DETERMINATION OF SOME HEAVY METALS IN FORAGE GRASSES IN ZUNGERU NIGER STATE, NORTH CENTRAL, NIGERIA

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Abstract

The serious indiscriminate local gold mining activities in Zungeru communities by the inhabitants led to possible environmental pollution particularly by heavy metal such as, Zinc, Copper, Lead, Nickel and Arsenic. These heavy metals were transported, dispersed and accumulate in plants being grown in that area and fed on by the grazing animals and these animals forms part of human diet as main source of protein. The study aimed at determining the concentrations of these metals in forage grasses being grazed by cattle around Zungeru area of Niger state, North central Nigeria and compared to European Union standards for these metals in forage grasses. Samples were collected at five different grazing pastures sites around the town and analyzed after wet digestion for levels of the heavy metals by atomic absorption spectrometry. The trend of the metal levels was Pb> Ni > As. The mean concentrations obtained in mg/kg were in the range of 4.643± 1.02 to 18.434±1.56 for Lead, 1.534±0.68 to 2.690±0.56 for nickel and 0.304±106 to 0.655±0.05 for Arsenic. Forage grasses examined in this study are relatively not safe for grazing by animals due to high forage lead level. Consumption of such levels may result to risk to public health.

Keywords: Heavy metals, forage grasses, grazing animals.

Introduction

Wushishi local government area in Niger state, north central Nigeria with a land mass of 402 square meter have a long history of illegal mining, highly influenced by metal pollution sourced from the mining activities. The major districts implicated were Zungeru and Beji areas. There has been confirmed reports of tragic Pb poisoning disaster in Zamfara state north central, Nigeria in 1990, where more over160 children died after coming into contact with galena polluted ore obtained from gold mining sites (Yabe et al., 2010). The soil in the affected areas was reported to have Pb levels up to 23 times the maximum acceptable levels in soils set by USEPA. Domestic animals were reported to be badly affected with several deaths recorded. The traditional system of management of livestock, free ranging, which involves animals taken from place to place in search for water and pasture, has remained the most practiced in the country. Free ranged animals can pick toxicants such as heavy metals from the environment by feeding on fodder in the open or from waste dumps, drinking polluted water from drains and streams, and intake of atmospheric depositions especially from vehicular emission and fumes from open burning of wastes (Ihedioha and Okoye, 2012). Mining is a major source of contamination of land surfaces as well as surface- and groundwater. There is a significant association between the presence of heavy metals and the incidence of some human diseases [Gupta, 1998]. The aim of this study is to determine the concentrations of Zinc, Copper, Lead, Nickel and Arsenic in forage grasses grazed by cattle and other livestock around Zungeru area.

Sampling Sites

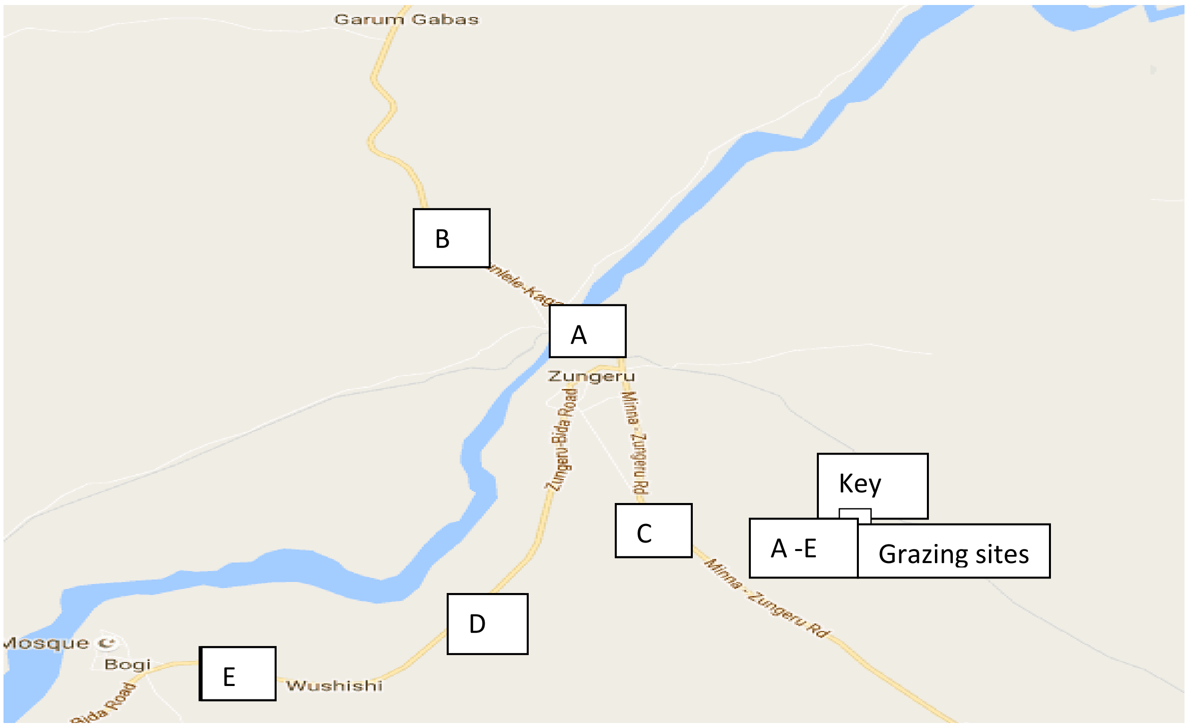

Fig. 1: Map of Zungeru area showing sampling sites

Zungeru is located within longitude 9^0 10’E and latitude 6^0 10’N. Five feeding sites where cattle grazed freely around Zungeru, Wushishi local government area of Niger state, north central Nigeria were selected for this study. The sites were designated as grazing sites A, B, C, D and E for Zugeru, 4km East, 5km west, 8km west and 12km south west of Zungeru respectively.

Methodology Forage grasses were collected from five different points per sampling site and stored in polyethylene bags, transported to advance chemistry laboratory, Sheda, Abuja. Samples were air dried in the shade to constant weight, then ground into powder, passed through a 0.02 mm sieve, mixed to homogenize. Mixture of Nitric acid and Perchloric acid at (4:1) was used for plant digestion according to Kakulu and Jacob 2003.

Reagent blank was prepared in similar manner. Metal analysis was carried out using GBC atomic absorption spectrophotometer, model no ICE 3000 AA was optimized for intended use and percentage recovery and co-efficient of variation were determined for precision. Which were shown from the table of the result.

Result and discussion Results were presented as mean ± S.D and the mean concentration of the five grazing sites were compared using one trial student t-test at $p<0.05$ level of significance. The result of the accuracy and precision of the analytical procedure shown in table 1 below indicates accuracy of the analytical method employed.

Table 1: Percentage recovery, coefficient of variation (Precision) for determination of Ni, Pb and As in forage grass samples

Metals	Percentage recovery (%)	Precision (Coefficient of variation) (%)	Wavelength (nm)
Ni	97.45	1.24	232.1
Pb	92.07	1.05	283.3
As	98.51	1.57	193.7

Table 2: Mean concentrations of Nickel (Ni), Lead (Pb) and Arsenic (As) in mg/kg of different forage grasses at grazing sites across Zungeru area North central, Nigeria

Grazing Sites	Pb	Ni	As
A	11.101± 2.53*	2.531± 0.345*	0.410± 1.36*
B	18.434± 1.56*	2.461± 1.33*	0.410± 1.36*
C	6.328± 2.83*	2.690± 0.56*	0.304± 106
D	9.436± 1.97*	2.663± 1.07*	0.655± 0.05
E	4.643± 1.02	1.534± 0.68*	0.528± 0.75
	5.0	1.0	0.5

MPL -maximum permissible limit; European Union (E.U. 2003a); and *(P<0.05) considered Significant

As shown in table 2, the results obtained for mean concentration of lead in forage grasses sampled are 11.101± 2.53mg/kg, 18.434± 1.56mg/kg, 6.328± 2.83mg/kg, 9.436± 1.97mg/kg, and 4.643± 1.02mg/kg for site A, site B, site C, site D and site E respectively. The values recorded in this study across the grazing sites were found to be above the stipulated limits of 5mg/kg by European Union 2003, except for sampling site E, which is the farthest to Zungeru among the grazing sites. Two grazing sites (A and D) recorded mean values that were almost twice the acceptable limit, while grazing site B recorded value that is almost four times the limit. However, these values were less than mean Lead concentrations distributed in forage grasses across Dareta village in Zamfara state sampled by Udiba*et. al*., 2013. The correlation (Anova, P<0.05) in forage lead concentrations across the grazing sites A and B, and sites B and D suggest same lead source of contamination at grazing sites A, B and D. Grazing animals are affected by the consumption of forage contaminated by lead dust particles and possibly through plants up-take of lead through their roots from contaminated soil. Lead content can result in higher levels of intake by grazing animals and subsequently accumulation along the food chain. Consumption of lead contaminated animals constitutes serious risk to public health. There is no exposure limit below which lead is said to be safe. It induces reduced cognitive development and intellectual performance in children, increase blood pressure, and cardiovascular diseases in adult as well as liver and kidney dysfunction (Singer *et al*., 1990).

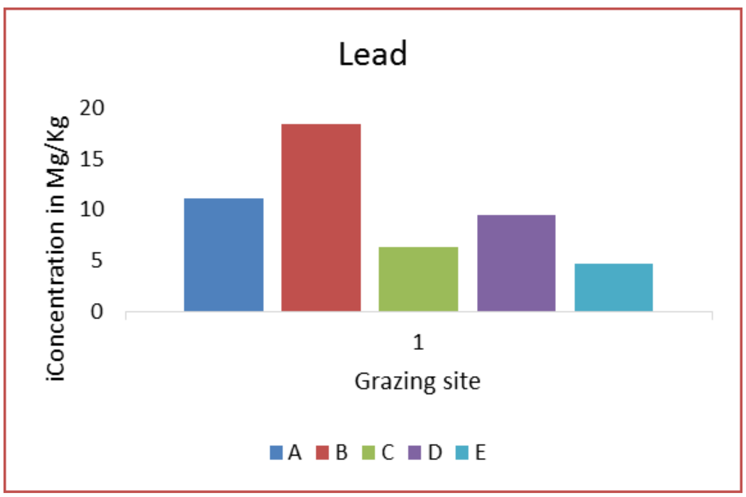

Fig 2. Mean concentration of lead in forage grasses across five grazing sites in Zungeru, Nigeria

The average concentration ranged from 1.534±0.68 to 2.690±0.56 mg/kg (table 2), Concentrations of Ni in grasses are higher than 1mg/kg the E.U 2003, limit guideline values for Nickel metal levels in feed but relatively lower than the values recorded in forage in Darate village (Udiba*et al* 2013). No significant difference (p<0.05) in forage nickel levels across the sampling sites was observed.Anthropogenic activities such as burning of oil and coal, smelting/ plating works, mining and agricultural activities have resulted in wide spread atmospheric nickel (Ahmad *et. al.*, (2009). They however, reported that concentrations of Ni in grasses were generally lower than those in soils. A minimum concentration of 0.041mg/kg dry weight and maximum concentration of 66.21mg/kg dry weight were reported for Dareta soil (Udiba*et. al.*, 2012). Nickel is reported to functions either as a co-factor or structural component in specific metal-enzyme or as a bio-legend. Diets very low in Nickel affects animal growth, development and reproduction. (Ahmad *et. al.*, 2009).

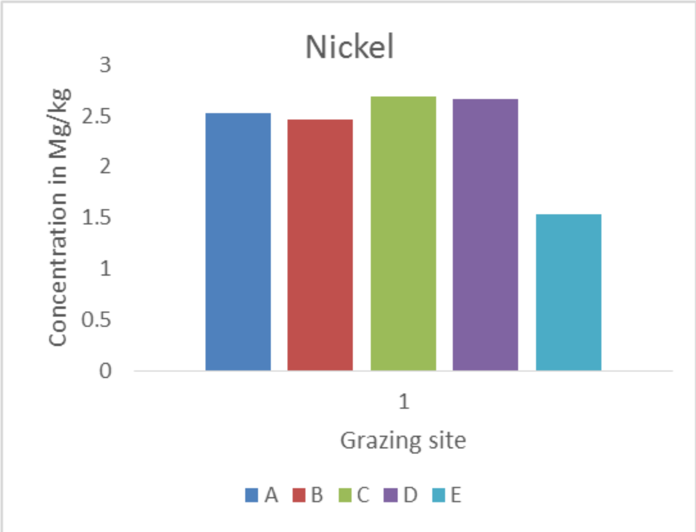

Fig 3. Mean concentration of Nickel in forage grasses across five grazing sites in Zungeru, Nigeria

As shown in table 2, the average concentrations of Arsenic in mg/kg in grasses across the grazing stations were 0.410±1.36, 0.410± 1.36, 0.304± 106, 0.655± 0.05 and 0.528± 0.75 for grazing sites A, B, C, D and E respectively. The EU maximum allowable level of As in feed is 0.5 mg/kg. The mean concentrations of Arsenic in forage from this study indicate that all the values are below the permissible limit except concentrations recorded in sampling sites A and B. The correlation between sampling site A and site B was statistically significant at 99% confidence level. Previous studies have suggested that arsenic has beneficial action in low amounts. Some organic arsenic compounds have been used in swine and poultry to improve weight gain [Giacomina*et al.*, 2010]. Organic arsenicals as growth promoters in animals have been removed from the market due to human health concerns. The toxicity of As is dependent on the chemical valence and form, as inorganic Arsenic is usually more toxic than organic Arsenic [Duruibe, 2007]. Plants take up Arsenic by absorbing them from contaminated soils, as well as from deposits on different parts of the plants exposed to the air from polluted environments. Arsenic toxicity affects Central nervous system and kidneys, heart diseases, memory deterioration, osteoporosis at excessive levels. [Duruibe, 2007]

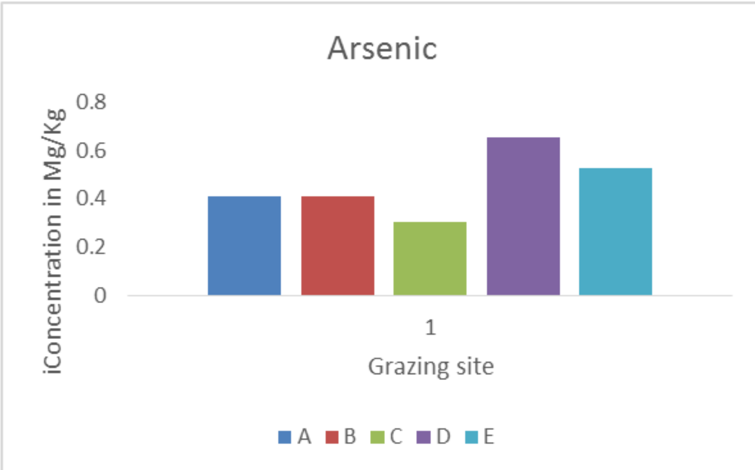

Fig 4: Mean concentration of Arsenic in forage grasses across five grazing sites in Zungeru, Nigeria

Conclusion

The presence of heavy metals in forage grasses around Zungeru area is an indication of environmental metal pollution affected possibly through processes such as agricultural and mining. Therefore, consumption of these contaminated animals and their products can lead to toxicity due to bioaccumulation posing risk to human.

Recommendation

Measures need to be taken such as restricting the locations where animals are grazed and remediation of the environment so as to prevent further re occurrence.

References

Ahmad K., Khan Z., Ashraf M., Valeem E. E., Shah R. and Mcdowell E. (2009). Levels of total amino acids, soluble proteins and phenolic compounds in forages in relation to requirements of ruminants grazing in thesalt range (Punjab), Pakistan, *Pak. J. Bot*, 41(3), 1521-1526.

Arogunjo AM (2007). Heavy metal composition of some solid minerals in Nigeria: Any Health Implication to inhabitants around the Mining sites.*Int.J.Appl.Environ.Sci*.2(2): 143-145.

Duruibe JO, Ogwuebu MO, Egwurugwu JN (2007). Heavy metal pollution and human biotoxic effects. *Int. JPhys. Sci*.(5):112-118.

Giacomino A, Malandrino M, Abollin O, Velayutham M, Chinnathangavel T, Mentasti E (2010). An approach for arsenic in a contaminated soil: Speciation. Environ. Pollution 158: 12-13.

Gupta, U.C. and S.C. Gupta. (1998). Trace elements toxicity relationships to crop production and livestock and human health: Implication for management. *Common Soil Sci. Plant Anal*., 29, 1491-1522.

Ibeto C.N and Okoye C.O.B., human and Ecological Risk Assessment: An International Journal, 2010a,16:5,1133-1144.

Igwegbe A.O., (2013). Effects of Location, Season, and Processing on Heavy Metal Contents in Selected Locally Harvested Fresh Fish Species from Borno State of Nigeria. A Ph.D Thesis, Department of Food Sciences and Technology, Faculty of Engineering, University of Maiduguri.

Ihedioha A, and Okoye P. C, (2012). Heavy metals in feeds, growth factors or unwanted environmental factors. *J. Anim. Feed Sci*., 7: 135-142.

Kakulu S. and J.O. Jacob (2006). Comparison of digestion methods for trace metal determination in moss samples, Proceeding of the 1National Conference of the Faculty of Science, University of Abuja, 77-8.

Khan Z., Ashraf M., Ahmad K, Mustafa I. and M. Danish (2007). Evaluation of micro minerals composition of different grasses in relation to livestock requirement, Pak. J. Bot, 39(3), 719-728.

Makridis S. Christos R. Nikolaos G. Nikolaos, R Loukia and L. Stefanos Journal of Agricultural Science and Technology 2012 A 2 149 – 154.

Mariam, D.O., P.A.C. Yusuf and J.O. Babayemi(2004). Assessment of heavy metal concentrations in the liver of cattle at slaughter during three different seasons. Res. J. Environ. Sci.,

Ogabiela E., Yabpella G., Adesina O. B., Udiba U., Ade – Ajayi A., M Agomya M., Hammuel C gandu U.J Abdulahi M. Journal of Applied Environmental and Biological sciences 2011a, (4) pp 69 – 73.

Ogundiran, M. B., Ogundele, D. T., Afolayan, P. G.andOsibanjo(2012).Heavy Metals Levels in Forage Grasses, Leachate and Lactating Cows Reared around Lead Slag Dumpsites in NigeriaInt. *J. Environ. Res.*, 6(3):695-702.

Singer M. J and Hanson L. Soil Science Society of America Proceedings (1969). 33:152-153.

Udiba U. U., Hassan D. B., Michael O., Bashir I., Lasisi A.(2013). Toxicological implications of grazing on forage grasses in Dareta Village, Zamfara, Nigeria Arch. *Appl. Sci. Res.* 5 (3):220-228.

USEPA (1996). United States Environmental Protection Agency.Acid digestion of Sediments, Sludge and Soils, Method 3050B *2nd ed.* Washington, DC, USA.

WHO (1983) Food safety issues associated with products from aquaculture. Report of a Joint FAO/NACA/WHO Study Group.World Health Organisation Technical Report Series 883: i-vii, 1-55.

Yaba S. A. Musa H. (2010). Effects of lead pollution on growth, nitrogen metabolism and tissue in humans and animals. *J. Nutr*., 116: 1873-1882.