# Heavy Metal Content of Agricultural Soils at Kashere, Akko Local Government Area of Gombe State, Nigeria.

**Ogidi Adam Ogidi, Danja B.A., Hammashi H.Lodma, Nathaniel Sunday Samuel, Sanusi K.A.**

Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria.

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***Abstract-***The heavy metals content of agricultural soils at kashere, Ako LGA, Gombe, were determined using an atomic absorption spectrophotometer (AAS). The result shows the mean heavy metal content of samples as follows, Fe (21.31 mg/Kg), Zn (7.86 mg/Kg), Cd(1.58 mg/Kg),Cr(2.32 mg/Kg) and Pb (36.10 mg/Kg). The concentration of heavy metals in samples increased in the following order, Cd < Cr < Zn< Fe < Pb. The mean values for some physiochemical parameters of the soil samples are; pH (5.7), moisture (27.2 %), the concentrations of heavy metals in soil samples were less than the permissible limits for heavy metals in soils set by USEPA / WHO.

***Index Terms***- agricultural soils, atomic absorption spectrophotometer, bioaccumulation, heavy metals.

## I. Introduction

Heavy metal contamination of agricultural soils and food crops is a severe ecological issue on a world scale. Heavy metals are currently of serious environmental concern. They have adverse effect on the health of humans, animals and are capable of bioaccumulation in food crops. Heavy metals are also non – biodegradable, persisting for long durations in the environment. They could be transferred from soil to ground water or absorbed by plants, including agricultural crops [7]. Excessive accumulation of metals in agricultural soils above the background concentration may result in soil pollution as well as affect food quality and safety. There is evidence to proof that agricultural soils have increased levels of heavy metals as a result of increased anthropogenic activities [15]. Certain trace metal elements are essential to the nutritional growth of plants, but at higher concentration they contaminate the environment and accumulate in the plants creating health problems for humans and when these plants are consumed. Heavy metals enter into air-soil-water systems, food crops, and animals, thus affecting the food chain. Health issues associated with heavy metal toxicity are cancer, gastrointestinal, pulmonary and kidney ailments [18]. Ingestion is the common route of heavy metal exposure in children. Children develop toxic levels from normal hand-to-mouth activity or by actually eating objects that are not food (soil, dirt or paint chips), [4]. Non- essential heavy metals; cadmium, chromium, mercury, lead, arsenic, and antimony pose threats to human health. The main threats to human well-being however, are associated with lead, arsenic, cadmium, and mercury [8]. The determination of free metal ions in soils, depends on the total metal content of soils, the metal species, pH, concentration of complexing ligands and soil colloid [6].

As the study location is free from industrial pollution, the major sources of heavy metals contamination of soil may be due to solid waste disposal, sludge applications, vehicular emission and application of agrochemicals. Excessive accumulation of heavy metals in agricultural soils via the use of agrochemicals leads to soil contamination and increased uptake by food crops planted on the soils [10].

In this study the heavy metals (Cd, Cr, Fe, Pb and Zn) content of agricultural soils at Kashere area of Akko logal government area of Gombe state was determined. An atomic absorption spectrophotometer was used to ascertain the level of heavy metals present in agricultural soils in the area [13].

## II. Materials and Methods

### 2.1 Study Site

Kashere is settlement in Ako L.G.A, Gombe state, Nigeria and located on lat 9°46'0" N and 10°57'0"E. It is located at an elevation of 431m above sea level with landmass of about 2,627km$^2$ [13].

### 2.2 Sample matrix/ sample codes

Ten soil samples was collected at each sample site and mixed into a composite representative sample for each sample site [12].

### 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,
[8], [11].

### 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 sample, covered with watch glasses, 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 [11], [19].

### 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 [2], [1].

### 2.4 Physio-Chemical Parameters Determined

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

| Sample site | pH | Moisture (%) |
|---|---|---|
| Model Farm | 6.6 | 15.0 |
| Jauro Dabel | 7.1 | 20.5 |
| Jauro Bose | 6.2 | 40.3 |
| Kunfayi Bille | 6.9 | 35.2 |
| Garin Jauro | 6.6 | 25.0 |

#### 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 [9].

#### 2.4.2 Determination of Moisture content determination

| Physiochemical parameter | Mean | Max | Min | Standard Deviation |
|---|---|---|---|---|
| pH | 6.7 | 7.1 | 6.2 | 0.3 |
| Moisture (%) | 27.2 | 40.3 | 15 | 10.4 |

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 [12][13]

$$moisture\ content = \frac{W_1 - W_3}{W_1 - W_0} \times 100\% \qquad (1)$$

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 metal content of the samples where determined using an atomic absorption spectrometer (AAS), Perkin Elmer 400ASS [13].

## III. Results /Discussion

### 3.1 Physio-Chemical Parameters of Samples

#### 3.1.1 pH of Soils

The pH of soil sample at Kashere ranged from 6.2 to 7.1. The maximum pH value was at Jauro Dabel and the minimum value was at Jauro Bose. the pH of soils at Kashere except for Jauro Dabel (slightly neutral) 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 of 5.4 and lower than 9.8 for soils around Ashaka cement factory in 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 [16].

#### 3.1.2 Moisture Content of Soils

The moisture content of soils at Kashere ranged from 15.0% to 40.3%. The maximum moisture content of soil was at Jauro Bose and the minimum was at Model Farm. 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),

**Table 1;** Physicochemical Parameters of Soil Samples at Kashere.

**Table 2:** Statistics of Physicochemical Parameters
(a) Max = Maximum, (b) Min = Minimum

### 3.2 Heavy Metal Content of Soils

#### 3.2.1 Cadmium

Cadmium content of soils in this study with mean value of 1.58 mg/Kg was within the range value for soils at Pindiga, Akko local government area Gombe, Nigeria reported by Ogidi et al., (2019), but 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 [12].

#### 3.2.2 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), than the value for soils at Pindiga, Akko local government area Gombe, Nigeria reported by Ogidi et al., (2019) but less Than the mean concentration of Cr in soils (8.87± 8.1mg/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 it bioaccumulation in plants [12].

### 3.2.3 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± 245 mg/kg) for soils at Makurdi, North Central Nigeria reported by Ogidi, (2015) and in soils at Pindiga, Akko local government area Gombe, Nigeria reported by Ogidi et al., (2019). 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 [14].

### 3.3.4 Lead

| Metal | Mean | Maximum | Minimum | Standard deviation |
|---|---|---|---|---|
| Cd | 1.58 | 2.00 | 1.10 | 0.35 |
| Cr | 2.32 | 3.60 | 1.20 | 0.99 |
| Fe | 21.31 | 52.00 | 0.56 | 23.35 |
| Pb | 36.10 | 59.90 | 16.20 | 16.70 |
| Zn | 7.86 | 15.70 | 5.20 | 4.42 |

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± 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 [12].

### 3.2.5 Zinc

Zn content of soils in this study has a mean value of 7.86 mg/Kg which is within the 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± 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) but higher than the value for soils at Pindiga, Akko local government area Gombe, Nigeria reported by Ogidi et al., (2019). 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 [7].

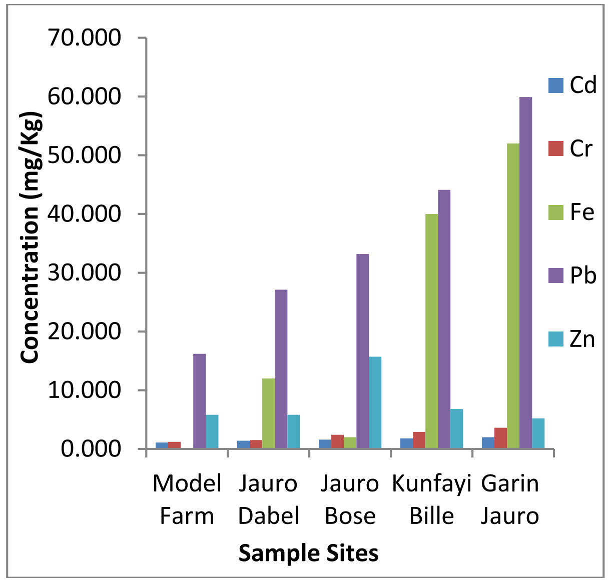


**Figure 1:** Heavy Metal Content of Soil Samples at Kashere.

**Table 3:** Statistics of Heavy Metal Content of Kashere

### 3.3 Heavy Metals Trends in Soils

The heavy metal trend in soils was the same for Jauro Dabel, Kunfayi Bille and Garin Jauro which is the same as the trend for heavy metals at Kashere using the mean concentration values of the metals. For all sample sites Pb had the highest concentration. Fe had the least concentration in soils at Model Farm; Cd had the least concentration at the remaining study sites. The heavy metal trends in soils at study sites at kashere are as follows;

Model Farm: Fe < Cr < Cd < Zn< Pb, Jauro Dabel: Cd < Cr < Zn< Fe < Pb, Jauro Bose: Cd < Fe < Cr < Zn< Pb, Kunfayi Bille: Cd < Cr < Zn< Fe < Pb, Garin Jauro: Cd < Cr < Zn< Fe < Pb. Kashere: Cd < Cr < Zn< Fe < Pb.

## IV. Conclusion/ Recommendations

### 4.1 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. Cd has the lowest concentration while Pb 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.

### 4.2 Recommendations

Heavy metals poisoning is of great concern to man and the environment, thus there is need to monitor the heavy metal 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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## AUTHORS

**First Author** – Ogidi Adam Ogidi, Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria
**Second Author** – Danja B.A., Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria
**Third Author –** Hammashi H.Lodma, Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria
**Fourth Author** –Nathaniel Sunday Samuel, Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria
**Fifth Author** – Sanusi K.A., Department of Chemical Sciences, Federal University of Kashere, Gombe state, Nigeria

**Correspondence Author –** ogidiadam1981@gmail.com