

**CONTENT OF SOME HEAVY METALS IN FORAGE GRASS IN KAGARA NORTH
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ABSTRACT

This work was designed to investigate the concentrations of zinc, copper, lead, nickel and arsenic in forage grass being grazed by cattle around Kagara in Rafi Local Government Area of Niger state, North Central Nigeria at five different grazing pastures sites around the town. There have been serious indiscriminate local gold mining activities in those communities by the inhabitants leading to possible environmental pollution particularly by heavy metals. These heavy metals can be transported, dispersed to and accumulated in plants being fed on by the grazing animals and these animals form part of human diet as our main source of protein. The samples collected were analyzed after wet digestion for levels of the heavy metals by Atomic Absorption Spectrometry. The trend of the metal levels was Zn > Cu > Pb > Ni > As. The mean concentrations obtained in mg/kg were in the range of 11.129 to 22.322 for zinc, 7.352 to 15.182 for copper, 4.732 to 18.173 for lead, 1.904 to 2.811 for nickel and 0.188 to 0.852 for arsenic. Forage grass examined in this study were relatively not safe for grazing by animals due to high forage lead level. Consumption of lead contaminated animals and their products constitute serious risk to public health.

KEYWORDS: Heavy metals, forage grasses, grazing animals.**INTRODUCTION**

Food safety is a major public concern worldwide. During the last decades, the increasing demand of food safety has stimulated research regarding the risk associated with consumption of food stuffs contaminated by pesticides, heavy metals and/or toxins.^[1] The implication associated with heavy metal contamination is of great concern. Heavy metals, in general, are not biodegradable, having long biological half-lives and having the potential for accumulation in the different body organs leading to unwanted side effects.^[2]

As developing countries of West African become industrialized and urbanized, heavy metal pollution is likely to reach disturbing levels. It has been pointed out that African's contribution to global lead pollution has increased from just 5% in 1980's to 20% in 1996.^[3] The critical issues however are that preparations are not being made towards the protection of the environment. Excessive levels of heavy metals may occur in the biosphere as a result of normal geological phenomena such as ore formation, weathering of rocks and leaching. Other activities that could contribute to excessive release of these metals into the environment include burning of fossil fuels, smelting, and discharges of industrial, agricultural and domestic wastes as well as deliberate

application of pesticides. Anthropogenic contributions or human activities such as petroleum mining and oil spillage are also major sources of these metals contamination. These metals can pose a significant health risk to humans, particularly in elevated concentrations above the very low body requirements.^[4] The risk associated with the exposure to heavy metals present in food product had aroused widespread concern in human health. Improvements in the food production and processing technology had increased the chances of contamination of food with various environmental pollutants, especially heavy metals. Ingestion of these contaminants by animals causes deposition of residues in meat. Hence contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain.^[5] Although contamination of animal feed by toxic metals cannot be entirely avoided given the prevalence of these pollutants in the environment, there is a clear need for such contamination to be minimized, with the aim of reducing both direct and indirect effects on animals and human health.

A number of reports have confirmed the transference of trace metals from contaminated soil to plants and from plants to livestock. Ruminants such as goats, sheep and

cattle feed on grass which have absorbed and accumulated elements from the soil over time. Grazing animals are directly affected by the consumption of forage and feed contaminated by airborne metals and somewhat indirectly by the up-take of the metals through plant roots.^[6] One major source of metal poisoning through the food chain is from metal-up take from contaminated soil or dust deposits on the plants being fed by these animals. Heavy metal transfer from soil to plant is dependent on many factors, such as soil properties, plant species and metals bioavailability for uptake in the soil-plant system.

Rafi Local government Area in Niger state, North Central Nigeria with a land mass of 359 square meter have a long history of illegal mining, highly influenced by metal pollution sourced from the mining activities. The major districts implicated were Kagara and Mariga areas. There has been confirmed reports of tragic Pb poisoning disaster in Zamfara state North West, Nigeria in 1990, where more over 160 children died after coming into contact with galena polluted ore obtained from gold mining sites.^[7] 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.^[8] 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.^[9] 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.^[10] 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 Kagara area.

MATERIALS AND METHOD

Sampling: Kagara is located within longitude 10° 11'E and latitude 6°15'N. Five feeding sites where cattle grazed freely around Kagara, headquarter of Rafi 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 Kagara, 4km East, 5km west, 8km west and 12km west of Kagara respectively. Forage grasses were collected from five different points per sampling site and stored in polyethylene bags and transported to advanced chemistry laboratory, Sheda, Abuja for metal analysis.



Fig. 1. Map of Kagara area showing sampling sites

Metal analysis.

The samples were washed with deionized water, air dried in the shade to constant weight. Samples were 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.^[11] Reagent blank was prepared in similar manner. Spiking of the sample was done using standards of concentration of each studied metal and extracted as above using GBC

atomic absorption spectrophotometer, model no ICE 3000 AA.

Statistical Analysis: The mean concentration levels of the heavy metals in forage grass across the five grazing sites were analyzed using student t- test and the level of significant difference at $p < 0.05$ assessed by one way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Table 1. Percent mean (n=3) recovery for Zn, Cu, Ni, Pb and As in forage grass samples

Metals	Percentage recovery (%)±SD
Zn	105.21±1.29
Cu	96.36±1.06
Ni	97.45±1.85
Pb	92.07±0.11
As	98.51±1.26

The results of the analysis of the heavy metals for the spiked forage grass samples are shown in table 1. The mean recovery for the metals examined ranged 92.07 –

105.21% indicating good recoveries of the metals thereby demonstrating accuracy of the analytical method.

Table 2. Mean concentrations of Zinc, Copper, Nickel, Lead and Arsenic in mg/kg in different forage grasses at grazing sites across Kagara Area North Central, Nigeria

Grazing Sites	Metals(mg/kg)				
	Zn	Cu	Pb	Ni	As
A	20.080±6.61	14.407± 4.10	10.050± 3.81	2.362± 0.64	0.852± 0.43
B	22.372±7.28	15.182± 4.33	18.173± 4.56	2.911± 0.93	0.601± 0.81
C	17.635±5.04	12.660± 3.01	6.682± 2.55	2.525± 1.08	0.317± 0.15
D	19.566± 8.27	12.380± 5.25	9.150± 1.91	2.106± 0.17	0.196± 0.11
E	11.129± 2.22	7.352± 2.36	4.732± 0.72	1.904± 1.62	0.188± 0.07
MPL[E.U]	500.0	100.0	5.0	1.0	0.5

MPL -maximum permissible limit; E.U –European union.^[12]

From the results of this study, the mean concentrations recorded for zinc in grasses across the grazing sites A, B, C, D and E were 20.080±6.61mg/kg, 22.372±7.28mg/kg, 17.635±5.04mg/kg, 19.566± 8.27mg/kg and 11.129± 2.22mg/kg respectively. Zinc was detected according to the order; site B > site A > site D > site C > site E. No significant difference in forage zinc level across the

sampling sites was observed (P>0.05) The values recorded in this study across the sampling sites were found to be within the permissible limit of 500mg/kg stipulated by European union,^[12] for zinc in feeds. Statistical analysis revealed positive correlation in forage zinc levels between all the sites suggesting same source is responsible for presence of zinc at the grazing sites (Fig. 1).

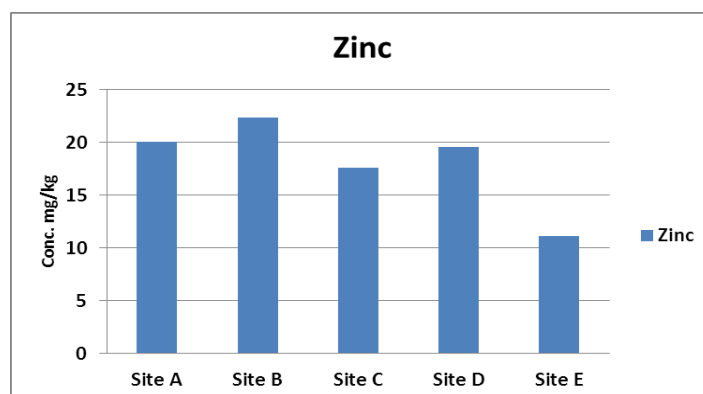


Figure 2. Mean concentration of zinc in forage grasses across five grazing sites in Kagara, Nigeria

Zinc is present in the body as a co-factor for enzymes such as arginase and diaminase. It takes parts in the synthesis of DNA, proteins and insulin. It is an essential element required for many biological processes, including protein synthesis, carbohydrate metabolism, cell growth and cell division in humans and animals. High zinc levels between 100mg/kg – 280mg/kg was reported for forage grasses in Daret village, Zamfara, North Westral, Nigeria by ^[13] after the remediation exercise due to lead poisoning crisis of 2010 in the area.

Exposure to excess amount of zinc can result to zinc poisoning, though is most commonly added as mineral supplements to the animal ration. The low concentration of zinc in this study implies that forage grasses sampled does not pose a toxicity problem for the grazing animals. Copper was detected according to the order below; grazing site B > site A > site D > site C > site E, same trend as observed in mean forage zinc concentrations across the sites, though, recorded at lower values. The mean Copper concentrations ranged from 7.352±2.36mg/kg to 15.182±4.33mg/kg.

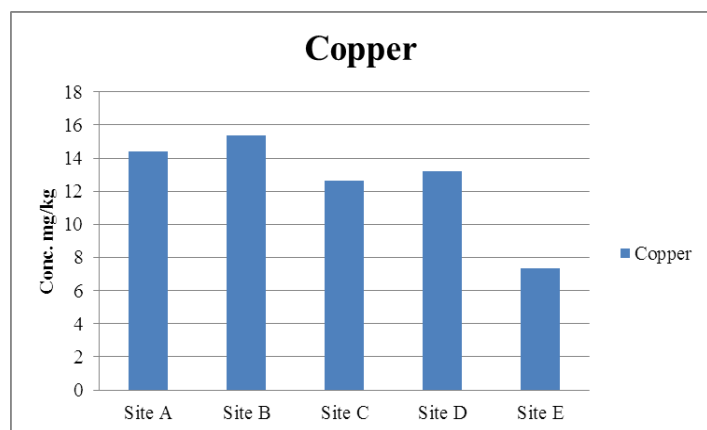


Figure 3. Mean concentration of copper in forage grasses across five grazing sites in Kagara, Nigeria

The Cu concentrations of forages obtained at sites A, B, C, D, E and F were not significantly ($P>0.05$) different from each other and were found to be within the permissible limit of 100mg/kg stipulated by European union,^[12] for copper in feeds. Copper is essential for enzyme function and stabilization of collagen and celating, in energy metabolism, pigmentation, antioxidant defence system, and iron metabolism.^[14] Cattle are more sensitive to Copper toxicity than goats. Ruminants typically develop hemolytic anemia, with liver and kidney lesions common to all species. A low

level of 5.55mg/kg reported for forage grasses in Ibadan, Nigeria was similar to mean copper levels obtained in this study.^[15] As shown in table 2, the results obtained for mean concentration of lead in forage grasses sampled are 10.050 ± 3.81 mg/kg, 18.173 ± 4.56 mg/kg, 6.682 ± 2.55 mg/kg, 9.150 ± 1.91 mg/kg, and 4.75 ± 0.72 mg/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,^[12] except for sampling site E, which is the farthest to Kagara among the grazing sites.

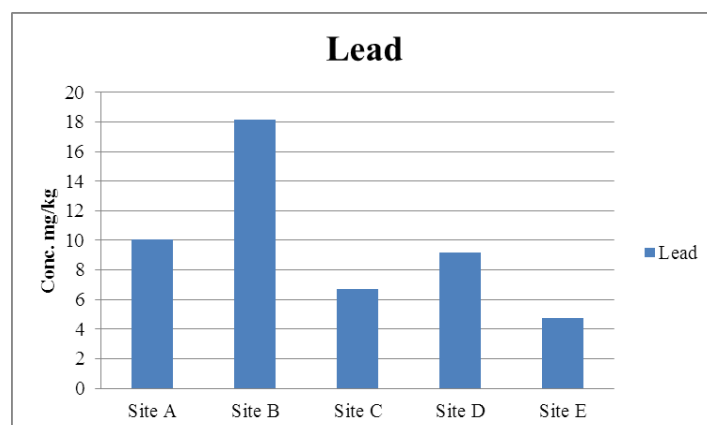


Fig 4. Mean concentration of lead in forage grasses across five grazing sites in Kagara, Nigeria

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 Daretta village in Zamfara state sampled by Udiba *et al.*^[13] 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.^[16]

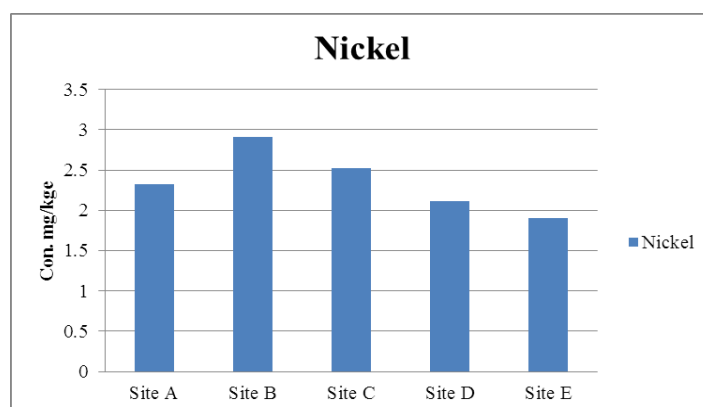


Fig 5. Mean concentration of Nickel in forage grasses across five grazing sites in Kagara, Nigeria

Nickel recorded mean concentrations in forage according to the order; grazing site B > site C > site A > site D > site E. The average concentration ranged from $1.904 \pm 1.62/\text{kg}$ – $2.911 \pm 0.93\text{mg}/\text{kg}$ (table 2, figure 5). Concentrations of Ni in grasses are higher than $1\text{mg}/\text{kg}$ the E.U. ^[12] limit guideline values for nickel metal levels in feed but relatively lower than the values recorded in forage in Darate village ^[13] 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. ^[17] They, however, reported that concentrations of Ni in grasses were generally lower than those in soils. A minimum concentration of $0.041\text{mg}/\text{kg}$ dry weight and maximum concentration of $66.21\text{mg}/\text{kg}$ dry weight were reported for Dareta soil. ^[18] 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. ^[17]

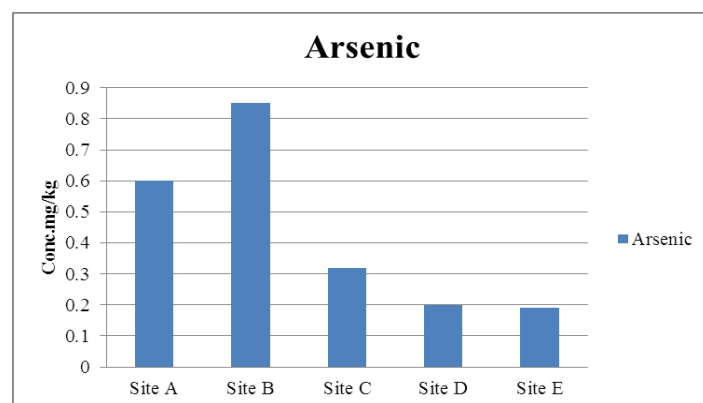


Fig 6. Mean concentration of Arsenic in forage grasses across five grazing sites in Kagara, Nigeria

As shown in table 2, the average concentrations of Arsenic in grasses across the grazing stations were 0.852 ± 0.43 , 0.601 ± 0.81 , 0.317 ± 0.15 , 0.196 ± 0.11 and 0.188 ± 0.07 for grazing sites A, B, C, D and E respectively. Arsenic (As) was detected in forage according to the order: site B > site A > site C > site D > site E. (figure 5). The EU maximum allowable level of As in feed is $0.5\text{mg}/\text{kg}$. 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. ^[19] 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. ^[20] 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. ^[20]

CONCLUSION

The presence of heavy metals in quantities in forage grasses around Kagara Area is an indication of environmental metal pollution affected possibly through processes such as agricultural and mining activities. However, the concentrations are within the tolerable limits for livestock feeding except for lead. However, long exposure to these metals through consumption of contaminated animals and their products might bring

about bioaccumulation and become harmful to the health of the human. Some specific measures such as restricting the locations where animals are grazed to prevent and control hazards should be taken in order to safe-guard the livestock reared in this area from the toxic effects of these metals posing risk to public health.

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