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### RESEARCH ARTICLE

## HEAVY METAL CONTENT OF AGRICULTURAL SOILS AT PINDIGA, AKKO LOCAL GOVERNMENT AREA OF GOMBE STATE, NIGERIA.

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#### Abstract

The concentrations of heavy metals in agricultural soils at Pindiga, Ako LGA, Gombe, were determined using an atomic absorption spectrophotometer (AAS). The mean concentrations of heavy metals in soil samples are as follows, Fe (21.31 mg/Kg), Zn (0.20 mg/Kg), Cd(1.58 mg/Kg),Cr(2.3mg/Kg) and Pb (36.10 mg/Kg). The concentration of heavy metals in samples increased in the following order, Fe > Pb > Cr > Cd > Zn. The mean values for some physiochemical parameters of the water samples are; pH (5.7), moisture (36.1), the concentrations of heavy metals in water samples were less than the permissible limits for heavy metals in soils set by USEPA / WHO.

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#### Introduction:-

Anthropogenic activities such as industrial and agricultural activities has been to a large extend responsible for environmental pollutions, some sources of environmental pollution via agricultural activities include the addition of manures, sewage sludge, fertilizers, herbicides and pesticides to soils (Ogidi, 2015). Studies have shown risk related to increased soil metal concentration and absorption by plants (Whatmuff, 2002). Commercial and residential areas are vulnerable to atmospheric pollution, in form of metal containing aerosols which can get into the soil environment and absorbed by plants. Analysis of heavy metal contents of vegetables grown around industrial areas has shown elevated concentration levels of heavy metals in food crops (Kachenko and Singh, 2006). Localization of industries and surge in commercial activities are advantageous to the economy but also brings along with it environmental pollution issues (Ogedengbe and Akinbile, 2004).

Heavy metals are electro-positive chemical elements which are hazardous and toxic at concentration levels above the regulatory or permissible limits in foods and the environment, they are non-biodegradable and having long half-lives (Heidarieh, *et al.*, 2013). Metals can pose significant health risk to human and animals at elevated concentration levels above the required body limits (Gupta *et al.*, 2008). Some of the health risks associated with heavy metals include damage to soft tissues and organs, bone disorders, headache, kidney failure, cancer, liver failure, breathing disorders and heart failure (Ogidi, 2015). Thus there is a need to monitor and control heavy metal content of food substances in order to ensure public health safety (WHO, 1995). Heavy metals of serious health concern to human health includes As, Pb, Hg, and Cd (Kisamo, 2003).

The study location is free of industrial pollution, major sources of metals contamination of soil could be due to solid waste disposal, sludge applications, vehicular emission and use of agrochemicals. Accumulation of metals in soils

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via the use of agrochemicals leads to soil contamination and increased absorption by food crops planted on the soils (Muchuweti *et al.*, 2006).

In this study the heavy metals (Cd, Cr, Fe, Pb and Zn) content of agricultural soils at Pindiga area of Akko local government area of Gombe state was determined using atomic absorption spectrophotometer to ascertain the level of heavy metal present the agricultural soils in the area.

## Materials and Methods:-

### Study Site

Pindiga is a settlement in Ako L.G.A, Gombe state, Nigeria and located on lat 9°59'0" N and 10°56'0"E. It is located at an elevation of 523m above sea level.

### Sample matrix/ sample codes

Ten soil samples was collected at each sample site and mixed into a composite representative sample for each sample site (Ogidi, 2015).

### Sample collection, preservation and pretreatment

The soil samples were collected from soil surface (0 – 20cm depth) at ten different spots with the help of stainless steel spoon and made into a composite sample. The soil samples were placed into a nitric acid treated polythene bag to prevent metals from adhering to the containers and then transported to the laboratory where they were air dried for about 3days then oven-dried to constant weight at 105°C, disaggregated in a ceramic pestle and mortar, ground to powder and sieved,

(Kisamo, 2003, Ndimele and Jimoh, 2011).

### Sample digestion

Soil samples were digested with 15mL of concentrated acid mixtures (5mL conc.HClO<sub>4</sub>, 15mL conc.HNO<sub>3</sub>, and 10mL conc. H<sub>2</sub>SO<sub>4</sub>) was poured into the 100mL beaker containing the soil sample (1g), covered with watch glasses, and heated over a water bath in a fume cupboard until the digestion was complete. The content of the beaker was then diluted to 100mL with de-ionized water and transferred to dispersing bottles for heavy metal analysis (Ndimele and Jimoh, 2011, Wufen, *et al.*, 2009).

### Apparatus/ reagents

All glass ware, including sample bottles, burette, and pipettes used were washed cleaned and rinsed with HNO<sub>3</sub>, followed by distilled water to avoid errors arising from contamination. All reagents used were of analytical grade (APHA, 1985; Ademoroti, 1996).

### Physio-Chemical Parameters Determined

Physio-chemical parameters of samples determined in the course of study are as follows

#### Determination of pH

The pH of the soil samples was measured using a kelilong portable electronic pH meter (KL- 009 (1)). Just before the pH meter was used it was standardized with three buffer solutions of different pH values to serve as check for proper instrument response. Buffers with pH values of 2,7and 12 were used, About 20g air-dry tailing sample was mixed with 100mL of distilled water and in a 250mL volumetric flask, shaken for 1 hour and the pH measured (Miller and Kissel, 2010).

#### Determination of Moisture content determination

About 4g of sample was weighed into a previously weighed crucible, and then transferred into an oven set at 105°C to dry to constant weight for 24 hours overnight. At the end of the 24 hours, the crucible plus sample was removed from the oven and transferred to desiccators, cooled for ten minutes and weighed. The moisture content of the sample was thus determined as below (Ogidi, 2015)

$$\text{moisture content} = \frac{W_1 - W_3}{W_1 - W_0} \times 100\%$$

Where, weight of empty crucible = W<sub>0</sub>

Weight of crucible + sample =  $W_1$

Weight of crucible + oven dried sample =  $W_3$ .

### Method of Analysis

The method of analysis used in determining heavy metals content of samples is the atomic absorption spectrophotometric (AAS) method, due to its accessibility, specificity, wide range of application, low detection limit, and cost effectiveness (Ademoroti, 1996). The heavy metal content of the samples were determined using an atomic absorption spectrometer (AAS), Perkin Elmer 400ASS.

### Statistical Analysis

The minimum, maximum, range, mean, and standard deviation, as well as the student t-test values of the concentrations of heavy metals in soil were determined. Microsoft excel (windows 2007), were employed in statistical analysis.

## Results /Discussion:-

### Physio-Chemical Parameters of Samples

#### pH of Soils

The pH of soil sample at Pidinga ranged from 5.1 to 6.6. The maximum pH value was at model farm and the minimum value was at Garin Jauro. the pH of soils at Pindiga where moderately acidic and similar to the pH range of soils used for irrigation farming at the banks of River Benue at Makurdi, Central Nigeria reported by Ogidi, (2015) , but higher than the mean value (3.1) at dump sites at Makurdi metropolis reported by Agber and Tsaku, (2013). The mean pH values of soils in this study is higher than the minimum value (5.4) and lower than the maximum value (9.8) for cultivated soils close to Ashaka cement factory at Gombe, Eastern Nigeria reported by Buba et al., (2016). The pH of soils in this study is favorable for the growth of food crops. Heavy metal ions are more mobile in acidic conditions; heavy metals are freely available and absorbed by plants from the soil at this condition (Sherene, 2010)

#### Moisture Content of Soils

The moisture content of soils at Pindiga ranged from 17.1% to 58.0%. The maximum moisture content of soil was at Sumbe and the minimum was at Garin Dawa. The mean percentage (%) moisture content of soils in the study was more than the value range of 3.1-4.6 % for soils around dump sites at Makurdi, Central Nigeria reported by Agber and Tsaku (2013), this could be due to the absorption and accumulation of water in soils at pidinga during the wet season since study was conducted during the wet season.

**Table 1:-**Physicochemical Parameters of Soil Samples at Pindiga

Sample	pH	Moisture (%)
GARIN DAWA	6.6	17.1
SABON GARI	6.2	45.2
SUMBE	5.4	58.0
SABON KAURA	5.1	25.1
GARIN ALKALI	5.2	35.0

**Table 2:-**Statistics of Physicochemical Parameters

Physiochemical parameter	Mean	Maximum	Minimum	Standard Deviation
pH	5.7	6.6	5.1	0.7
Moisture (%)	36.1	58.0	17.1	16.2

### Heavy Metal Content of Soils

#### Cadmium

Cadmium content of soils in this study with mean value of 1.58 mg/Kg was higher than the values (0.48 – 0.64mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017) and by Ibrahim *et al.*, (2014) also higher than the maximum value 0.551 mg/kg at Mwazan Region in Tanzania reported by Kisamo, (2003), but less than the recommended limit for soil (85 mg/kg) set by USEPA. Cd has no essential to the health of humans and animal, at higher concentrations in organisms above the recommended limits it is toxic (Ogidi, 2015).

### Chromium

The mean value of Cr in this study (2.3mg/Kg), is higher than the value (0.29 – 0.74 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017), The mean concentration of Cr in soils ( $8.87 \pm 8.1$ mg/kg) at Makurdi reported by Ogidi, (2015), less than the maximum value 31.2 mg/kg at Mwazan Region in Tanzania reported in Kisamo, (2003), 3.12 mg/kg at Keritis, Chania, Greece reported in Papafilippaki1, *et al.* (2007) but less than the recommended limit for soil (3000 mg/kg) set by USEPA. Significant sources of Cr released to soils include industrial / agricultural waste, atmospheric fallout, organic compost manures, and agrochemicals. Excessive concentration in soils has adverse implication on the health of humans and animals due to its bioaccumulation in plants (Ogidi, 2015).

### Iron

Iron in agricultural soils in this study has a mean concentration of 21.31 mg/Kg and this falls within the range (13.14 – 27.01 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017). was greater than the maximum value 2.79 mg/kg at Mwazan Region in Tanzania reported by Kisamo, (2003), but less than the mean concentration of Fe in soil ( $746 \pm 245$  mg/kg) for soils at Makurdi, North Central Nigeria reported by Ogidi, (2015). Extreme concentrations of iron in soils can create mineral nutrient imbalance through antagonistic effects on the uptake of certain essential metals like K and Zn (Sahrawat, 2015).

### Lead

The concentration of Pb in soils has a mean value of 36.10 mg/Kg this is higher than the values (2.67 – 5.23 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017), 3.98mg/kg reported in Papafilippaki1, *et al.* (2007), the mean concentration of Pb in soil ( $33.6 \pm 16.5$  mg/kg) for soils at Makurdi, North Central Nigeria reported by Ogidi, (2015), but less than the recommended limit for soils set by USEPA. Excess Pb content of soils above regulatory limits create serious health hazards to both humans and animals due to its ability to bio-accumulate in soft tissues creating organ and tissue failures (Ogidi, 2015).

### Zinc

Zn content of soils in this study has a mean value of 0.20 mg/Kg which is less than the value range (7.61 – 14.69 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017), less than the mean concentration of Zn in soil ( $55.9 \pm 21.0$  mg/kg) for soils at Makurdi, North Central Nigeria reported by Ogidi, (2015), and the value 137mg/kg at Mwazan Region in Tanzania reported by Kisamo, 2003. The Zn content of soils in this study was within the natural range (10 – 300 mg/Kg) for soils reported by Eddy *et al.*, (2004) and below the regulatory limit of Zn in soils (50mg/Kg) set by WHO (2007). High concentration of Zn in soil food crops does not constitute any serious toxicity hazard to humans or animals consuming them but often zinc contaminated soils are also contaminated with non essential elements such as Cd and Pb (Hasnine, *et al.*, 2017).

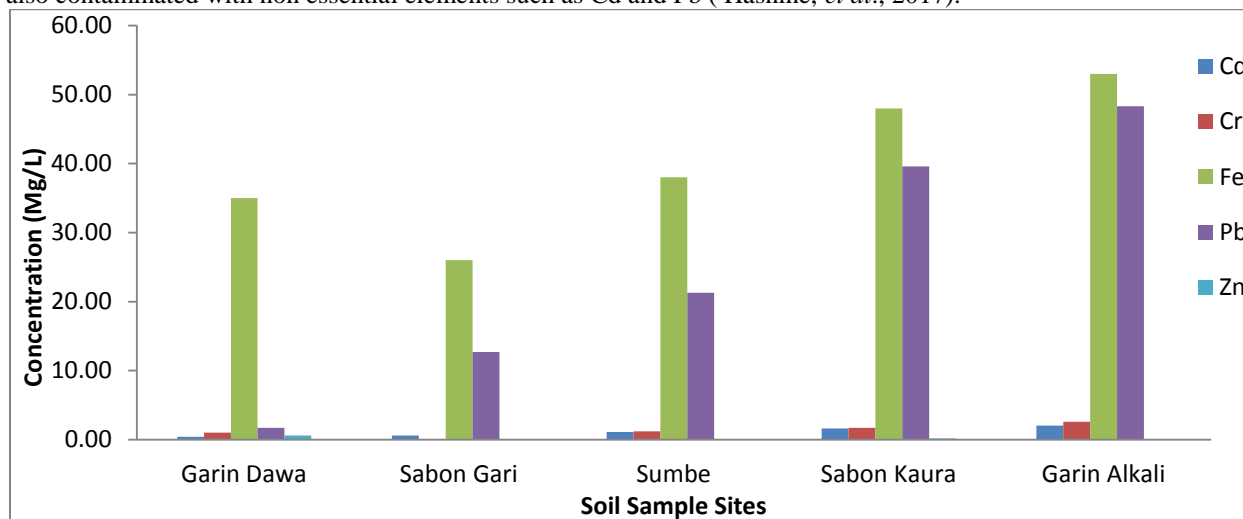


Fig 1:-Heavy Metals Concentrations (Mg/L) of Soils at Pindiga

**Table 4; Statistics of Heavy Metal Content of Pindiga**

SAMPLES SITES	Cd (mg/kg)	Cr(mg/kg)	Fe(mg/kg)	Pb(mg/kg)	Zn(mg/kg)
average	1.15	1.32	40.00	24.72	0.20
Standard deviation	0.68	0.92	10.70	19.13	0.23
minimum	0.40	0.10	26.00	1.70	0.00
maximum	2.04	2.60	53.00	48.30	0.60

**Heavy Metals Trends in Soils**

The heavy metal trend in soils was the same for Sumbe, Sabon Kuara and Garin Alkali which is the same as the trend for heavy metals at Pindiga using the mean concentration values of the metals. For all sample sites Fe had the highest concentration followed by Pb. Zn was not detected in soil samples from Sumbe. Zn had the least concentration at the study sites except for Garin Dawa where Cd had the lowest concentration. The metals trends in soils at study sites at kashere are as follows;

Garin Dawa; Fe > Pb < Cr < Zn < Cd, Sabon Gari; Fe > Pb > Cd > Cr < Zn, Sumbe; Fe > Pb > Cr > Cd > Zn, Sabon Kuara; Fe > Pb > Cr > Cd > Zn, Garin Alkali; Fe > Pb > Cr > Cd > Zn  
Pindiga; Fe > Pb > Cr > Cd > Zn

**Conclusion:-**

The study indicates that the pH of soils at study areas from Ako LGA, Gombe state, Eastern Nigeria is moderately acidic, and this pH value is good enough for agricultural activities by enhancing the availability and mobility of mineral nutrients in the soil. The moisture content of the soils also encourages the growth of microorganisms in the soils and also aid in soil mobility of nutrients within the soil. The study shows the presence of heavy metals in agricultural soils at study sites at levels below the regulatory limits set by WHO and USEPA. From the mean concentration of heavy metals, Zn has the lowest concentration while Fe had the highest concentrations in the soils, but Cd and Pb which are non-essential and highly toxic above the permissible limits have concentrations below the regulatory limits. Thus the soils are safe for cultivation of food crops since they are free of heavy metal contaminations.

**Recommendations**

Heavy metals poisoning is of great concern to man and the environment, thus there is need to monitor the heavy metals content of soils on regular bases. The government needs to enforce regulations against the illegal dumping of refuse, metallic waste, agrochemicals and other harmful substances into the environment. The application of green pesticides in place of conventional synthetic and persistent agrochemicals should be promoted and encouraged. There is also a need for assessing the heavy metals content of soils before food crops are cultivated on them so as to avoid bio-absorption of toxic levels of heavy metals by food crops from the soil.

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