Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.3 No.5, 2013

Determination of Some Heavy Metals in Soil Samples Obtained From Rimi Local Government in Katsina State, Nigeria

*[1]N. Tijjani, [1]I.J. Dioha, [1]B. Alhassan, [1]A.I. Eleri, [2]A.M. Lawal and [3]I. Muhammad
[1]Energy Commission of Nigeria, Plot 701C, PMB 358, Central Business District, Abuja.
[2]Department of Pure and Applied Chemistry, P.M.B. 2346, Usmanu Danfodiyo University, Sokoto.
[3]Department of Chemistry, Zamfara State College of Education, P.M.B. 1002, Maru, Zamfara State.
Email: tnafy10@yahoo.com, +1238038 701 2324

Abstract
The concentration of lead, chromium, iron, zinc, potassium, magnesium and sodium in soil samples obtained from Rimi local government in Katsina state was analyzed using Atomic Absorption Spectroscopy Technique. The Highest Mean concentration of the metals for each sample were as follows: Lead (8.3 ± 0.000 mg/g), Chromium (3.125±4.4.42 mg/g), Iron (14.2±0.000 mg/g), Zinc (4.2 ± 0.000 mg/g), Potassium (218.7 ± 44.19 mg/g), Magnesium (68.75 ± 8.84 mg/g) and Sodium (1446.45 ± 25.24 mg/g), The results were discussed in terms of effects of the concentration of these metals on the agricultural soil understudy and the concentration obtained was below the ECDG (2004), WHO (2008), Kabata-Pendias (1995), SEPA (2000) and DPR (1991) Permissible limits of heavy metals in Agricultural land. Although it was concluded that the soil is suitable for agricultural purposes, Remediation of heavy metal contaminated soils is necessary to reduce the associated risks, make the land resource available for agricultural production, enhance food security and scale down land tenure problems arising from changes in the land use pattern.
Keyword: Agricultural Soil Pollution, Trace and Heavy Metals, Environmental Pollution

1.0 Introduction
Soils vary across the landscape, therefore each soil contains unique trace element concentrations based on its parent material and other soil-forming factors that may have added or removed these elements from the soil. High background concentrations of trace elements, whether natural or anthropogenic, could result in mobilization and release into surface and subsurface waters and subsequent incorporation into the food chain. Soil factors such as organic matter, type and amount of clay, pH and cation exchange capacity (CEC) influence the quantity of trace elements available for mobilization and release or sorption in a soil. Several studies document gradual increases in the trace element contents of agricultural and forested soils due to waste applications (Berthelsen *et al.,* 1995; Chang et al., 1984; McBride, 1995). While essential in small quantities for plant growth, micronutrients like copper (Cu), manganese (Mn), molybdenum (Mo), and zinc (Zn) can be toxic at high concentrations in the soil. Some elements not known to be essential to plant growth, such as arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), nickel (Ni), and selenium (Se), also are toxic at high concentrations or under certain environmental conditions in the soil. The extent of soil pollution by heavy metals and base metal ions some of which are soil micronutrients is very alarming. It has been observed that the larger the urban area, the lower the quality of the environment (Eka,and Udotong,2003).

2.0 Materials and Methods
Sample Collection
The sampling was carried out in the months of August - December, 2010 and the triplicate samples were collected from each sample location using clean, stainless materials. Soil samples were systematically collected from six different spots within 100m radius of each sample area and the control site. The soil samples were obtained at a depth of 0 - 15cm around the major sampling areas. They were thoroughly mixed and transferred into clean and labeled plastic containers for analyses in the laboratory.
2.1 Sample Treatment
The soil samples were oven dried at 105OC to constant weight for 6hrs(Inuwa et, al,2007) the oven dried material was crushed and sieved through a 20µm plastic mesh from which the representative sample was obtained(Inuwa et,al,2007;IITA,1979) .
2.2 Soil pH
The soil pH was determined in 1:1 soil water suspension and 1:2 soil 0.01M calcium Chloride suspension as described in IITA, 1979. The mixture was stirred for 30 minute and allowed to stand for 1hour. The pH reading were taken after inserting the electrode of the pH in to partly settled suspension and reported the result as soil pH in the water and 0.01M CaCl2. The pH meter was calibrated with pH to buffer before used and the electrode were washed with distilled water and cleaned wiped with dry clean filter paper after each reading(Inuwa *et,al*,2007).

2.3 Apparatus and Reagents

All the chemicals and reagents used in this study were of analytical grades, the glass wares used were cleaned, rinsed with distilled water and air dried. The analyses of the metals were carried out using 305B atomic absorption spectrophotometer attached to graphite atomizer and a HP 960C Computer Printer.

2.4 Sample Digestion

One gram of the oven dried ground soils samples in each case was placed in 100cm3 kjedahl digestion flask, which has been previously washed with nitric acid and distilled water, the samples were subjected to wet digestion (AOAC, 1990) reacted with 2cm3 of 60% perchloric acid (HClO4), 10cm3concentrated nitric acid (HNO3) and 1.0 cm3 concentrated sulphuric acid (H2SO4), the mixture was swirled gently and slowly at moderate heat on the digester, under a fume hood. The heating continuous until dense white fumes appeared which was then digested for 15 min, set aside to cool and diluted with distilled water. The mixture was filtered through the Whatman filter paper into a 100cm3 volumetric flask, diluted to mark (Sahrawat et,al,2002;Inuwa et,al,2007,DARA,1993). The blank and the samples were digested in the same way. The concentration of the metals present in each soil was obtained from the calibration plot made with various concentrations of the standard.

3.0 Result and Discussion

3.1 Result

Table 1.0: pH of Soil samples

Source	Soil pH in H2O	Soil pH 0.01 CaCl2
Soil A	6.92± 0.2	5. 87 ± 0.4
Soil B	6.62 ±0.1	5.82±02
Soil C	6.79± 0.5	5.55±0.3
Soil D	6.84±0.5	5.49 ±0.6
Soil E	6.78± 0.2	5.97 ± 0.4
Soil F	6.73±0.5	6.04 ±0.2
Soil G	6.96± 0.3	5.71± 0.2

Source: Current Research

Table 2.0: Means and standard deviation of concentration of heavy meal in Rimi Local Government in Katsina State.

S/N	Sample	Pb (mg/g)	Cr (mg/g)	Fe(mg/g)	Zn (mg/g)	K (mg/g)	Mg (mg/g)	Na (mg/g)
1	A	3.15 ± 1.48	1.56 ± 2.21	9.50 ± 1.34	5.75 ± 1.22	187.50 ± 0.00	25.10 ± 0.00	1285.70 ± 0.00
2	B	6.25 ± 0.00	3.12 ± 0.02	14.30± 0.00	1.30 ± 0.00	218.75 ± 4.19	37.50 ±0.00	1303.50 ± 75.66
3	C	8.30 ± 0.00	1.56 ± 2.21	11.60± 1.27	2.60 ± 0.00	71.88 ± 5.13	68.75 ± 8.84	1392.80 ± 50.63
4	D	2.10±0.00	3.13±4.42	9.80±1.27	4.60 ± 0.00	106.25±1.49	56.25± 8.84	1142.85 ± 0.07
5	E	5.23±1.48	1.56±2.21	8.90 ± 0.00	6.60 ± 0.00	71.88±5.30	25.10± 0.00	1446.45±25.24
Mean Conc.		5.01±0.59	2.19±2.21	10.82±0.78	4.17±0.24	131.25±3.22	42.54±3.38	1314.26±30.32

3.2 Discussion

The pH of the soil is an important parameter that influences mineral mobility. The soil pH of the sampling sites varied on the average from 6.5 to 7.12 in water indicating only a slightly acidic to neutral (table 1), the pH in CaCl2 is within the range of 5.49 to 6.39 indicating moderately acidic soil. In general the acidic nature of the soil is attributed to the agricultural activities such as, application of fertilizers, insecticides, bush burning and harmattan dust. According to Brady and Weil (1999) the neutral to alkaline soil pH observed in semi-arid soil such as that of Rimi L.G Katsina state was due to low rain fall and alkaline compounds are not leached away, thus making the soil of the area too alkaline.

The experimental data shows that, Pb concentration (Mg/g) (table 2) in soils range from 2.10 – 8.30 with an average of 5.01. The values are lower than the permissible limits (table 3). Cr conentration (Mg/g) in soils shows a range of 1.56 – 3.13, with a mean concentration of 2.19. the concentration (Mg/g) of Fe is within the range of 8.90 – 14.30 and a mean concentration of 10.82. while Zn has a range concentration (Mg/g) of 1.30 – 6.60, with average mean of 4.17. The concentration of Mg (Mg/g) range between 25.10 – 68.75 with an average concentration of 42.54. for Na the concentration range between 1142.85 – 1446.45 with an average of 1314.26. From the result we can see that, the metals were in the following order of abundance Na > K > Mg > Fe > Pb > Zn > Cr.

The distribution pattern for chromium, iron, zinc, potassium, magnesium and sodium in agricultural soil understudy is clearly showing the unsuitability of these soils for agricultural purposes since most of the concentrations of the trace metals understudy were above the permissible limit of trace metals in agricultural land as recommended by various agencies in the world, the permissible limits was presented in table 3.0.

4.0 Conclusion

The levels of these trace metals in the Rimi local government were generally below the permissible level of normal agricultural land particularly, Cr, Fe, K, Mg, Na, Pb and Zn. The significant concentration of these metals in the agricultural lands is not favourable to the crop yield and it may arise from the activities of heavy machines and applications of fertilizers as well as other agricultural chemicals that contain such metals.

Table 3.0: ECDG (2004), WHO (2008), Kabata Pendias (1995), SEPA (2000), DPR (1991) Permissible limits

Trace Metals	ECDG	WHO	KABATA PENDIAS	SEPA	DPR
Pb	40-100	70	100	350	85-530
Cr	30-100	NA	100	250	100-380
Zn	NA	200	300	300	140-720
Fe	Na	1.0	NA	NA	NA
K	NA	12	NA	NA	NA
Mg	NA	150	NA	NA	NA

5.0 References

Adefolhan, D.O (1940), The Case Study of the Vertical Distribution of Dust During Occurrence of Harmattan Haze Over Nigeria, Technical Note 21, Meteorological Department, Lagos, Nigeria.P13

Ademoroti, C.M.A (1996), Environmental Chemistry and Toxicology, Foludex Press Ltd, Ibadan, Nigeria P 162-203

Agbo, S. (1997) Effects of Lead Poisoning In Children, In Proceedings at a Workshop on Vehicular Emission and Lead Poisoning in Nigeria, Edited By A.A. Falomo and C.C Chikwedu, Organized By Friends Of The Environment (Fote), Lagos P20-28.

Alka, M.N. (2000), Environmental Biochemistry, In Chatteerjea M.N and Rana S. 2000 (Edu) Textbook Of Medical Biochemistry, Jaypee Brothers Medical Publishers Ltd. New Delhi, India P432.

Astor (1992), Case Studies In Environmental Medicine – Lead Toxicity. U.S Department Of Health And Human Services (September) P1-21.

Berthelsen, B.O., E. Steinnes, W. Solberg, and L. Jingsen, Heavy metal concentrations in plants in relation to atmospheric heavy metal deposition. J. Environ. Qual. 1995, 24:1018-1026.

Bockris, J.Om (1978) Environmental Chemistry, Penium Press Ldt, New York P 440-469

Brady and Weil (1999). The nature and properties of soil. 12th edition Nature and Properties of Soils, 12th Edition. Upper Saddle River, NJ: Prentice-Hall, Inc. 88

Brown, T.L And Lemay, H.E (1983) Qualitative Inorganic Analysis, Prentice-Hall International (New Jersey).

Chang, A.C., J.E. Warneke, A.L. Page, and L.J. Lund, Accumulation of heavy metals in sewage sludge-treated soils. J. Environ. Qual. 1984, 13: 87-91.

Dara, S. S., A textbook of environmental chemistry and pollution control. S. Chand & Company Ltd. Ram Nagar, New Delhi 110055, 1993

Eka, O. U. and Udotong. I. R., A case study of Effects of Incessant Oil Spills from Mobil Producing Nigeria Unlimited on Human Health in Akwa Ibom State. In: Adinna, E. N., Ekpo, O. B. and Attah, V. I. (Eds), Environmental Pollution and Management in the Tropics. Snaap Press Ltd. Enugu. P219, 2003.

Inuwa M, F.W. Abdurrahman, U.A Birnin Yauri and S.A Ibrahim,2007, Analytical determination of some trace metals in soils around tnhe mojor industrial areas of north western Nigeria, trends in applied sciences research,2(6)515-521

IITA, 1979, Selected Methods for Soil and Plant. Manual Series No:1, Ibadan,pp:2-50.

Jack, G, Robert, P.O, Sharon, S. Parl N.C (1979) Environmental Impart Book, Ann Arbor Science Publishers Inc. P982.

Koral, T.M And Kassem, A.H (1972), Agricultural Ecology Of Savanna P.88.

McBride, M.B., Toxic metal accumulation from agricultural use of sludge: are USEPA regulations protective? J. Environ. Qual. 1995, 24:5-18.

Nriagu, J.O Blackson M.I And Ocram, K (1996), Childhood Lead Poisoning In Africa A Growing Public Problem, Science Of The Total Environment 181 (2): 93-101.

Nriagu, J.O (1978), Lead in the Atmosphere in the Biogeo-Chemistry Lead In The Environment. Amsterdam. Elsevier – North, Holland, Part A, P138-164.

Nriagu, J.O (1979), Global Inventory of Natural and Anthropologenic Emission of Trace Metals to The Atmosphere, Nature, (London), 279, P408-411.

Nriagu, J.O (1989). A Global Assessment of Natural Sources of Atmospheric Trace Metals, Nature (London), P48-49.

Nyle S.B. (1999), Soil Science, John Wiley and Sons Technical Inc. U.S.A P248-249.

Sahrawal, K.L., G. Ravi kumar and J.K., Rao, Procedures for the Determination K,Mg,Fe,Zn and Cu in plant materials commun. Soil Sci. plant Anal., 33:95-102

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage: http://www.iiste.org

CALL FOR PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** http://www.iiste.org/Journals/

The IISTE editorial team promises to the review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar