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Effects of Heavy Metals in Agricultural Soils of Dunukofia Local Government Area of Anambra State, Nigeria

Ojiako E.N*, Aduaka P .C

Department of Pure and Industrial Chemistry
Chukwuemeka Odumegwu Ojukwu University
Uli, Anambra State, Nigeria.
*oeugenianonye@yahoo.com**

Abstract: *The effects of heavy metals in agricultural soils and their uptake in plants on five towns in Dunukofia Local Government Area of Anambra State, was carried out using quantitative and qualitative analysis. Atomic Absorption Spectrophotometer was used to assay for the heavy metals. The results obtained showed that the soils were moderately acidic with a pH range of 6.43-6.90. The total organic carbon (TOC) levels showed 1.102, 1.090, 1.406, 1.242, 1.640 for samples A, B, C, D and E respectively which are higher than (>0.86%) of the WHO specified standard while the cation exchange capacity showed a range of 10.66-12.10cmol/kg. The particle size of the soils were observed to be 81% sand, 13% silt for samples A, C, D, and E , while sample B has 15% sand and 13% clay. The results of heavy metals analysis of the samples revealed that Cu and Cd concentrations were found within the permissible limit while Fe, Zn, Cr, Pb, Ni, and Mn were below the permissible limits recommended by WHO standard for agricultural soil. The Pb values in the samples A, B, and E were above the WHO standard. This showed that lead is the major pollutant of the area.*

Keyword: *heavy metals, soil, agriculture, effects.*

1. INTRODUCTION

Soil is the valuable resource of a nation whose quality determines its capability to function well for many contended uses (Ideriah *et al.,* 2005). Soils may become contaminated by the accumulation of heavy metals through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, land application of fertilizers, animal manures, sewage sludge, pesticides, waste water irrigation, atmospheric deposition (Wuana and Okieimen, 2011). Heavy metal is a general term used to describe a group of metals and metalloids with an atomic density greater than 5.0g/cm^3 (Duffus, 2002). These elements occur naturally in soils and rocks at various ranges of concentrations; they are also found in ground and surface water bodies and sediments (Hutton and Symon, 1986). Some of these heavy metals are essential to plants and animals lives in small amount like Cu, Mn and Zn. If excess are toxic to plants and animals (Ideriah J.K., 2005).

The aim of this work was to analyse the heavy metal content (Fe, Cu, Zn, Cr, Cd, Pb, NI, and Mn) in agricultural soils of the towns in Dunukofia L.G.A of Anambra State with a view to reducing the effects on the residents, animals and agricultural products of the area.

2. MATERIALS AND METHOD

2.1. Sample Pretreatment

The samples were obtained from Umunnachi, Umudioka, Ukpo, Ifitedunu and Ukwullu in Dunukofia Local Government Area of Anambra State using a hand trowel at the depth of six (6) inches. This depth is measured from the soil surface after non-decomposed plant materials were pushed aside. A total of five (5) composite samples of agricultural soils were collected from each town and were mixed together to get a representative sample of the town.The composites were stored in a clean polythene bags and labelled A, B, C, D, and E to represent Umunnachi, Umudioka, Ukpo, Ifetedunu and Ukwullu respectively.

2.2. Experiment

The wet soil was dried to break down aggregates.The mechanical analysis was done for particle size using hydrometer method. The nitrogen, phosphorous and multi- elemental digestion was carried out as contained in (Novozamsky et al, 1983). Other analyses like nitrogen carbon was also done.

3. RESULTS AND DISCUSSION

The pH of the samples was found in the range of (6.43 - 6.90) which was found within the permissible limits in all the five samples between (4.00 - 8.50) as shown in Table 1. Soil pH is important because it influences nutrient availability (especially micronutrients), solubility of toxic ions and microbial activit. The maximum availability of the primary nutrients required for plant growth is greatest at a pH value between 6.5 and 7.5 (Isirimah *et al.,* 2003). The pH of (6.49 - 6.90) of the soil samples will enhance plant growth and possible increase soil nutrient. The samples showed a cation exchange capacity of A (10.66), B (11.22), C (11.45), D (11.18) and E (12.10) all in cmol/kg respectively, whereas the permissible range of CEC is (<10) cmol/kg. It was found that all the samples have values little above the permissible limit. There is evident that the soil would exchange cations easily and adjust their content either positively or negatively. The CEC is the amount of exchangeable cation per unit weight of dry soil that plays important role in soil fertility, therefore, the samples have the capacity of adsorbing heavy metals since the adsorption behaviour depends on the combination of the soil properties and the specific characteristics of the elements which helps in the soil fertility (Zhang *et al.,* 2010). It is reported by Brummer and Herms (1982) that sandy soils (below pH of 6) have lower CEC than loamy soils. The samples are within the pH range of (6.43 - 6.90), showing that CEC. Is high which were greater than that of Loamy soil.

Table1. *Physical and Chemical Properties of the Samples*

PROPERTIES	SAMPLE A	SAMPLE B	SAMPLE C	SAMPLE D	SAMPLE E	WHO LIMIT
pH	6.81	6.5	6.6	6.43	6.9	4-8.5
CEC (cmol/kg)	10.66	11.22	11.45	11.18	12.10	<10
TOC (%)	1.102	1.090	1.406	1.242	1.640	>0.86
Sand (%)	81	81	81	81	81	-
Silt (%)	13	15	13	13	13	-
Clay (%)	6	4	6	6	6	-

CEC: cation exchange capacity, TOC: total organic carbonate.

The value of %Total Organic Carbonate (TOC) for all is above the WHO permissible limit of (>0.86%) for agricultural soil. The values increase in the order B (1.090) < A (1.102) < D (1.242) < C(1.406) < E(1.640). This entails that the soils will be rich in nutrients. From this result, sample E (1.640%) has the highest TOC while sample B has the least (1.090%). Organic matter of soils immobilizes heavy metals at strongly acidic conditions and mobilizes metals at weakly acidic to alkaline reactions by forming insoluble or soluble organic metal complexes, respectively (Brummer and Hermls, 2006).

3.1. Total Heavy Metal Content

In general, the soil Fe and Mn concentrations are not reported in studies focussing on soil heavy metal content because they are not contaminant elements. Both metals are important in plant nutrition as they are essential crop micronutrients. These elements can be in insoluble forms in calcareous soils causing deficiencies (e.g. ferric chlorosis). From the result obtained, it was found that the soil concentration of iron and manganese was found in the range of 42.1-75mg/kg and 20.1-58.4mg/kg respectively.

Table II. *Heavy Metal Contents in the Samples (mg/kg)*

HEAVY METAL	SAMPLE A	SAMPLE B	SAMPLE C	SAMPLE D	SAMPLE E	WHO LIMIT
Fe	42.3	48.4	43.6	64.2	74.8	NGVS
Cu	1.5	1.0	1.0	2.0	1.4	2.0
Zn	33	33	35	37	44	250
Cr	23.5	8.5	16.5	7.5	26.0	50
Cd	0.5	BDL	BDL	BDL	1.0	1.0
Pb	15	13.5	5.5	5.0	14.5	10
Ni	BDL	BDL	BDL	BDL	7.0	20
Mn	26.2	20.1	31.3	49.6	58.4	NGVS

NGVS: no guideline value set. BDL: below detection limit

The soil concentration of nickel was found in the range of BDL-7mg/kg. The target values Ni are 35mg/kg whereas the intervention values are 210mg/kg according to Netherland standard and 20mg/kg was according to WHO limit. The highest soil concentration of Ni was found in Sample E

(7mg/kg) while the lowest concentration is found in samples A, B, C and D. The analysis of Ni shows that all the samples have low concentration of Ni. Nickel has been considered to be an essential trace element for human and animal health. In living systems, it is associated with DNA and RNA molecules and also a regulatory element for the various enzyme systems (Roux, 2005)

The concentration of Cu ranged between 1.0-1.5mg/kg. The permissible of Cu for agricultural soil is 2.0mg/kg according to WHO. The value of Cu concentration in the samples is acceptable compared to WHO standard. Copper is involved as an enzyme activator and is thought to be involved in chlorophyll formation. It is also involved in protein synthesis.

The concentration of Zn ranges from 33-44mg/kg. The permissible limit of Zn for agricultural soil is 250mg/kg according to WHO. In this work, the soil samples recorded the lowest concentration of Zn when compared to WHO standard. Zinc (Zn) deficiency is interveinal chlorosis of the upper (youngest) leaves. Afterwards, shoot growth slows down; giving the affected plant parts a rosette-like appearance.

The concentration of Cadmium in sample ranges BDL (below detection limit) to 1.0mg/kg. The permissible limit of Cd in the soil according to WHO standard is 1.0mg/kg . The concentrations of Cd in all the samples were below the standard with exception of sample E which is within permissible limit of 1.0mg/kg of the WHO Standard. Cadmium is highly toxic metal not known to have any beneficial effects for plants and animals. Many cadmium compounds are also believed to the carcinogenic (Ezeaku, 2003). Cadmium enters the body via the gastrointestinal tract by eating food products grown on contaminated soil. Some sources of phosphate in fertilizers contain cadmium in amounts of up to 100%mg/kg which can lead to an increase in the concentration of cadmium in soil (Taylor, 2007).

The concentration of Pb in the samples ranged between 5.0-15.0mg/kg. The permissible limit for lead (Pb) according to WHO standard is 10mg/kg. Sample C and D are within the permissible limit whereas sample A, B and E are above the limit (Table 3.3). Therefore soil samples C and D are lead rich while soil samples A, B and E are high in lead and this will affect the production of crops in the areas. Lead as a soil contaminant is a wide spread issue; it accumulates with age in bones aorta, and kidney, liver and spleen. It enters the human body through uptake of food (65%), water (20%) and air (15%), Lindgvist (1991). The high level of Pb in the soil samples A, B and E could be from the application of agrochemicals or as a result of fertilizer use (e.g. urea and superphosphate).

The concentrations of chromium (Cr) in the samples were found in the range of 7.5-26mg/kg. The permissible limit for Cr is 50mg/kg according WHO standard for agricultural soil. The values of all the samples are below the permissible limit and there is need for remediation. In this study Cr was highest in sample E when compared to other samples.

4. CONCLUSION

This work has revealed that these samples from Dunukofia L.G.A of Anambra State have a good soil pH. From the concentration of these heavy metals, it can be seen that the concentration of the heavy metals were below the maximum permissible concentration. Therefore it may be necessary to reduce the use of agrochemicals and having seen the sources these of heavy metals (i.e. agricultural practices), and identification of some agricultural contaminated lands, further studies under semiarid conditions are required to identify a possible increase or decrease in the total soil heavy metal content to preserve the environment and production from these soils.

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AUTHOR'S BIOGRAPHY

Eugenia Ojiako is a teacher per excellence. She is a senior lecturer in the Department of Pure and Industrial Chemistry, Chukwuemeka Odumegwu Ojukwu University, Uli.

She holds a doctorate degree in environmental chemistry. Dr. Ojiako was the Head of Department of Pure and Industrial Chemistry in 2011/2012 session in the said University. She has good leadership qualities which are rooted to the academic excellence of her students.

She has published many journal articles.