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Blood Heavy Metal Levels in Cows at Slaughter at Awka Abattoir, Nigeria

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Abstract: Pollution has become a global problem and the results are implied in high levels of contanminants reported for soil, water, air, plants and animals. Blood being a major medium of transfer of heavy metals into milk as indicated in several literatures, it is necessary to constantly assess the levels of these metals in cow tissues, cow being a major source of milk in several countries. Hence, blood levels of Pb, Cd, Co, Zn, Cu and Fe in cows at slaughter at Awka abattoir, Nigeria, at three different seasons, are assessed in this investigation. The blood samples were digested and analyzed with atomic absorption spectrophotometer. The blood levels of Pb range from 0.21-10.6 mg kg^{-1}, Cd, 0.004-0.02 mg kg^{-1}, Co, 0.10-0.97 mg kg^{-1}, Zn, 2.32-12.4 mg kg^{-1}, Cu, 0.04-2.00 mg kg^{-1} and Fe, 0.73-2.14 mg kg^{-1}. There were significant correlations between the levels of Cd and Cu, Cd and Zn and Co and Zn.

Key words: Lead, cadmium, cobalt, zinc, copper, blood, milk

INTRODUCTION

Food items that constitute human diet (including animals) are contaminated when they get in contact with polluted environmental media-air, soil and water. Various researchers from different regions had attempted to assess the degree of pollution in various environmental media and at times related the results with the living organisms in the environment of study. Some physico-chemical characteristics and heavy metal prophiles of some Nigerian rivers, streams and waterways revealed high concentrations of some heavy metals (Asonye *et al*., 2007). In the evaluation of Cd and Zn in atmospheric deposit, soil, wheat and milk, Vidovic *et al*. (2005) observed that decreased Cd levels of 93% in atmospheric deposits resulted in decreased Cd concentrations of 17% in cattle feeds and 13% in milk and decreased Zn levels of 58% in atmospheric deposits resulted in decreased Zn concentrations of 30% in soil, 17% in cattle feeds and 17% in milk concluding that heavy metals from atmospheric deposits directly influence the level of heavy metals in other studied media. Industrial activities are major sources of heavy metal pollution and elevated levels of heavy metals in tissues of animals in a polluted environment may be attributed to grazing on contaminated pastures (Okada *et al*., 1997). Swarup *et al*. (2006) assessed the Pb burden and

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status of Cu, Co, Zn and Fe in the blood of goats reared around a primary lead-zinc smelter and it is concluded from the study that goats reared around a primary lead-zinc smelter had higher blood lead levels that also affected blood copper and cobalt concentrations in a dose-dependent manner. Liu (2003) reported higher levels of Pb and Cd in some tissues, including blood, in sheep and horses, correlating the values with those observed in soil, water, forage and feed in the vicinity of non-ferrous metal smelters and suggested that the disease of sheep and horses in that region was caused by Pb poisoning combined with Cd, as a result of heavy metal pollution by industrial activity. Geens *et al.* (2010) observed in the study of haemotological status of wintering great tits (*Parus major*) along a metal pollution gradient, that haemoglobin concentration, haematocrit, mean corpuscular volume and mean corpuscular haemoglobin were lower in great tits from the more polluted sites and as well significantly negatively correlated with blood Pb concentration. Changes in haematological parameters were observed in tilapia exposed to cadmium level of 5.5 ppm (Al-Attar, 2005). To evaluate the relationship between metal concentrations in soil, forage and animal tissues, Miranda *et al.* (2009) studied metal accumulation in cattle raised in serpentine-soil area and observed that high percentage of the animals showed tissue concentrations of Ni and Cu. Pourjafar *et al.* (2008) studied the profile in blood and hair from cattle around Isfahan oil industry in Iran and the cows closer to the industry showed higher blood and hair Pb levels. Ward and Savage (1994) recorded significantly elevated blood Pb and Cd levels in sheep grazing alongside motorway when compared with control. The results of investigation of tissue metal residues in cattle grazing on sludge-treated pasture suggested caution on prolonged grazing of cattle on pastures receiving heavy sludge applications, because significantly higher levels of fecal Cd were observed in samples collected from cattle immediately after grazing on the sludge-treated pastures when compared to the pre-exposure Cd levels in the same animal (Reddy *et al.*, 1985). Analysing heavy metal contents in Egyptian meat, Abou-Arab (2001) recorded higher levels of Pb and Cd in tissues of some grazing animals-bovine, buffalo, elk, sheep and goat. In some instances, it is even the non-essential elements that are more importantly transferred through the food chain than essential elements (Rogival *et al.*, 2007).

In the evaluation of blood Pb levels in lactating cows reared around polluted localities, with the aim of assessing the transfer of Pb into milk, Swarup *et al.* (2005) and Patra *et al.* (2008) reported significant correlation between blood and milk Pb concentrations. Possibility of metal transfer to animal's milk was demonstrated by Assimakopoulos *et al.* (1995) by studying radiostrontium transfer to sheep's milk as a result of soil ingestion and inferred that soil ingestion could be a main source of radiostrontium contamination in sheep and other free-grazing ruminants. Lorenzo *et al.* (1977) studied the equilibration of Pb between blood and milk of lactating rabbits and reported thus: The basal concentration of lead in milk of lactating rabbits is approximately 65% that of blood. After the intravenous injection of lead acetate, the lead concentration in blood peaked at 1 hour and thereafter declined rapidly, reaching a plateau within 5 days. In contrast, the lead concentration in milk continuously increased with time and by 7.5 days (maximum) exceeded that of blood 8-fold. The possibility that passage of Pb^{++}, like Ca^{++}, Sr^{++} and other ions from blood to milk occurs against a concentration gradient is suggested.

Effects of toxicants on blood could indicate the health condition of animal under study (Dauwe *et al.*, 2006). The level of Pb in blood has a significant correlation with the levels and/or metabolism of essential trace metals (Labbe, 1970; Miller *et al.*, 1990; Singh *et al.*, 1994). The interaction of Pb with some essential trace metals in the blood of anemic children from Lucknow, India, was studied by Ahmed *et al.* (2007) and their results indicated significant association between elevated blood Pb levels and the risk of anemia.

Mineral and trace metal concentrations studied in some diary products collected from Turkey indicated high levels (Mendil, 2006). There exist permissible levels of mineral and trace metals in body tissues, which, if exceeded, may constitute health hazards. Lead up to a level of 0.25 μg mL^{-1} in blood is considered safe and above 0.35 μg mL^{-} is toxic for ruminants and concentration of 1 μg mL^{-1} in blood is fatal for animals (Radostits *et al*., 2000; Swarup *et al*., 2006). The recommended tolerable levels of Pb and Cd for infants through baby foods are 3.57 and 0.8-1.0 μg kg^{-1}, respectively (Tripathi *et al*., 1999). Kazi *et al.* (2009) in their report on the assessment of toxic metals in raw and processed milk samples suggested continued monitoring of toxic elements in food and the environment. Blood being a major medium of transfer of heavy metals into milk as indicated in some of the literatures cited, it is necessary to constantly assess the levels of these metals in cow tissues, cow being a major source of milk in several countries. Hence, blood levels of Pb, Cd, Co, Zn, Cu and Fe in cows at slaughter at Awka abattoir, Nigeria, at three different seasons, were assessed in this investigation.

MATERIALS AND METHODS

Blood from each cow at slaughter at Awka abattoir, Nigeria, was collected fresh. Fifteen cows were sampled, five in each of the three different seasons of the year: on-set of rainy season (April-July, 2004), peak of rainy season (July-October, 2004) and dry season (January-April, 2005), the samples were collected in contaminant-free sample containers and preserved in refrigerator, pending the time of analysis.

Ten gram (weight instead of volume) of each blood sample contained in conical flask was digested with 5 mL of phosphoric acid, heated on a heating mantle for about an hour, until heated to dryness; 100 mL of distilled water were added, thoroughly shaken and filtered into a 100 mL standard flask and the filtrate was made up to mark with distilled water. Aliquots were analyzed for Pb, Cd, Co, Zn, Cu and Fe using atomic absorption spectrophotometer, model Shimadzu AA-6800 (Nwude *et al*., 2010).

Correlations were made between the levels of the various metals to establish any possible relationships in the accumulation of the metals in the blood using the RSQ worksheet function.

RESULTS

As shown in Table 1, the blood levels of Pb range from 0.21-10.6 mg kg^{-1}, Cd, 0.004-0.02 mg kg^{-1}, Co, 0.10-0.97 mg kg^{-1}; Zn, 2.32-12.4 mg kg^{-1}, Cu, 0.04-2.00 mg kg^{-1} and Fe, 0.73-2.14 mg kg^{-1}. The average levels of metals in blood in each season are shown in Table 2: the aggregate being 2.79 mg kg^{-1} for Pb; 0.01 mg kg^{-1}, Cd; 0.50 mg kg^{-1}, Co; 5.38 mg kg^{-1}, Zn; 0.79 mg kg^{-1}, Cu and 1.21 mg kg^{-1}, Fe. Blood heavy metal levels in cows/calves from different environments in previous works are shown in Table 3 to compare with the results in this study. Correlations were made between the levels of various metals during the three seasons and the results are shown by Fig. 1-3, to establish any possible relationships. In Fig. 1, April-July, the correlation coefficients (R^2) range from 0.0012-0.6138; Fig. 2, July-October, 0.0194-0.9133; and Fig. 3, January-April, 0.0005-0.6646.

Blood Zn level was highest at the on-set of rainy season, at the peak of rainy season and during the dry season. That might imply that Zn was the most accumulated of these metals studied in cow's blood, followed by Pb and the least being Cd. As recorded by Radostits *et al*. (2000) and Swarup *et al*. (2006), if Pb up to a level of 0.25 μg mL^{-1} in blood

Table 1: Blood heavy metal levels (mg kg^{-1}) in cows 1-15 in April-July, July-October and January-April

Duration	Pb	Cd	Co	Zn	Cu	Fe
April-July						
1	10.6±0.01	0.01±0.03	0.43±0.11	12.00±0.02	0.11±0.05	-
2	3.00±0.00	0.01±0.01	0.93±0.04	6.93±0.03	0.12±0.01	-
3	7.00±0.02	0.01±0.01	0.60±0.01	4.14±0.04	0.04±0.10	-
4	8.54±0.02	0.02±0.03	0.97±0.00	12.4±0.03	0.05±0.04	-
5	2.10±0.03	0.01±0.03	0.40±0.10	2.32±1.00	0.04±0.05	-
July-Oct.						
6	2.03±0.03	0.02±0.04	0.73±0.10	5.90±0.02	2.00±0.01	1.40±0.02
7	2.10±0.05	0.01±0.33	0.41±0.02	3.31±0.06	0.50±0.22	1.35±0.03
8	0.90±0.10	0.005±0.04	0.63±0.10	3.34±0.01	0.14±0.11	1.31±0.01
9	1.40±0.05	0.004±0.101	0.10±0.33	3.55±0.03	0.40±0.30	0.84±0.01
10	1.41±0.10	0.01±0.03	0.30±0.10	3.20±0.01	0.71±0.10	1.50±0.02
Jan-April						
11	0.81±0.12	0.01±0.02	0.50±0.10	3.70±0.03	0.92±0.03	0.80±0.02
12	0.50±0.20	0.01±0.01	0.70±0.10	3.62±0.01	0.90±0.04	0.81±0.02
13	1.00±0.10	0.02±0.01	0.25±0.15	6.52±0.01	1.10±0.05	1.20±0.05
14	0.21±0.99	0.01±0.20	0.30±0.22	5.40±0.01	2.00±0.10	0.73±0.04
15	0.32±0.14	0.01±0.10	0.32±0.21	4.40±0.00	1.40±0.01	2.14±0.00

Table 2: Averages of blood heavy metal levels (mg kg^{-1}) in the three seasons

Duration	Pb	Cd	Co	Zn	Cu	Fe
April-July	6.23	0.01	0.67	7.56	0.36	-
July-Oct.	1.57	0.01	0.43	3.86	0.75	1.28
Jan-April	0.57	0.01	0.41	4.73	1.26	1.14
Average	2.79	0.01	0.50	5.38	0.79	1.21

Table 3: Blood heavy metal levels in cows/ calves from different environment

	Pb	Cd	Co	Zn	Cu	Fe
(a)Calves (µg L^{-1})						
Industrial	ND-171	ND-1.91	-	0.83-5.97	0.05-1.14	-
Rural	ND-141	ND-2.25	-	1.50-3.98	0.06-1.13	-
(b)Lactating Cows (µg mL^{-1})						
U	0.00-0.25	0.00-0.05	-	-	-	-
C	0.13-0.96	0.00-0.05	-	-	-	-
P	0.03-0.31	0.02-0.07	-	-	-	-
CM	0.00-0.60	0.01-0.07	-	-	-	-
L/Z	0.17-1.22	0.01-0.05	-	-	-	-
OI (ppm)	0.017-0.074	-	-	-	-	-
TS	0.21-10.60	0.004-0.02	0.10-0.97	2.32-12.40	0.04-2.00	0.73-2.14

U: Unpolluted area, C: Closed zinc cum zinc smelter area, P: Phosphate fertilizer and mining area, CM: Coal mining area, L/Z: Lead/Zinc smelter, OI: Oil Industry (Pourjafar *et al*., 2008) TS: This study; [a]Miranda *et al*. (2005); [b]Patra *et al*. (2008)

is considered safe, above 0.35 µg mL^{-1} is toxic for ruminants and 1 µg mL^{-1} is fatal for animals; then, the blood Pb levels observed in this study could be said to indicate health risk to the animals under study and consequently to humans who are at the receiving end of the food chain, since the observed values were far higher than the recommended values. When compared with those references as shown in Table 3, the results observed in this study (0.21-10.60 mg kg^{-1}) were a bit similar to those observed for lead zinc smelter (0.17-1.22 µg mL^{-1}) (Patra *et al*., 2008) and in other instances, were far higher than those recorded for the industrial areas: ND-0.171 mg L^{-1}, Miranda *et al*. (2005); 0.017-0.074 ppm, Pourjafar *et al*. (2008); this may then imply some levels of pollution in the environment of this study. The Cd levels in this study ranged from 0.004-0.02 mg kg^{-1} and those observed by Patra *et al*. (2008) in lactating cows ranged from 0.00-0.05 µg mL^{-1} for unpolluted area and closed zinc cum zinc smelter; 0.02-0.07 µg mL^{-1}, phosphate fertilizer and mining area;

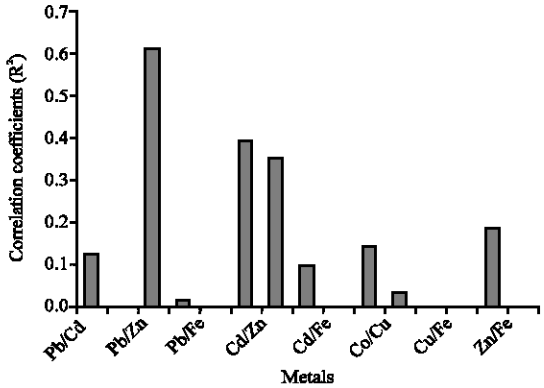

Fig. 1: Results of correlations between the levels of various metals in April-July

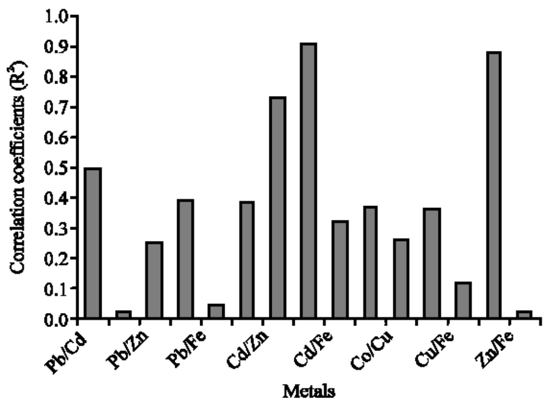

Fig. 2: Results of correlations between levels of various metals in July-October

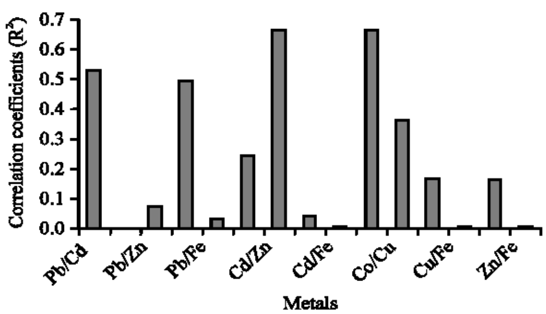

Fig. 3: Results of correlations between levels of various metals in January-April

0.01-0.07 μg mL^{-1}, coal mining areas; and 0.01-0.05 μg mL^{-1}, lead zinc smelter area. The observed Cd levels agreed with these references. The Cu and Zn levels recorded in this study were slightly higher than those of the references; greater pollution in the environment of this study may be inferred.

The correlations between the blood levels of various metals were more clearly observed at the peak of rainy season (Fig. 2) than at the on-set (Fig. 1) and dry season (Fig. 3). There were significant correlations between Cd and Cu, Cd and Zn and Co and Zn, implying that the concentration of one may be a function of the level of the other. Further work may be needed to establish this.

In conclusion, previous works established the possibility of metal ion transfer from blood into milk against concentration gradient. Higher blood heavy metal levels in lactating cows may present potential health risk to consumers of milk and milk product. Hence, there is the need for continued monitoring of blood heavy metal levels in cows.

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