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HEAVY METALS CONTENT IN SOILS IN GOMBE STATE, NIGERIA

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ABSTRACT

The study was conducted at Gombe State, Nigeria during the period (2014 – 2015). The objective of the study was to asses the concentration content and distribution of heavy metals, Zn, Cr, Cd, As, Fe, Cu and Ni in soils in three senatorial zones namely, Gombe north, Gombe central and Gombe south. From each zone four locations were selected. The soil samples were taken randomly from the selected locations and replicated three times. The collected samples of soil were analysis in standard laboratory analysis.

The results showed that there was a significant difference observed among the concentration of heavy metal studied. Gombe north zone had higher Ni and As concentration content than the other zones. Gombe north and central zones recorded higher Zn, Cu, Fe content than Gombe south zone. The concentrations of heavy metals in this study are below the permissible limit set by UK and Germany.

Key Words: Heavy metals, pollution, irrigation water, concentration, waste water. .

Introduction

Heavy metals are metallic elements that are present in both natural and contaminated environment. In natural environment, they occur at low concentration. However, in contaminated environment, the concentrations of the element are high (Hutchison, 1980). Anthropogenic activities like mining, smelting operations, domestic, industrial and farming activities are recognized as some of a major sources of heavy metals in the environment (Nriago, 1990). However, Wilson and Pyatt (2007) pointed out that, potentially harmfull metals in soil may come from the bed rock itself. The clean and safe environment is the basic requirement of human existence. Industrial activities may contain various heavy metals especially Zn, Cu, Pb, Cd, Mn,

Ni, Cr depending of the type of the activities associated with continuous irrigation which may cause heavy metals accumulation in soil (Ibrahim *et al* ., 2014).

Heavy metals pollution in soil refer to cases where the quantities of the elements in soils are higher than maximum allowable concentrations than this is potentially harmful biological life at such locations (Adeleken and Abengunde, 2012). Heavy metals released from vehicular emission can accumulate in soil surface and their deposion over time can lead to abnormal enrichment, thus causing metal contamination of the soil surface (Fog *et al.,* 2008). Studies have shown that both long term and short term contamination of soils have effects on microbial activity and enzyme activity of the soil (Adeleken and Abegunde, 2012).

Many investigators reported that heavy metals concentrations has reached the level which is toxic to humans and ecosystem, therefore measurement of the fluxes of heavy metals concentration can aid to in the assessment of the environment and to find out the activities leading to this problem. Therefore, this study is carried out to determine the concentrations and distribution of heavy metals in Gombe State, Nigeria.

MATERIALS AND METHODS:

MATERIALS:

Apparatus: Soil augar, 2mm stainless sieve, Oven drier, Plastic bottles and Atomic Absorption Spectra photometer machine (AAS). Reagents: H_2SO_4, HNO_3, HCl and distilled water.

Study area:

The research was conducted in Gombe State, Nigeria in the period (2014 – 2015). The area is located within latitude 9° 30 - 12° 30 N, and longitude 8° 45 - 11° 45 E at the north east region of Nigeria. The State covers area of 20,265 km^2 and at attitude of 400 – 500 m above sea level (Yahya, 2005). The area is underlain by basement complex structure in the south and sedimentary chad formation in the north – east part of the State (Umer, 2003).

Annual average fall 850 mm and temperature ranges 17° - 42° C. The vegetation of the area is of several types consisting of complex, composite of thick acacia shrubs and open grass land (Olefin, 1989).

Soil sampling:

Soil samples were taken from the senatorial zones in the State, namely, Gombe north, Gombe central and Gombe south. At each senatorial zone there three locations were randomly chosen. From each zone and location understudied, samples of soil taken using an auger at the depth 0 – 30 cm. Soil samples taken were separately labeled and transferred into air tight polythene bags and brought to the laboratory, care was taken to the extent possible to ensure that there was no sources of contamination at the sites or locations of investigation.

In the laboratory the soil samples were air dried, grind and pass through 2mm stainless sieves in order to remove materials greater than 2mm and subsamples used to laboratory analysis, each treatment replicated three times.

Heavy metals determination in soil samples:

Five grams of each dried, sieved and grinded soil samples were placed in 100ml beaker. 15ml of HNO_3, H_2SO_4 and HCl mixture (5.1.1) of tri acid were added and the content heated and digested gently at low heat on digestion block machine for about 2hours at 80 – 100 C° until transparent or colorless solution was obtained. After cooling, the digested sample was filtered using what man N◦42 filter paper. It was then transferred to a 100ml volumetric flask and distilled water was added.

The digested samples transferred into plastic 100ml bottle for the heavy metals determination at their respective wavelength using A.A.S machine (USEPA, 1996).

RESULTS and DISCUSSIONS:

Heavy metals concentration in the studied zones soil:

Table I showed that the concentrations of the heavy metals was moderately variable with a CV% of 32.14 (Zn), 25.93% (Cu), 34.09% (Fe), 36.32% (Pb) and low variability with a CV% of 14.16% (Cd), 10,86 (Cr), 7.16% (Ni) and 18.98% (As) respectively. Gombe north and central senatorial zones recorded higher significantly (P = 0.05) different of zinc (Zn), copper (Cu), iron (Fe) and nickel (Ni) each with a mean of 14.69 and 13.89 (Zn), 6.01 and 5.78 (Cu), 27.01 and 21.09 (Fe), 0.21 and 0.23 (Ni). The distribution of cadmium (Cd) was presented in table I. Gombe central zones had significantly (P = 0.05) different of Cd content (0.64mg kg^{-1}). The other zones which was statistically the same each have a Cd mean of 0.54mg kg^{-1} (Gombe south) and 0.48 mg kg^{-1} (Gombe north) with CV% of 14.61%.

Also significant difference was observed among the senatorial zones with respect to lead (Pb) distribution mg kg^{-1}. A mean of 5.23mg kg^{-1} Pb was found in Gombe north and significantly differ with the other zones, each with a mean values of Pb (Gombe central = 3.20 mg kg^{-1} and Gombe south = 2.6 mg kg^{-1}) and statistically recorded the same Pb content and a CV% of 36.32%. On the other hand table I show chromium (Cr) concentration in the senatorial zone soils decreased significantly from a mean of 0.36 mg kg^{-1} at Gombe north to 0.32 mg kg^{-1} at Gombe central and 0.2 mg kg^{-1} at Gombe south with a CV% 10.86%. Arsenic (As) content shows that there was a significant (P = 0.05) difference existed between the zone (Table I). Gombe north recorded mean of 0.03 where as Gombe central and south zones which among them they did significantly. Both zones have the same mean of 0.18 mg kg^{-1}.

Table I shows heavy metal concentration at Gombe senatorial zones (mg kg^{-1})

zone	Zn	Cu	Fe	Cd	Pb	Cr	Ni	As
Gombe north	14.96[a]	6.01[a]	27.01[a]	0.48[a]	5.23[a]	0.36[a]	0.21[a]	0.23[a]
Gombe central	13.89[a]	5.78[a]	21.09[a]	0.64[a]	3.20[b]	0.32[b]	0.23[a]	0.18[b]
Gombe south	7.61[b]	3.60[b]	13.14[b]	0.54[b]	2.67[b]	0.29[c]	0.20[ab]	0.18[b]
mean	12.06	5.13	20.41	0.55	3.70	0.32	0.21	0.19
set	1.29	0.44	2.32	0.03	0.45	0.01	0.01	0.01
CV%	32.14	25.93	34.09	14.61	36.52	10.86	7.16	18.98

Heavy metals concentration at the senatorial zones soil: Zinc (Zn):

Tables I, II, III and IV showed that there was a significant variation with Zinc metal concentration between the zones and locations at each zone. That is Gombe north and central zones recorded significantly higher Zn content than Gombe southern zone, while Dukku, Kwami and Fankaye locations at Gombe north senatorial zone recorded a significantly higher Zinc content than control soil. Also at Gombe central senatorial zones all the three studied locations Akko, Dadin Kowa and Kwadon had higher significant Zn content than the control soil. Balanga locations at Gombe south have significant Zinc content than the other locations within the zone.

The values of Zinc concentration in all the soil studied will below both the standard set by United Kingdom and Germany permissible limits. However, the results obtained in this study were high than the values reported by Ibrahim *et al.,* (2014). Dokman *et al.,* (1994) reported that both N mineralization and nitrification were inhibited at high concentration of Zn. Letunova *et al.,* (1985) observed that stronger inhibition cyan bacteria (autotrophic N_2 fixer) in Swedish clay soil to which metal contaminated sludge had been applied, resulting in a high concentration of Zn. The natural range of Zn in soil is 10 – 30 mg kg^{-1} (Eddy *et al.,* 2004). The concentration of soil Zn in this study was within these range. Also the results were low when compared with many investigators. Kebata Peudias and Kwami (2007) reported higher mean values of Zn in different countries.

Copper (Cu):

Tables I, II, III and IV show that there was significant difference at (P = 0.05) of concentration between the senatorial zones and within the different locations at each zone, where by Gombe north and central zone recorded significant higher Cu content than Gombe south. Location wise, Dukku, Kwami and Funakaye locations at Gombe north zone contained significant higher Cu content than the control site. At Gombe central zone, the content followed the same pattern with north zone. On the other hand the Cu content at the southern zone indicated that Kaltung and Balanga content statistically higher Cu content than Billin and control locations. The content of Cu in all the soil studied were bellow the UK (1982) and Germany (1992) limits. However, the

Cu concentrations in this study were higher than the values obtained by Ibrahim, *et al.,* (2014) and Uwah, *et al.,*(2011).

Iron Fe:

Tables I, II, III and IV showed that the levels of Fe in the soils range from 3.33 mg kg^{-1} to 39.20 mg kg^{-1}. The concentrations of Fe in soils could be said to be too high as reported by Gborbani, *et al.,* (2002). The concentrations of Fe reported here are higher than the values reported by Ibrahim (2014).

Cadmium Cd:

Tables I, II, III and IV showed that the levels of Cd in the soil range from 0.05 to 0.98 mg kg^{-1}. The content of Cd in the studied soil revealed a significant variation but it below the permissible limits reported by UK (1989). This values of the studied zones were lower than those Cd values earlier reported by Ibrahim, *et al.,* (2014).

Lead Pb:

Tables I, II, III and IV showed that Pb is one of the more persistent metals and is estimated to have a soil retention time at 150 to 500 years. This etudy reported a mean level ranging from 0.52 to 7.42 mg kg^{-1}. This shows lower ranges than ranges of soils lead studies by Premarathna, *et al.,* (2011) who reported ranges of 15 to 311 mg kg^{-1}. Similarly ranges found by Haluschak, *et al.,* (1998).

Chromium Cr:

Tables I, II, III and IV showed that the mean concentration of Cr in the examined soil were also within the permissible limits according to UK (1982) and Germany (1992). Roychowdhury, *et al.,* (2002) reported similar concentration of Cr. Cr ranged between 0.29 – 0.36 mg kg^{-1} at Gombe north zone, 0.04 – 5.01 mg kg^{-1} at Gombe central zone and 0.06 – 0.74 mg kg^{-1} at Gombe south zone.

Nickel Ni:

Tables I, II, III and IV showed that there is significant difference exist between the zones. 0.21 – 0.23 mg kg^{-1} at Gombe north zone, 0.03 – 0.34 mg kg^{-1} at Gombe central zone and 0.07 – 0.45 mg kg^{-1} at Gombe south zone. This range is below permissible limits set by UK and Germany.

Arsenic As:

Tables I, II, III and IV showed that the mean values of As metal in the soil studied were less than permissible limits set by UK (1980) and Germany (1992). The ranges of As concentration is 0.03 to 0.35 mg kg^{-1}. Mehang and Rahman (2003) studied the As levels in paddy at Bengladesh, they reported range of As concentration between 3.5 to 4.25 mg kg^{-1}. Alan and Satter (2000) found that As in soils (depth 0.15m) ranged from not detectable level to 31.8 mg kg^{-1}. They found that

As content in irrigation water. Roychoudhurry, *et al.,* (2002) reported that a mean value of 10.7 mg kg^{-1} of As content.

In this study the As content of the soil studied was lower compared to the reported values above. The As level in the soil may vary throughout the year, this may be one of the possible reasons that As levels in this study were lower.

Heavy metals in Gombe north soil:

Gombe north senatorial zone comprised of four locations namely, Dukku, Kwami, Funakaye and Control. Table II show the level of heavy metals concentration of the zone. From the table we can observed that high variability found with heavy metal concentrations. A non significant difference at 0.05 was existed between mean of concentration of Zn, Cu, Fe and Cd at Dukka, Kwami and Funakaye where as a significant differences is observed between the above mention zones and the control which recorded the lowest mean of the Zn, Cu, Fe and Cd. Table also show that a significant difference at (P = 0.05) observed between the mean of Pb content of the studied zones, where as a non significant difference existed between the means of Pb content at Kwami and Funakaye soil locations. Means of Pb content of the soil of Dukku, Kwami, Funakaye and the control was 9.42, 5.98, 5.00 and 0.53 mg kg^{-1} respectively. There is a significant difference at (P = 0.05) between means of conent of Cr, Ni and As (Table). Funakaye location soil had higher Cr (mean = 0.37), Ni (mean = 0.34) and As (mean = 0.37). A non significant difference at (P = 0.05) existed between Ni, Cr, As metals content at Dukku and Kwami locations soil and recorded higher Ni, Cr, As metals content than the control soil.

Table II show heavy metal concentration at Gombe north senatorial zone mg kg^{-1}

Location	Zn	Cu	Fe	Cd	Pb	Cr	Ni	As
Dukku	13.44^{a}	6.26^{a}	21.39^{ab}	0.52^{a}	9.42^{a}	0.35^{b}	0.22^{b}	0.26^{b}
Kwami	13.51^{a}	7.34^{a}	32.76^{a}	0.61^{a}	5.98^{b}	0.40^{b}	0.24^{b}	0.24^{b}
Funakaye	17.11^{a}	7.92^{a}	39.20^{a}	0.72^{a}	5.00^{b}	0.62^{a}	0.34^{a}	0.37^{a}
Control	4.11^{b}	2.50^{b}	14.15^{b}	0.05^{b}	0.53^{c}	0.06^{c}	0.03^{c}	0.06^{c}
Mean	14.69	6.01	27.01	0.48	5.23	0.36	0.21	0.23
SET	1.39	0.61	3.92	0.07	0.06	0.03	0.03	0.03

Source : Field work 2014

Heavy metals in Gombe central soil:

Gombe central zone comprised of four locations namely, Akko, Dadin-Kowa, Kwadon and control. Table III show that a non significant difference at (0.05) existed of the mean content of Zn, Cu, Cd and Cr between the locations and recorded mean content higher than the control. The means of the metal concentration were Zn (18.77 to 4.80), Cu (1.87 to 7.74), Cd (0.10 to 0.98) and Cr (0.04 to 0.51) mg kg^{-1}. Each have a CV% of 45.52, 47.18, 59.52 and 63.16 respectively.

Table also show that a significant difference at (P = 0.05) existed among the content of Fe at the locations studied.

Table III Heavy metal content of Gombe central senatorial zone (mg kg^{-1})

Location	Zn	Cu	Fe	Cd	Pb	Cr	Ni	As
Akko	17.42^{a}	7.53^{a}	31.92^{a}	0.64^{ab}	3.28^{c}	0.32^{ab}	0.22^{b}	0.25^{b}
Dadin-Kowa	14.56^{a}	5.93^{a}	19.10^{b}	0.98^{a}	4.74^{b}	0.51^{a}	0.24^{b}	0.35^{a}
Kwadon	18.77^{a}	7.74^{a}	29.17^{a}	0.87^{a}	6.33^{a}	0.42^{a}	0.45^{a}	0.18^{c}
Control	4.80^{b}	1.87^{b}	3.33^{c}	0.10^{c}	0.54^{d}	0.04^{c}	0.07^{c}	0.08^{d}
Mean	13.89	5.78	21.09	0.64	3.20	0.32	0.23	0.18
SET	1.58	0.68	3.23	0.09	0.47	0.05	0.05	0.07
CV%	45.42	47.18	61.24	59.52	58.64	63.16	78.18	60.25

Heavy metals in Gombe south soil:

Table IV show that there was higher variability of the metal concentrations between the location studied. From the table we can observed that there was a significant difference at (P = 0.05) observed between the metals content of Balango and the other locations.

Table IV show heavy metals concentration at Gombe south senatorial zone (mg kg^{-1})

Location	Zn	Cu	Fe	Cd	Pb	Cr	Ni	As
Kaltungo	7.40^{b}	5.42^{a}	11.52^{b}	0.18^{b}	1.16^{b}	0.14^{b}	0.16^{b}	0.13^{b}
Billin	5.61^{b}	2.14^{b}	7.16^{b}	0.35^{b}	3.91^{a}	0.20^{b}	0.18^{b}	0.17^{b}
Balanga	13.63^{a}	4.47^{a}	29.46^{a}	1.45^{a}	5.09^{a}	0.74^{a}	0.38^{a}	0.29^{a}
Control	4.06^{bc}	2.35^{b}	4.44^{b}	0.18^{b}	0.52^{b}	0.06^{b}	0.06^{c}	0.03^{c}
Mean	7.61	3.60	13.14	0.54	2.67	0.29	0.20	0.16
SET	1.05	0.40	2.82	0.15	0.55	0.08	0.03	0.03
CV%	54.69	38.52	85.69	113.32	81.76	108.32	68.74	69.34

CONCLUSION and RECOMMENDATION:

From the results of this study we can concluded that a significant differences existed among the heavy metals concentrations, in soil and all the heavy metals content were below the permissible limits set by UK and Germany. Regular monitoring of heavy metals in soil is essential in order to prevent excessive build up of contents. Nevertheless all heavy metals have toxic potential, but the detrimental impact become apparent only after decades of exposure. Good management of anthropogenic activities in order to reduce accumulation of the heavy metal. Finally the paper adds data serve as baseline information in this field.

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