INFLUENCE OF SOME PHYSICO-CHEMICAL PARAMETERS OF SOIL ON HEAVY METAL ACCUMULATION

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ABSTRACT
Soil contaminated with heavy metals is poor in nutrients and contribute to sub-optimal plant biomass accumulation. Soil, whether in urban or rural areas, represent a major sink for metals released into the environment from a variety of activities. Some of the metals will persist because of their immobile nature; others will be more mobile migrating to either ground water or plants. Samples were collected using stratified random sampling method. Each sampling area was divided into ten smaller units and from each unit; ten (10) samples were collected randomly at an average depth of 10-15 cm, the sample were mixed and homogenized. The following metals were analysed Cu, Cr, Cd,Pd, Co,Ni and Zn the result obtained showed that correlation is significant at 5% level.
Keywords: Soil, Plant and Heavy metals.

INTRODUCTION
Understanding of soil pollutants and their dependence on soil's physico-chemical properties has provided a basis for careful soil management that limits, as far as possible, the negative impact of the pollutant on the ecosystem (Dawaki*et al*, 2013). Soil contaminated with heavy metals is poor in nutrients and contribute to sub-optimal plant biomass accumulation (White *et al.* 2006). Soil, whether in

urban or rural areas, represent a major sink for metals released into the environment from a variety of activities. Some of the metals will persist because of their immobile nature; others will be more mobile migrating to either ground water or plants (Nwajei and Iwegbue, 2007). Heavy metals are persistent contaminants of soils, coastal waters and sediments (Osakwe, 2009).

Many sources of soil pollution have been identified to include; emission of fumes and dusts containing metals that are transported in the air and eventually deposited onto soils and vegetables, effluents (industrial, domestic, etc), agricultural fertilizers and pesticides, organic manure, atmospheric pollutant from motor vehicular exhaust, industrial machines etc (Obahiagbon *et. al.*, 2007).

It is believed that greater percentage of man and animal are exposed to Heavy metal through environment, (Umar and Ebbo, 2005). Due to their non-biodegradability; they accumulate in living organisms, thus causing various diseases and disorders even in relatively lower concentrations (Pehlivan *et. a*l., 2009).

Cadmium accumulates in the kidney of mammals and cause kidney dysfunctions (Lenntech, 2008). The most severe form of cadmium toxicity in humans is called "Itai-Itai" a disease condition which causes pain in the bones (Yasuda *et. al.*, 1995)

Lead (Pd) is a relatively stable nevertheless, when released in the air, it stays airborne for a short period, then falls to the soil and enters the food chain (Chia; 2001: Cited in Inuwa: 2004). It (Pb) can affect many biological systems, especially

nervous system (Ang*et. al.*, 2003).

Chromium (Cr) is used in melting alloys and pigments for paints, paper, rubber, tanning and other materials. Low-level exposure can irritate the skin and cause ulceration. Long-term exposure can cause kidney and liver damage and damage to the circulatory and nerve tissue. It often accumulates in aquatic life adding to the danger of eating fish that might had been exposed to highest levels of chromium (Umar and Ebbo, 2005). It may also cause congestion and inflammation of organs (Liman, *et. al.*, 2007).

Copper is an essential elements to human life but in high doses it can cause anemia, liver and kidney damages, stomach and intestinal irritation (Lenntech, 2008).

Zinc is also an essential element for the growth of much kind of organs in both plants and animals. Zinc and its compounds taken orally are relatively non-toxic, although its soluble salts in a very large doses can produced an acute gastroenteritis characterized by nausea, vomiting and diarrhea (Parker, 1987).

Air borne nickel pollution has been reported as the cause of plant wilting and deterioration of livestock (Bockris, 1978). Too much nickel can be toxic. It has been reported to increased risk of respiratory infections, asthma and *sinusi* problems (Balch *et. al.,* 2012)

Nickel is an essential element for a person's health; excessive levels are considered poisonous and can cause significant health problems or even death. Cobalt dermatitis may occur but the

condition is more likely from associated chrome or nickel (Taylor, 1990).

Plants uptake of heavy metals depends on certain parameters such as; the concentration and chemical speciation of the metals in the soil solution, the movement of the metals from a bulk soil to the root by diffusion or convection, metals absorption by the root, metals translocation within the plants, pH, soil organic matter (SOM), cation exchange capacity (CEC) etc (Abubakar*et. al.*, 2004)

MATERIALS AND METHODS

Materials

All the reagents used were of analytical grade (Analar) and all the glassware used, containers and tools were washed with liquid detergent first, rinsed with 20% (v/v) nitric acid and finally rinsed with deionised water. The containers and glassware were kept in an oven at 105 ^{0}C until needed. Deionised water was used throughout the work.

Description of the Study Area

Gashua is a community in Yobe State in northeastern Nigeria, on the Yobe River a few miles below the convergence of the Hadejia River and the Jama'are River. Average elevation is about 299 m. The population in 2006 was about 125,000. Thehottest months are March and April with temperature ranges of 38-40° Celsius. In the rainy season, June-September, temperatures fall to 23-28° Celsius, with rainfall of 500 to 1000mm.

Gashua is one of the largest and most developed towns in Yobe State. Since 1976 it has been headquarters of the Bade Local Government Area. The Bade language is spoken in Gashua and in an area fanning out east and south of Gashua. Bade is one of seven languages of the

Chadic family indigenous to Yobe State. The town lies near the Nguru-Gashua Wetlands, an economically and ecologically important ecological system. The town is the location of the court of Mai Bade, the Emir of Bade.

Sampling and sample treatment

Soil Sampling

Samples were collected using stratified random sampling method. Each sampling area was divided into ten smaller units and from each unit; ten (10) samples were collected randomly at an average depth of 10-15 cm, the sample were mixed and homogenized. Cone and quartered method was used until the required (representative) sample was obtained. Clean polythene bags were used to transport the sample for Laboratory analysis (Radojevic and Bashkin, 2006). The sampling areas were labeled as follows:

USR = Usur

GM = Gasma

SGR = SabonGari

TBT = Tarbutu

Plant Sampling

The plant (*Cassia occidentalis*), was also collected from thesame site where the soil sample was obtained using a method described in Radojevic and Bashkin, (2006) and Onomrerhinor(2010).

Sample preparation

Soil was air dried for 5 days. Foreign and non-soil materialswere removed and the soil was crushed using pestle and mortar,passed through a 1.5mm mesh sieve. Phosphorus, calcium and magnesium were determined using the methods of Ademorati, (1996) and Agbenin, (1995). The pH was determined using the 1:2.5 soil-

distilled water ratio using EL model 720 pH meter, The Walkley-Black wet oxidation method was used to determine organic carbon while ammonium acetate extraction and saturation techniques both as described in Adepetu et al. (2000) were used in determining CEC, Na and K that were determined using flame photometry.

Sample Digestion for Heavy Metals Analysis

2g of air-dried and sieved soilwas placed in a 150cm^3 beaker. 10cm^3 1:1HNO_3 (ie 5cm^3 water +5cm^3 conc. HNO_3) was added. And the beaker was covered with a watch glass and reflux on a hot plate for 15 minutes. The mixture was allowed to cool and 5cm^3 conc. HNO_3 was added, heated for 30 minutes. The content of the beaker was heated again for another 30 minutes without covering the beaker after adding 5cm^3 of conc. HNO_3 until the volume was reduced to 5cm^3. 2 cm^3 of deionized water + 3 cm^3 of 30% H_2O_2 was added and heated gently until effervescence was vigorously evolved. And 1 cm^3 of 30% H_2O_2 repeatedly added until effervescence subsides. 10 cm^3 of deionized water +5cm^3 of conc. HCl were also added and re-heated for 15 minutes. The contents were allowed to cooled, filtered into a 50cm^3volumetric flask and diluted to the mark with distilled water (Radojevic and Bashkin, 2006; Onomrerhinor, 2010; Orhue andUza, 2010). The filtrate was used for analysis.

The plant samples were washed several times with distilledwater and oven dried at 80^{0}C to constant weight. The plant waslater homogenized using pestle and mortar and passed through a1.5mm sieve. 2g of the sieved plant was digested in the sameway as the soil (Osakwe,

2009; Onomrerhinor, 2010). Thedigested samples were used for metals analysis using flameatomic absorption spectrophotometer (AA6500).

The concentration of the metal was calculated using the relation below:

$concentration\ of\ the\ metal\ (mgkg^{-1} = C \times V/m \times 1000)$

Where C is the concentration in the sample extract (μgL^{-1}), V is the volume of the sample extract, and m is the weight of the sample

Statistical Analysis

Data obtained were statistically analyzed using one-wayanalysis of variance (ANOVA) with SPSS version 10.0statistical packages and reported as mean ± standard error ofmean of six and three replicate analysis for soil and plantrespectively. LSD test was applied to determine the direction ofthe differences between mean values at 5% level.

RESULTS AND DISCUSSIONS

Table 3.1: Physicochemical parameters of Soil

Parameters	USR	GSM	SGR	TBT
% OM	1.48±0.01	1.69±0.00	1.41±0.03	1.45±0.06
Moisture (%)	1.5±0.01	1.5±0.02	2.0±0.09	1.0±0.05
pH	5.58±0.04	6.46±.01	6.35±0.08	6.0±0.00
CEC(%)	4.68±0.11	4.12±0.05	4.18±0.05	4.32±0.01
%N	0.042±0.00	0.035±0.00	0.028±0.00	0.039±0.00
P (mg/kg)	0.65±0.00	0.57±0.01	0.53±0.01	0.61±0.00
K (mg/kg)	1.13±0.02	1.00±0.00	1.03±0.03	1.36±0.05
Na (mg/kg)	0.70±0.00	0.43±0.01	0.35±0.01	0.65±0.02
Ca (mg/kg)	0.60±0.00	0.50±0.01	0.50±0.00	0.55±0.00
Mg (mg/kg)	0.7-±0.01	0.40±0.00	0.45±0.02	0.35±0.01

- Values were presented as mean± standard deviation of three analysis

OM = Organic Matter

CEC = Cation Exchange Capacity

Table 3.3: Results of Heavy Metals Contents of Soil in Usur, Gasma, SabonGari and Tarbutu Villages

Metals Concentration (mg/Kg)

Sample	Cr	Cd	Pb	Cu	Co	Ni	Zn
USR	22.61±2.63^{ab}	2.23±0.67^{ab}	8.63±0.91^{abc}	0.59±0.14^{a}	23.49±1.67	4.63±0.93^{abc}	124.37±3.78
GSM	16.18±3.76^{a}	2.43±0.35^{ab}	9.51±2.01^{abc}	1.75±0.17^{a}	21.44±1.39	7.35±1.16^{bc}	48.08±0.88
SGR	16.85±1.20^{a}	2.56±0.41^{ab}	8.00±0.99^{abc}	1.24±0.14^{a}	19.87±1.72	3.28±1.12^{ab}	35.72±1.85
TBT	18.96±2.90^{a}	3.07±1.00^{b}	3.09±1.03^{a}	7.70±3.11^{c}	10.68±2.46	7.57±1.33^{c}	18.18±1.13

- Values were presented as mean ± standard error of mean of six replicate analysis
- Values within the same column with different superscripts are significantly ($P<0.05$) different

Table 3.5: Results of Heavy metals Contents in Plant of Usur, Gasma, Sabon Gari and Tarbutu Villages

	Metals Concentration (mg/Kg)						
Sample	Cr	Cd	Pb	Cu	Co	Ni	Zn
USR	3.97±1.61[a]	1.56±0.45[ab]	3.75±0.14	4.55±0.01	12.60±4.16[ab]	BDL	66.63±13.08[c]
GSM	4.31±2.46[a]	2.14±0.28[ab]	0.23±0.00	4.12±0.11	11.87±3.87[ab]	11.87±0.43[c]	50.28±0.27[ab]
SGR	6.85±1.19[a]	BDL	0.17±0.06	5.83±0.19	11.29±3.02[ab]	7.61±2.10[b]	48.41±0.21[ab]
TBT	5.67±0.90[a]	1.94±0.21[ab]	0.42±0.00	4.60±0.19	BDL	0.75±0.07[a]	59.26±0.20[bc]

- Values were presented as means ± standard error of men of three replicate analysis
- Values within the same column with different superscripts are significantly different.

	Cr	Cd	Pb	Cu	Co	Ni	Zn
Cr	1	0.137	0.045	0.290	-0.162	0.341	-0.161
	0	0.496	0.823	0.142	0.421	0.081	0.422
Cd	0.137	1	0.215	-0.608**	-0.171	0.220	-0.316
	0.496	0	0.281	0.001	0.394	0.270	0.108
Pb	0.045	0.215	1	-0.128	0.435*	0.090	-0.006
	0.823	0.281	0	0.523	0.023	0.657	0.975
Cu	0.290	-0.608**	-0.128	1	0.114	0.123	0.272
	0.142	0.001	0.523	0	0.570	0.541	0.169
Co	-0.162	-0.171	0.435*	0.114	1	0.063	-0.188
	0.421	0.394	0.023	0.570	0	0.754	0.347
Ni	0.341	0.220	0.090	0.123	0.063	1	-0.282
	0.081	0.270	0.657	0.541	0.754	0	0.154
Zn	-0.161	-0.316	-0.006	0.272	-0.188	-0.282	1
	0.422	0.108	0.975	0.169	0.347	0.154	0

* Correlation is significant at 5% level

** Correlation is significant at 1% level

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