J. Appl. Environ. Biol. Sci., 1(4) 69-73, 2011

ISSN 2090 – 424X
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Assessment of Metals Levels in Cow Blood from Cow's Grazed around Zango, Zaria and Challawa Industrial Estate, Kano - Nigeria

*Ogabiela E.E[1], Yebpella G.G[2,3], Adesina O.B[2], Udiba U.U[1], Ade-Ajayi F. A[1], Magomya A.M[2], Hammuel C[1], Gandu I[3] and Mmereole U.J[2], Abdullahi M[1].

[1]Environmental Services Division, National Research Institute for Chemical Technology, Zaria, Nigeria
[2]Industrial Chemicals Division, National Research Institute for Chemical Technology, Zaria, Nigeria
[3]Instrumentation Unit, National Research Institute for Chemical Technology, Zaria, Nigeria

ABSTRACT: The evaluation of metals levels in cow blood is important for assessing the potential effects of pollutants on grazing cattle and for quantifying contaminant intakes by humans. Hence Atomic Absorption Spectrophotometer (AAS) was used to determine trace and heavy metals of toxicological implications in cow blood. Six trace metals (Fe, Zn, Cu, Mn, Ni, Al) were found in a range between 0.18±0.10 to 36.62±7.71ppm and 0.20±0.06 to 35.11±14.78ppm in sample area A and B respectively. Three heavy metals (Cd, Pb, Cr) of toxicological implications were also found to range between 0.12±0.04 to 2.12±1.54 in area A and 0.17±0.14 to 2.81±0.90ppm in study area B. No statistically significant difference was observed between the two study areas for all the elements determined at 95%confidence levels. Except for Cu and Mn the values obtained were higher than the allowable limit for trace elements in blood.

Keywords: Metal levels, contaminants, toxicological implications, cow blood, allowable limits.

INTRODUCTION

Environmental pollution has become a global issue and the results are implied in high level of contaminants reported for soil, water, air, plants and animals. Food items that constitute human diet are contaminated when they get in contact with polluted environmental media [1]. In a previous work [2], significantly elevated blood Pb and Cd levels in sheep grazing alongside motor way when compared with control was recorded.

Studies on the impacts of pollutant metals and metalloids on livestock have largely focused on animals with relatively high levels of exposure. Industrial, agricultural, mining and natural processes have resulted in the release of many toxic metals into the environment. These metals are readily transferred through food chains and can pose a potential health risk to animal and human being.

Excessively higher levels of these metals in blood and tissues of animals suggest an exposure either from the air, soil, water or feeds or all these sources [3]. Contamination of animal feeds by toxic metals cannot be completely eliminated considering there levels of distribution in the environment although can be minimized with the aim of reducing both direct effects in animals and indirect effects on human health [4]. The contamination of food of animal origin with lead in some areas of Slovenia is presented in amounts higher (> 0.500 mg/kg weight/weight) than the levels allowed by national guidelines [5].

The need to reduce trece metals contamination in animal feeds pose a significant problem for agricultural region located in more or less industrialised areas in which animals are reared on locally produced feed [6]. The transfer of heavy metals into tissues and organs of cattle reared and kept in the area exposed to a metallurgical plant was studied [7]. The concentrations of heavy metals in sampled cattle were found to exceed the maximum allowable limits for food. The effect of low level environmental contamination on trace metal metabolism in cattle from the rural and relatively uncontaminated region of Galicia was examined [8]. Also a correlation between toxic metals and essential trace elements were evaluated in the tissues and blood of sampled cattle. Animals can tolerate elevated levels of heavy metals though at certain levels clinical signs of toxicity manifest which can be acute or chronic at low exposure for a long time.

Lead and copper are among the heavy metals implicated to cause toxicity in animals and man. This is due to wide spread environmental pollution by materials containing these metals such as paints batteries, soldering rods, gun powder, pesticides, fungicides, gasoline, engine oils, chemical fertilizers or when they occur in high amounts in air, soil, water, plants and other compounded animal feeds [9].

***Corresponding author:** Dr. Ogabiela E.E, Environmental Services Division, National Research Institute for Chemical Technology, Zaria, Nigeria.

Lead content in tissues and blood of animals that live in polluted areas is usually elevated and risk of acute or chronic poisoning is increased [10]. 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 [6].

Challawa industrial estate has conglomerates of large tanneries, textile, food and beverage, metal, plastics and ceramic industries that indiscriminately dispose solid and liquid waste on the land and water bodies. Zaria on the other hand has concentration of industries ranging from animal feeds, tobacco manufacturing factory, vegetable oil production industry, beverages industry and railway line network. Cattles grazes around these industrial sites. From the study carried out by Ogabiela [11] shows that the Challawa river receives polluted effluents.

The aim of this study is to assess the metal levels in blood of cows grazing around the Challawa industrial estate of Kano-Nigeria and moderately polluted area of Zaria.

The evaluation of heavy metals of toxicological effects in blood could indicate the health condition or contamination of animals under study.

MATERIALS AND METHODS

Sample Collection

Samples analysed in this work were collected from both male and female cows reared and fed predominantly on grasses grown in the studied areas – Kano (A) and Zaria (B).

Blood samples from seventeen (17) cows reared in industrialised area of Challawa in Kano-Nigeria and ten (10) cows reared in less polluted area of Zaria, Kaduna-Nigeria were collected. By means of sterilized disposable syringe, about 10mL of blood was taken into sterilized 20mL polypropylene tubes. The tubes and their contents were preserved in ice packed cold box, transported to quality control laboratory in National Research Institute for Chemical Technology (NARICT), Zaria-Nigeria and stored in a freezer until analysed.

Sample Preparation

For trace and heavy metals analysis 1g of the blood sample was digested with concentrated HNO_3 and concentrated H_2O_2 in a ratio of 3:1 on a hot plate. At the end of complete digestion it was filter hot using a Whatman filter paper No. 1 into 50mL volumetric flask and made up to mark with ultrapure water.

Metal Analysis

Metals concentrations were determine by Atomic Absorption Spectrophotometer, Shimadzu AA-6800 apparatus with graphite furnace and background correction (SR-BDG). The flame conditions were optimised for maximum absorbency and linear response while aspirating known standards. The standards were prepared from individual 1000ppm stock solution, product of Scharlau, Chemie. 100mL of the combined standards were prepared in 0.1 HNO_3. The lamb current was automatically selected for each metal. The pre-spray time, integration time and response time were 3, 5, and 1 respectively. Reproducibility was better than 1.0% and all the metal concentrations are expressed on a wet mass basis.

Quality Control

One blank and combine standards were run with every batch of 10 samples to detect background contamination and monitor consistency between batches. The result of the analysis was validated by analysing Standard Reference Material, Animal blood coded IAEA-A-13.

Statistical Analysis

All data was statistically analyzed with SPSS STATISTICsS 17.0 (One-Way ANOVA).

RESULTS AND DISCUSSION

A standard reference material of animal blood coded IAEA-A-13 was analysed in like manner to our samples. The values determined and the certified values of the six (6) elements determined were very close (table 1) suggesting the reliability of the analytical method employed.

Table 1 shows the results of analysis of reference material (animal blood IAEA-A-13) compare to the reference value

Elements(mg/L)	*Fe*	*Cu*	*Pb*	*Ni*	*Zn*	*Ca*	*Na*
A Value	2360	4.75	0.22	1.37	14.2	292	13486
R Value	2400	4.30	0.18	1.00	13.0	286	12600

A Value = Analysed value   R Value = Reference value.

In this study, six microelements were determined in the analysed samples. High concentration of Fe, Zn, Ni, Al, Cu and Mn were observed in the study areas. Analysis of variance between heavy metals in study areas revealed that there is no significant difference ($p<0.05$). The trend of occurrence of heavy metals in the two study areas A and B are as follows: Fe > Zn > Ni > Cr > Al > Cu > Mn and Fe > Ni > Zn > Al > Cu > Mn respectively.

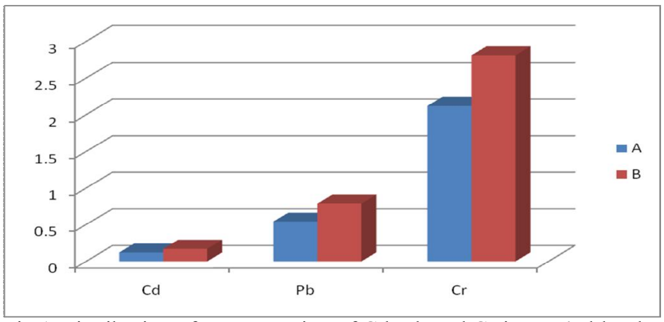

Fig 1 Distribution of concentration of Cd, Pb and Cr in cow's blood from A (Kano) and B (Zaria)

Manganese is an essential nutrient required in trace amounts for human health. Manganese can be released into air from various industrial operations or deposited from airborne releases into water or soil [12]. Plants can absorb and bioconcentrate manganese from contaminated water and soil which ended up in animals and human beings through food chain. Mn contents averaged 0.20±0.06ppm in cow blood collected in study area B. The value is slightly higher than the averaged concentration obtained for samples collected in study area A (0.18±0.10ppm). Manganese concentrations have been measured in cord blood and children's blood [13]. The amount of Mn obtained in the two studied areas falls within the allowable limit (0.17-1.00ppm) for Mn in blood [14]. It has been demonstrated that cadmium and lead interacts with manganese metabolism [15], this may be responsible for low Mn content recorded than Pb in the two studied areas. Elevated intake of manganese above recommended amounts may be of concern in some dietary situations.

Table 2 showing the mean levels (MEAN±SD) and range of trace and toxic metals in study area A and B in ppm

Elements (ppm)	***Study area A***	***Range in area A***	***Study area B***	***Range in area B***
Pb	0.54±0.42	0.001-1.37	0.79±0.17	0.50-0.99
Cd	0.12±0.04	0.02-0.16	0.17±0.14	0.001-0.46
Cr	2.12±1.54	0.53-5.36	2.81±0.90	1.41-4.48
Fe	36.62±7.71	25.16-55.87	35.11±14.78	16.03-62.78
Zn	5.48±0.52	0.17-15.81	1.93±0.38	0.09-11.08
Cu	0.25±0.16	0.02-0.49	0.26±0.12	0.01-0.38
Mn	0.18±0.10	0.01-0.49	0.20±0.06	0.12-0.29
Al	0.74±0.42	0.13-1.49	0.58±0.31	0.02-0.94
Ni	2.49±1.28	0.04-5.05	3.20±0.55	0.48-12.92

Iron, Zinc and Copper are essential micronutrient in animals and humans with well defined role in body metabolism though at elevated concentration could tend to be toxic. This study revealed a concentration of 36.62±7.71 and 35.11±14.78ppm for iron; 5.48±0.52 and 1.93±0.38ppm for zinc; 0.25±0.16ppm and 0.26±0.12ppm for copper in the two study areas A and B respectively. Fe and Zn were found to be higher in studied area A than B while Cu was found to be higher in area B than A. There was no significant difference observed between the mean concentration of Fe, Zn and Cu ($p < 0.05$).

However, when the levels of these metals in the study areas were compared with values reported in literatures, Fe levels was found to be about thirty times higher than 1.21mg/kg reported [16] , while Cu in the two studied areas were found to be lower than 0.79mg/kg reported by the same author. Zn in study area A was found to be about three times higher than study area B and slightly higher than 5.38mg/kg reported in literature [16]. The result was also compare to allowable limits for trace elements in blood [14]. Zn was found to be higher than 0.5-1.2ppm recommended while Cu was found to be lower than the allowable limit in blood (0.75-1.5ppm).

There is mutual antagonism between Cu and Zn in terms of uptake owing to similarities in electronic configuration of their common ions (*d*10). Elevated levels of dietary Zn can have a negative effect on Cu balance, which is exploited therapeutically to "de-copper" Wilson disease patients. Long-term oral intakes of 18-25 mg/day can interfere with Cu absorption [17].

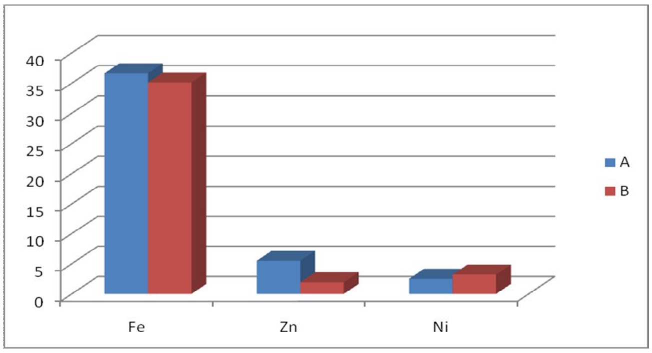

Fig 2 Distribution of concentration of Fe, Zn and Ni in cow's blood from A (Kano) and B (Zaria)

Nickel appears to be an essential micronutrient in animals and so it is likely to be essential for humans but its precise function in humans is unknown. Estimates of the presumed human Ni requirement range from 5-50 µg/day [17]. Ni concentration in studied area A and B varied from 0.04-5.05 and 0.48-12.92ppm respectively. When compared statistically, no significant difference was observed ($p < 0.05$).

Aluminium has no known significant role in body metabolism but used in the formulation of antacid for the relief of constipation and heart burn. The metal has been implicated with the case of Alzheimer disease [18]. In this work, a mean concentration of 0.74±0.42ppm and 0.58±0.31ppm was detected in samples from study area A and B respectively table 2.

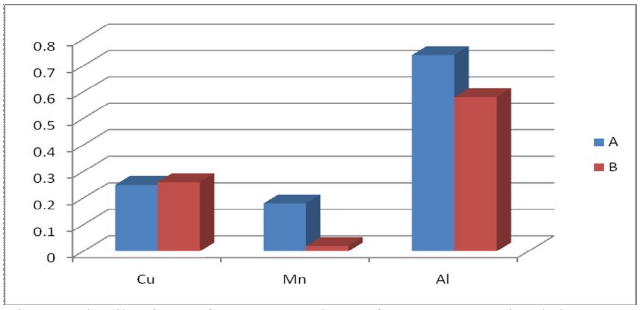

Fig 3 Distribution of concentration of Cu, Mn and Al in cow's blood from A (Kano) and B (Zaria)

Three heavy metals (Pb, Cd and Cr) of health implications were determined in this work. These metals especially (Cd and Pb) have drawn public attention resulting from food safety issues and potential health risk. They are regarded as the most important contaminants in our environment today.

Trace metal levels in cattle from the industrialized area of Challawa, Kano- Nigeria were low compared to moderately polluted area of Zaria- Nigeria fig 3. The results of the present study suggest that these metals nevertheless disturbed trace element metabolism to some extent.

Cadmium contents in cow blood from sample area A was in the ranged of 0.02-0.16(0.14±0.04ppm) lower than the observed value for cow blood from sample area B 0.01-0.46 (0.17±0.14ppm) table 2. Cd level in the study areas are higher than 0.007ppm allowable limits for cadmium in blood [14], also higher than 0.01 mg/kg reported in literature [16]. Cadmium level in blood below 1µg/dL could result to local irritation of the lungs and gastrointestinal tract, kidney damage and abnormalities of skeletal system. Relating to present work, most cattle grazed in study area A and B are not safe for human consumption. Cadmium has been reported to cause reductions in both intestinal zinc absorption and hepatic zinc reserves in cattle as a result of competition for the cation-binding sites of MT [19 & 20], possible reason for high level of Cd in area B than A and low level of Zn in area B than A.

Lead is a heavy metal of wide occupational and environmental concern. Pb contents in cow blood from study area A ranged from 0.001-1.37 (0.54±0.42pmm) while in cow blood from study area B ranged between 0.50-0.99 (0.79±0.17ppm) table 2. Lead is accumulative poison. Accumulation of Lead in the nervous system, bones, liver, pancreas, teeth, gums and blood, disturbs body function [21]. In this work, the mean level obtained for lead in the studied areas fall within the range of 0.21-10.6mg/kg reported in previous studies [16]. The values 0.403µg/l and 0.402µg/l were reported [6] for industrialised and rural area of Northern Spain. Pb level below 10µg/dL of blood is linked with impairment of neurological development, suppression of the haematological system, kidney failure, immunosuppression etc [22]. In this work Pb level is far higher than 0.02ppm allowable limit for trace metals in blood.

Chromium and other microelements are essential to maintain the metabolic systems of the body despite this they can lead to poisoning at higher level. Chromium concentration for livestock requirement ranges from 0.3 to 1.6 mg/kg, levels higher than these values are toxic to livestock and it badly affects the reproductive potential of ruminants [23]. In this work Cr contents were found to averaged 2.12±1.54 ppm and 2.81±0.90ppm in study area A and B respectively with higher mean level observed in area B. The maximum intake of chromium has been estimated to be 0.77 mg/day, comprising up to 0.17 mg/day from food, up to 0.002 mg/day from drinking water and up to 0.6 mg/day from supplements [24]. This implies that cows from the studied areas are not safe and could pose health threat to humans through food chain. There is no significant difference observed between the two means from the studied areas at 95 % confidence level. In assessment of Cr concentration in soil-plant-animal continuum [25], concentration range of 0.0011 to 0.0016 mg/L at all sampling intervals were reported. These are far lower than 0.53-5.36ppm and 1.41-4.48ppm obtained in this work indicating Cr pollution in the studied areas.

CONCLUSION

The trend of occurrence of heavy metals determined in blood samples from two studied areas A and B are as follows: Fe > Zn > Ni > Cr > Al > Cu > Mn and Fe > Ni > Zn > Al > Cu > Mn respectively. The levels of Pb, Cr and Cd detected in comparison to the allowable limit for trace elements in blood reveals that cattle grazed in the study areas are not safe for human consumption. Therefore routine monitoring of heavy metals is necessary for our health.

REFERENCES

[1] Nwude D.O., P. C. Okoye2, J. O. Babayemi (2010b). Assessment of accumulation of heavy metals in the kidney of cattle as a function of seasonal variation. Africa Journal of Animal and Biomedical Sciences 5 (3) 1-8. ISSN: 1819-4214

[2] Ward, N.I. and J.M. Savage (1994). Element status of grazing animals located adjacent to the London Orbital (M25) motorway. Sci. Total Environ, 146: 185-189.

[3] Farr, G. (2004). Why heavy metals are a hazard to your health. *http://www.becomehealthynow.com/ebookprint.php?id=122* Cited on 26th April 2007.

[4] SCAN (Scientific Committee on Animal Nutrition). Opinion of the on Undesirable Substances in Feed, adopted on 20 February 2003, updated on 25 April 2003 (http://europa.eu.int/comm/food/fs/sc/scan/ out126_bis_en.pdf); 2003.

[5] Doganoc, D. (1994) "Tissue contamination in poultry with lead and cadmium in Slovenia," *Zbornik Veterinarske Fakultete, Univerza Ljubljana*, vol. 31, no. 1-2, pp. 117–128.

[6] Miranda, M., M. Lopez-Alonso, C. Castillo, J. Hermandez, J.L. Benedito (2005). Effects of moderate pollution on toxic and trace metals levels in calves from a polluted area of northern Spain. Environmental Instrumentation. 31, 543-548.

[7] Korenekova, B., M. Skalicka., P. Nai (2002). Concentration of some heavy metals in cattle reared in the vicinity of a metallurgical industry. Vet. Arhw 72, 259-267.

[8] Lopez-Alonso, M., J.L. Benedito; M. Miranda; C. Castillo; J. Hemandez and R.F. Share (2002). Interaction between toxic and essential trace metals in cattle from a region with low levels of pollution. Arch. Environ. Contam. Toxicol. 42, 165-172

[9] Mlay, P.S. and Y.O. Mgumia (2008). Levels of lead and copper in plasma of dairy cows, pastures, soils and water

from selected areas of Morogoro suburbs, Tanzania. Livestock Research for Rural Development. 20 (4).

[10] Zadnik, T. (2007) "A 25-year long monitoring of lead content in the blood of cows from a stationary polluted area," *International Journal of Environment and Pollution*, vol. 31, no. 1-2, pp. 34– 41.

[11] Agunwa U.B, **Ogabiela E.E**, Lawal F.A and Owoeye L.D (2006). Analysis of Tannery effluent from Challawa Industrial Estate in Kano, Nigeria. ***Global Journal of Pure and Applied Science, Vol. 12, No 1***

[12] U.S. Centers for Disease Control (ATSDR). 2000. "Toxicological Profile for Manganese." http://www.atsdr.cdc.gov/toxprofiles/tp151.html.

[13] Vigeh, M., et al. 2006. "Lead and other trace metals in preeclampsia: a case-control study in Tehran, Iran." Environ.Res. 100(2):268-275. In US. EPA 2007. Toxicity and Exposure Assessment for Children's Health.

[14] Crounse, G.R. Walter, J.P. John, B. and Richard, L.M. (1983). Geochemistry and Man Health and Disease, 311-12.

[15] Puls R, 1994. Mineral levels in animal health, 2nd ed. Canada7 Sherpa International; 1994. 356 pp.

[16] Nwude D.O.**,** P. C. Okoye2, J. O. Babayemi (2010a). Blood heavy metals levels in cows at slaughter at Awka abattoir, Nigeria. International Journal of Diary Science. 5 (4) 264-270 ISSN: 1811-9747

[17] EMEA (2008) European Medicines Agency. Guideline on the specification limits for residues of metal catalysts or metal reagents. Doc. Ref. EMEA/CHMP/SWP/4446/2000. HTTP://www.emea.europa.eu

[18] Domingo J. L. Reproductive and Developmental toxicity of aluminium; A review, Neurotoxicol Teratol., 17: 515-521

[19] Smith RM, Leach RM, Muller LD, Griel LC, Baker DE. Effects of long-term dietary cadmium chloride on tissue, milk, and urine mineral concentrations of lactating dairy cows. J Anim Sci 1991;69: 4088– 96.

[20] Goyer RA. Toxic and essential metal interactions. Annu Rev Nutr 1997;17:37– 50.

[21] Curtis, D.K. (1990). Heavy Metals and Heavy Metal Antagonist. Pharmacologist Basis of Therapeutics, Edt., Good Man and Gilman's 2 (8), 1592-1613.

[22] Kimani N.G. (2007) Environmental Pollution and Impact to Public Health; Implication of the Dandora Municipal Dumping Site in Nairobi, Kenya. a pilot study report In cooperation with The United Nations Environment Programme (UNEP)

[23] McDowell, LR. 2003. *Minerals in Animal and Human Nutrition* (2nd Ed), Amsterdam. Univ. Florida.

[24] FSA. 2003. Safe Upper Levels for Vitamins and Minerals. Expert group on Vitamins and Minerals. Food Standards Agency, May 2003. ISBN 1-904026-11-7.

[25] Khan, Z.I., Ahmad, K., Raza, N., Al-qurainy, F., Ashraf, M and Hussain, A. (2010) Assessment of chromium concentrations in Soil-plant-animal continuum: possible risk for grazing cattle *Pak. J. Bot*., 42(5): 3409-3414.