# Heavy Metal Content of Agricultural Soils at Tumu, 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 (76.80 mg/Kg), Zn (0.28 mg/Kg), Cd(4.92 mg/Kg),and Cr(4.42mg/Kg). The concentration of heavy metals in samples increased in the following order, Fe > Cr > Cd > Zn. The mean values for some physiochemical parameters of the soil samples are; pH (6.3), Moisture (26.4), the concentrations of heavy metals in soil samples were less than the permissible limits for heavy metals in soils set by USEPA / WHO.

**Keywords;** Agricultural Soils, Atomic Absorption Spectrophotometer, Heavy Metals, Moisture.

## 1.0 INTRODUCTION

### 1.1.0 Background of Study

Naturally in soils, chemical elements occur as components of minerals though at certain concentrations some may be toxic. Heavy metals are not biodegradable, but they can be absorbed by plants or animals (Ogidi, 2015). Soil is said to be uncontaminated when substances of environmental concern occurs in concentrations equal to or lower than the value found in nature (which is used as a reference) normally called background concentration. The background concentration is the total elemental concentration obtained from an environment that is not affected by anthropogenic activities. (Shayley*et et al.*, 2009). Environmental contamination refers to the addition or presence of any chemical substance at concentrations that are above background levels and represents, or potentially represents, an adverse health or environmental impact. It can result in a potential financial, social and environmental cost (Stavrianou, 2007). Anthropogenic activities arising from urbanization such as combustion, transportation, production of municipal wastes, sewage sludge, medical/pharmaceutical wastes, and Agricultural practices (including application of fertilizers, pesticides and herbicides), industrialization (Mining, manufacturing and construction), the use of synthetic products (including plastics, polythene, batteries, paints, tins/cans, and other range of chemical products), crude/petrochemical spillage, metal scraps, leaded gasoline are common sources that could contaminate or further increase the heavy metal load of the soil. Heavy metals also occur naturally, but rarely at toxic levels. Soils are the major sinks for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon (IV) oxide by microbial action, most metals do not undergo microbial or chemical degradation (Kirpichtchikova *et al.*, 2006). Heavy metal contamination of soil pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil- plant-animal-human), drinking of contaminated ground water, reduction in food quality (safety and marketability), reduction in land usability for agricultural production causing food insecurity, and land tenure problems Environmental contamination in developing countries are attributed to negative effect of technological developments, like urbanization and industrialization, and poor planning in waste disposal and management (Bhagure and Mirgane, 2010). Sources of contamination include: accidental spills, leaks of chemicals and human activities. Spills, runoff, or aerial deposition of chemicals used for agriculture or industry, materials stored or dumped on the site, contaminants in imported fill and demolition can also result in contamination of the soils and water at residential sites (Worksafe, 2005). Activities of humans have added substances such as pesticides, fertilizers and other amendments to soils. Milling operations together with grinding ores provide a route for contamination in the surface environment (Jung, 2001). Burning of fossil fuel, mining and metallurgy, industries and transport sectors redistribute toxic heavy metals into the environment (Stavrianou, 2007). The distribution of contaminants released to soils by human activities is related to how and where they are added. Soil contaminants can leach from landfills or other garbage disposal sites, including petroleum products, solvents, pesticides, lead, and other heavy metals (Shayley *et al.*, 2009). Also, the waste electrical and electronic equipment contains substantial quantities of materials which can be a source of potential environmental contaminants (Wäjer *et al.*, 2011). Certain contaminants are also bio-available and depend on many characteristics of the soil and the site. The site conditions affect how tightly the contaminant is held by soil particles and its solubility (Shayley *et al*., 2009).

The presence of heavy agricultural activities in these communities involving the use of agrochemicals contributes to the heavy metals content of the soils. These heavy metals are bio-available for absorption by food crops and when consumed by man and animals bio-accumulates in body tissues and organs creating adverse effects on humans and animals, thus affecting productivity and the economy. The aim of this study is to determine the heavy metal content of agricultural soils in some selected sites at Tumu, Akko L.G.A. of Gombe state, Nigeria.

**2.0 materials and methods**

**2.1 Study Site**

Tumu settlement in Ako L.G.A, Gombe state, Nigeria is located on lat 9°46'0" N and 10°57'0"E. with an elevation of 431m above sea level with landmass of about 2,627km$^2$.

**2.2 Sample matrix/ sample codes**

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

**2.2.1 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℃, disaggregated in a ceramic pestle and mortar, ground to powder and sieved,
(Kisamo, 2003, Ndimele and Jimoh, 2011).

**2.2.2 Sample digestion**

Soil samples were digested with 15mL of concentrated acid mixtures (5mL conc.$HClO_4$, 15mL conc.$HNO_3$, and 10mL conc. $H_2SO_4$) was poured into the 100mL beaker containing 1g soil stirred and covered and heated 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).

**2.3 Apparatus/ reagents**

All glass ware, including sample bottles, burette, and pipettes used were washed cleaned and rinsed with $HNO_3$, followed by distilled water to avoid errors arising from contamination. All reagents used were of analytical grade (APHA, 1985; Ademoroti, 1996).

**2.4 Physio-Chemical Parameters Determined**

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

**2.4.1 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).

**2.4.2 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℃ 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)

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

Where, weight of empty crucible = $W_0$

Weight of crucible + sample = $W_1$

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

**2.4.4 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 metals content of the samples where determined using an atomic absorption spectrometer (AAS), Perkin Elmer 400ASS.

**3.0 RESULTS /DISCUSSION**

**3.1 Physio-Chemical Parameters of Samples**

**3.1.1 pH of Soils**

The soil pH Tumu ranged from 5.8 to 6.7, with maximum pH value at Kombani Kasuwa and the minimum value at Londo. pH of soils at Tumu where moderately acidic and similar to the pH range (5.1- 6.6) of agricultural soils at Pindiga reported by Ogidi et al., (2018) and 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 of 5.4 and lower than 9.8 for soils around Ashaka cement factory in Gombe, Eastern Nigeria as reported by Buba et al., (2016). The pH of soils in this study makes the soil 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)

### 3.1.2 Moisture Content of Soils

Moisture content of soils at Tumu ranged from 21.3% to 35.6%. The maximum was at Londo and the minimum was at Kombani Isah. The mean percentage (%) moisture content of soils in the study was less than that for soils at Pindiga reported by Ogidi et al., (2018) but higher than the range of 3.1-4.6 % for soils around dump sites at Makurdi, Central Nigeria reported by Agber and Tsaku (2013),

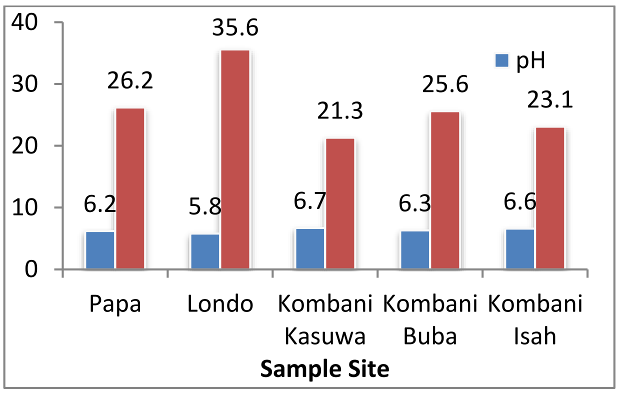


**Figure 1:** physicochemical parameters of soil samples at Tumu

**Table 1: Statistics of Physicochemical Parameters**

| Parameter | pH | Moisture (%) |
|---|---|---|
| Average | 6.3 | 26.4 |
| Standard deviation | 0.4 | 5.5 |
| Maximum | 6.7 | 35.6 |
| Minimum | 5.8 | 21.3 |

### 3.2 Heavy Metal Content of Soils

#### Cadmium

Cadmium content of soils in this study with mean value of 4.92 mg/Kg is higher than the mean value of 1.15mg/Kg for soils at Pindiga reported by Ogidi et al., (2018), the values range (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 (4.42mg/Kg), is higher than the mean value of 1.32mg/Kg for soils at Pindiga reported by Ogidi et al., (2018), the value (0.29 – 0.74 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017), 3.12 mg/kg at Keritis, Chania, Greece reported in Papafilippaki1, *et al.* (2007) but less than the mean concentration of Cr in soils (8.87± 8.1mg/kg) at Makurdi reported by Ogidi, (2015), the maximum value 31.2 mg/kg at Mwazan Region in Tanzania reported in Kisamo, (2003), and 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 it bioaccumulation in plants (Ogidi, 2015).

#### Iron

Iron in agricultural soils in this study has a mean concentration of 76.80 mg/Kg and this is higher than the mean value of 40.00mg/Kg for soils at Pindiga reported by Ogidi et al., (2018), the range (13.14 – 27.01 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017) and 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± 245 mg/kg) for soils at Makurdi, North Central Nigeria reported by Ogidi, (2015). Extreme concentrations of ion in soils can create mineral nutrient imbalance through antagonistic effects on the uptake of certain essential metals like K and Zn (Sahrawat, 2015).

#### Zinc

Zn content of soils in this study has a mean value of 0.28 mg/Kg which is within the range (0.06-0.60) for soils at Pindiga reported by Ogidi et al., (2018), but less than the range (7.61 – 14.69 mg/Kg) for irrigated soils in Gombe state, Nigeria reported by Babangida *et al.*, (2017), the mean concentration of Zn in soil (55.9± 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 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).

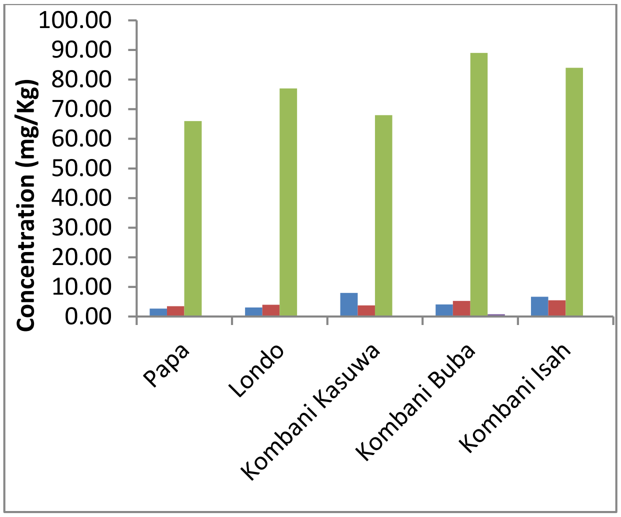


**Figure2:** Heavy Metals Content of Soils at Tumu

**Table 2; Statistics of Heavy Metal Content of Kashere**

| Metal | Mean | Maximum | Minimum | Standard deviation |
|---|---|---|---|---|
| Cd | 4.92 | 8.00 | 2.70 | 2.32 |
| Cr | 4.42 | 5.50 | 3.50 | 0.91 |
| Fe | 76.8 | 89.00 | 66.00 | 9.93 |
| Zn | 0.28 | 0.80 | 0.20 | 0.34 |

### 3.3 Heavy Metals Trends in Soils

The heavy metal trend in soils was the same for Papa, Londo and Kombani Buba and this is the same as the trend for heavy metals at Tumu using the mean concentration values of the heavy metals, the metal trends for Kombani Kasuwa and Kombani Isah are the same. For all sample sites Fe had the highest concentration and Zn had the least concentration. The heavy metal trends in soils at study sites at Tumu are as follows;

Papa: Zn < Cd < Cr < Fe, Londo: Zn < Cd < Cr < Fe, Kombani Kasuwa: Zn < Cr< Cd < Fe, Kombani Buba: Zn < Cd < Cr < Fe, Kombani Isah: Zn < Cr< Cd < Fe

Tumu: Zn < Cd < Cr < Fe.

### Conclusion

The study indicates that the pH of soils at study area is moderately acidic, good for agricultural activities and also enhances the availability and mobility of mineral nutrients in the soil. Moisture content of the soils also aid in soil mobility of nutrients within the soil. The study shows that the heavy metals content of agricultural soils at study sites are 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; agree with the study on heavy metals in agricultural soils at Pidinga reported by Ogidi et al., (2018). Cd and Cr which is non-essential and 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.

### 4.2 Recommendations

Heavy metals contamination of the natural environment and its effects is of great concern to man, there is need to monitor the heavy metals content of soils on regular bases. The government needs to monitor the agricultural processes involving the use of agrochemicals and the dumping of refuse, metallic waste, and other harmful substances into the environment. The use of green pesticides in place of conventional synthetic and persistent agrochemicals should be encouraged. There is also a need to assess 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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