL of concentrated phosphoric acid were added and heated in the digestion chamber at temperature of 250 to 300°c for 2½ h. 20 ml deionized water were added, thoroughly shaken and filtered into a 50 mL standard flask. It was then made up to mark with deionized water (Nwude et al., 2010a; 2010b). As, Cd, Co, Cr, Pb and Ni in the filtrates were determined using Flame Atomic Absorption Spectrometer S- series 712354v1.27 at wavelengths 193.7, 228.8, 240.7, 357.9, 217.0, and 232.0 nm, respectively.

RESULTS AND DISCUSSION

Table 1 shows the metal concentrations in the liver ranging from 12.864 to 18.441 mg/kg for As; 0.581 to 0.844 mg/kg, Cd; ND- 0.03 mg/kg, Co; 0.522-1.515 mg/kg, Cr; 0.276-0.994 mg/kg, Pb; and 0.093 to 0.446 mg/kg, Ni. Levels in the kidney (Table 2) ranged from 15.334 to 18.475 mg/kg, As; 0.739 to 1.342 mg/kg, Cd; ND to 0.021 mg/kg, Co; 1.151 to 1.71 mg/kg, Cr; ND to 1.227 mg/kg, Pb; 0.306 to 0.573 mg/kg, Ni. From Table 3, muscle tissue gave 15.931 to 17.803 mg/kg, As; 0.463 to 0.831mg/kg, Cd; ND, Co; 0.955 to 2.131mg/kg, Cr; ND to 0.994 mg/kg, Pb; and 0.216 to 1.075 mg/kg, Ni. Blood concentration ranged from: 16.733 to 17.85 mg/kg, As; 0.523 to 0.843 mg/kg, Cd; ND to 0.112 mg/kg, Co; 0.942 to 1.357 mg/kg, Cr; ND to 0.742 mg/kg, Pb; and ND to 0.414 mg/kg, Ni (Table 4). Figure 1 compares the mean levels in the cow parts.

DISCUSSION

The concentrations of As were observed to be the highest in all parts of the 5 different cows. Concentration in the kidney was higher in cow D and lowest in cow B. The muscle tissue concentration had the highest value in

Table 4. Variation of metal concentrations (mg/kg) in the blood of the cows.

COW	As	Cd	Co	Cr	Pb	Ni
A	17.031	0.523	ND	1.285	0.742	0.414
B	17.521	0.72	ND	0.999	ND	0.166
C	17.85	0.638	ND	0.942	0.222	0.19
D	16.747	0.798	ND	1.023	ND	ND
E	16.733	0.843	ND	1.357	0.129	0.195

ND = Not detectable range.

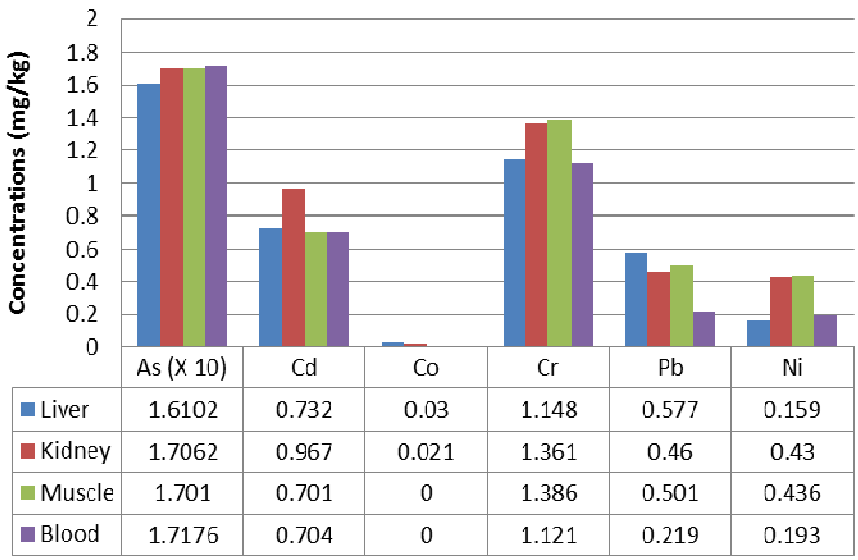

Figure 1. Mean concentrations of metals in cow parts.

cow B and lowest in cow A; while in the blood; maximum concentration was observed in cow D. As is a toxic metal which exert its toxic effect through an impairment of cellular respiration by inhibition of various mitochondrial enzymes (Sesha et al., 2007). The level observed in this study exceeds the permissible limit of 0.01 mg/kg WHO standard (WHO, 2002). Also, considering the concentration in various cows from each column, from cow A, it was observed that the levels were higher in the kidney and the blood; from cow B, the levels in the muscle tissue and the blood were closer. In cow C, accumulation was greatest in the blood. Cow D had the highest concentration in the kidney; and Cow E in the liver. It could be inferred that the target organs for As includes the blood and kidney. The tolerable limit for Cd as set by (WHO, 2001) is 0.005 mg/kg; thus from the analyzed results, Cd is not only at a higher concentration level in all parts, but could also be said to have considerably accumulated in the liver and kidney perhaps due to long term exposure (Lenntech., 2009). In cow A, lowest Cd concentration was in the muscle tissue; highest concentration was observed in the kidney for Cow D. In cow C, maximum concentration was as well in the kidney.

The same were observed for Cows D and E. The varying levels of Cd concentrations in the parts of the different cows may however be related to the age factor. Cd is toxic in virtually every system in the animal and almost absent in the humans at birth, but accumulates with age (Akan et al., 2010). Aside the age factor, the nature of their feed (forage) and drinking from stagnant water and streams could contribute to their concentration levels, as the levels are significantly higher in all the five (5) cows. Co was detected only in the liver and kidney of cow A. Concentrations in other parts of the cows were below detection. The highest concentration of Cr in the liver was observed in cow C and lowest in cow A. In the kidney, the highest concentration was observed in cow B and lowest in cow E. Concentration in the muscle tissue was highest in cow B and lowest in cow E. Similar studies on the distribution of metals by Akan et al. (2010) revealed that the lowest levels of Pb were observed in the liver and the muscle tissue. Given the permissible limit of Pb concentration as 0.01 mg/kg (WHO, 2002), it could be said that the concentration levels in the various parts of the cows are harmful, except for those which were below detection limit. The source of the metal contamination could be traced to the nature of their feed, water, and location such as presence of refineries. The concentration of Ni in the liver was highest in cow A but below detection limit in cow E. The muscle tissue had the highest concentration in all the 5 cows. Figure 1 summarises the mean levels of the metals in the various cow parts. As had the highest concentrations in all the parts while Co was almost not detected.

Conclusion

Since the observed levels of metals in this study were higher than the WHO standards, pollution could be inferred; and the quantification of these metals in organs of cattle could be used as biomarkers of pollution, though several factors have to be put into consideration.

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