EXTENT OF SOME HEAVY METALS CONTAMINATION IN SOIL OF FARMLANDS AROUND SOKOTO METROPOLIS

S. A. Zauro

M. U. Dabai

A. I. Tsafe

K. J. Umar

A. M. Lawal

Department of Pure and Applied Chemistry,Usmanu Danfodiyo University, Sokoto, Nigeria

Abstract

Soil samples were collected from six different farmlands along the major roads at the outskirt of Sokoto metropolis. The samples were digested and the filtrate subjected to quantitative analysis using Atomic Absorption spectroscopy (AAS). The results indicated the presence of all the metals under consideration apart from cadmium in FSI and FDU. The concentration of all the metals in all the samples area were below the standard set up by NYS DEC in soil with exception of Cr in FK. High levels ofCr in FK could be attributed to traffic Volume tanning processes taking place in the areas. The results also revealed that significant ($p<0.05$) difference exist between the samples in terms of heavy metals concentration.

Keywords: Heavy metals, contamination, soils, farmlands, Sokoto

Introduction

Soil as a component of terrestrial ecosystems, being essential for the growth of plants is a dynamic system and subject to short term fluctuations, such as variation in moisture status, pH and release conditions and also undergoing gradual alterations in response to changes in management and environmental factors.(Abubakar *et al*,2004).

The high level of civilization related soil pollution has recently become a major issue and chemical analysis of soil is important for environmental monitoring and legislation (Nwajei and Iwegbue, 2007).

As human activities began to undergo industrialization, the amount of waste thrown into the environment increased tremendously (Inuwa (2004). The combination of population explosion and increasing level of industrialization and urbanization has led to environmental pollution (Filazi *et al*, 2003). Industries have largely been responsible for discharging of effluents containing trace metals such as zinc (Zn), Cadmium (Cd), Mercury (Hg), Lead (Pb) and Chromium (Cr) into our environment (Inuwa, 2004).

The uptake of toxic heavy metals from contaminated soils by food and foliage plants comprises a prominent path for such elements to enter the food chain and finally be ingested by human. Ingestion and eventually accumulation of toxic heavy metals such as Lead, Cadmium, Chromium etc. pose a threat to human health and should therefore be minimized (Dieckmanni, *et al*, 2001).

Contamination by heavy metals in the environment is of major concerned, because of their toxicity, threat to human life and the environment. Therefore, the levels of these metals in soils require constant monitoring. Hence, unexpected rapid mobilization of heavy metals could result in environmental catastrophe, menacing human health and welfare, poisoning of water sources, soils and food chains (Nwajei and Iwegbue, 2007).

However information on levels of heavy metals in around Sokoto metropolis is limited, and attempt to bridge this gap informed the basis of this study.

Materials And Methods

Material

The materials used for this analysis were soils samples from six different farmlands around Sokoto metropolis**.**

Sampling

The samples were collected from selected farmlands along major roads and at a depth of 5-20cm from the surfaces at ten different points and mixed together to obtain a bulk samples and then cone and quartered method was used to obtain a representative sample. The samples were kept in a clean polythene bag labeled and transported to the laboratory for analysis.

Sample Description

The farmlands on the outskirt of the Sokoto metropolis where the samples were obtained are described in table 1.

Table 1: Samples and their descriptions

S/NO.	SAMPLE	DESCRIPTION
1	FSI	Farmlands Along Sokoto -- illela Road
2	FSB	Farmlands Along Sokoto – Birnin Kebbi Road
3	FK	Farmlands Along Kalambaina Road
4	FSG	Farmlands Along Sokoto – Gusau Road

5	FU	Farmlands in UDUS
6	FDU	Farmlands at Durbawa Village (Control Sample)

Sample Treatment

The soil samples were air dried for four days and later oven dried for a day to constant weight, grounded and sieved with 2mm mesh size. 1.5g of the soils samples were placed in 100cm^3 Kjeldahl flask and treated with a mixture of 60% $HClO_4$, Conc. HNO_3 and Conc. H_2SO_4 in the ratio 5 : 1 : 0.5. The mixture was swirled gently and digested for fifteen minutes as reported in Radojeviv and Bashkin (1999), Aliyu and Bello (2004) and Inuwa (2004). The mixture was allowed to cooled and diluted to 50cm^3, heated gently and filtered. The filtrate was then diluted to 100cm^3 and used for analysis using Atomic Absorption Spectrophotometry.

Sample Analysis

The metal concentrations were determined using AAS (Shimadzu AA-6300 Model) by adopting specific cathode-ray tube for each heavy metal as reported by Garry (1989).

All assays were carried out in triplicates. Means and standard deviation of all the values were calculated.

Results

Table 2: Heavy Metals in the Soil of Farmland around Sokoto Metropolis

	METAL CONCENTRATION (µg/g)				
Samples	**Cr**	**Cd**	**Cu**	**Pb**	**Zn**
FSI	1.095±0.000^{c}	ND	6.120±0.002^{a}	0.3405±0.00500.3405±0.0010.3425±0.00 17.025±0.001^{a}	17.125±0.012^{a}
FSB	7.295+0.004^{a}	0.11±0.000^{a}	5.600±0.001^{a}	3.800±0.020	10.505±0.003^{b}
FK	39.975±0.129^{b}	0.195±0.000^{a}	4.250±0.001^{b}	0.630±0.000^{c}	3.710±0.000^{c}
FSG	7.1650±0.028^{a}	0.085±0.000^{b}	4.930±0.004^{b}	18.700±0.039^{a}	12.725±0.006^{b}
FU	7.750±0.025^{a}	0.065±0.000^{b}	4.360±0.008^{b}	5.015±0.002^{b}	3.545±0.002^{c}
FDU	5.680±0.010^{a}	ND	5.350±40.004^{a}	0.610±0.001^{c}	3.625±0.031^{c}
NYS DEC	11	0.43	270	200	1100

- Data are mean ± The Standard Deviation of three replicate results
- Values within the same column with different superscript are significantly different at $p<0.05$

Key:

ND= Not Detected

NYS DEC = New York State Department of Environmental Conservation

Discussion

The summary of the results of heavy metals analyzed in all the samples were reported in table 2.

Chromium

It can be observed that, from the table that, all the samples concentration (µg/g) for chromium are below the NYS DEC standard 11 µg/g with the exception of FK which has the concentration of 39±975 µg/g. Similarly, the results indicated no significant ($p>0.05$) different between the samples except for FSI and FK which were significantly ($p<0.05$) different with the remaining samples. These high level of chromium in FK could be attributed to the discharge of waste products from industries into the environment, by the activities of cement, paper, leather tanning & paint industries (Umar and Ebbo (2005). The concentration of chromium in the entire samples are far below the value (182.20±10.62µg/g) reported by Ekwumemgbo and Audu (2006).

Cadmium

The results for cadmium revealed that either it was absent or below the detection limit of the machine in FSI and FDU despite the excessive use of fertilizers in the areas. The results also showed significant ($p<0.05$) difference between the samples. The obtained values for Cadmium were far below the values obtained by Aliyu and Bello (2004) of 4.8$_{\mu}$g/g and 3.46$_{\mu}$g/g in soils of battery chargers workshop and mechanical workshops respectively in Sokoto. The values obtained in this work are far below the values (0.43µg/g) in unrestricted soil adopted by NYS DEC (US EPA, 2002). The results deviated from the findings of Iwegbue *et al*, (2004) and Nwajei *et al,* (2007). The low level of this metal and absent of it in other areas (FSI and FDU) could be attributed to the fact that, there is less demand for its usage in the sample area.

Copper

The concentration of copper reported in this work showed that, FSI has the highest values of 6.120±0.002 µg/g, with FK having the least values of 4.250±0.01 µg/g.The concentrations of copper in all the samples were below the permissible limit of 270 µg/g set by the NYS DEC for unrestricted soils. The values reported were lower than the ones reported by Abubakar and ayodele (2002). Copper deficiency, even though rare, is associated with hyperchromic, microcytic anemia resulting from defective hemoglobin synthesis (Umar & Ebbo, 2005)

Lead

Lead is toxic heavy metal, which can be taken up by plant from the soil, there by interfering with the food chain (Tsafe, 2001). Concentrations of Lead (Pb) in these samples were in the order FSG>FSI>FU>FSB>FK>FDU. All the samples low high concentration of this (Pb) element compared to the NYS DEC values of 200µg/g.

Lead is known to exert its most significant effect on the nervous system, including motor disturbances, sensory disturbances, the hematotiopic system and the kidney and ultimately, major brain damage (Macrea *et al*, 1993) .

The higher level of lead in FSG and FSI might be due to traffic volume, automobile mechanical workshop the areas. It could also be due to the use of lead compound (tetra ethyl Lead) as an additive, which is an important source of lead (Pb) in automobile exhaust emission (Aliyu and Bello, 2004 and Tangahu *et al*, 2011) and also because of its use in soldering metals and paints (Umar & Ebbo, 2005). Lead ingestion has been associated with deleterious health effects; including disorder of central nervous system (NAS, 1982). Background Pb concentrations in Australian soils has been reported to ranged between 2 and 200 mg/kg (NEPC, 1999). Lead is widely known to be toxic even at low concentration especially in young children (Ang *et al*, 2003).The higher Pb concentrations in the study area may be as a result of atmospheric deposition from mixed anthropogenic sources including, motor vehicle emissions, sewage sludge additions or through other industrial emissions (Kachenko and Singh, 2005).

Zinc

Zinc is an essential nutrient for humans and animals that is necessary for the function of a large number of metalloenzymes, including alcohol dehydrogenase, alkaline phosphatase, carbonic anhydrase, leucine aminopeptidase, and superoxide dismutase. Zinc deficiency has been associated with dermatitis, anorexia, growth retardation; poor wound healing, hypogonadism with impaired reproductive capacity. However, zinc as a neurotoxin is able to chelate and deplete the neuronal concentration of the glutathione (GSH), causing neuronal cell death in a dose dependant manner (Diekcmanni *et al*, 2001).

The result obtained for zinc showed that, FSI had the highest concentrations 17.125±0.012 µg/g, followed by FSG with 12.725±0.006 µg/g, while FU had the lowest concentration of 3.545µg/g. Despite widespread use of zinc for domestic purposes, electroplating, paints in alloys, and dyes, the value obtained are still far below the threshold limit value of 1100 µg/gapproved NYS DEC. It could be deduced, therefore, that the values obtained for zinc in this work were not harmful, but further works need to be carried out before making any conclusive statement, since deficiency of it (zinc) has been found to retard growth and maturity and produced anemia (Parker, 1987).

Conclusion

The present study revealed that all the metals contents investigated were within the limit recommended by NYS DEC in soils with the exception of Cr in FK, which was higher. The high level of Cr could be attributed to the high traffic and tanning processes taking place in the area. Similarly, the results indicated that the metals were distributed differently in the soils with high significant ($p<0.05$) different between the samples.

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