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DETERMINATION OF HEAVY METAL CONCENTRATION IN DIFFERENT PARTS OF AZANZA GARKEANA PLANT AND THE CULTIVATED SOIL USING AAS TECHNIQUE.

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ABSTRACT

Azanza garckeana is an edible fruit with medicinal values in the treatment of different ailments. The presence of Six Heavy metals (Cd, Co, Cr, Mn, Ni, and Pb) in different components of Azanza garckeana plant (seed, leaves, pulp and bark) and the cultivated soil, in part of Tula Kantungo LGA of Gombe State is investigated using atomic adsorption spectrometry (AAS). Digestion of the samples was carried out by mixing 2 g of each sample with solution of HCL and HNO_3 in the ratio 2:1 and then heated at 100 ^oC for 1 hour. The concentration of the heavy metals in the seed, leaves, pulp, bark and soil are found to be in the range of 0.001- 0.791 ppm for Mn, 0.010-0.372 ppm for Co, 0.067-0.264 ppm for Cr, 0.006-0.237 ppm for Pb. 0.002-0.200 ppm for Ni, and 0.001-0.002 ppm for Cd. These values were compared with the recommended values set by World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA).

Keywords: Medicinal plants, Gombe State, Toxic, Plants parts

INTRODUCTION

The world is endowed with rich abundance of medicinal plants. It is estimated that around 70,000 plant species, from lichens to towering trees, have been used at one time or another for medicinal purposes (Michael *et al.*, 2015). Among such plants with medicinal purpose is *Azanza garckeana*, which was reported by Burkill *et al.* (2002) to have medicinal values in the treatment of ailments. *Azanza garckeana* is widely distributed in East and Southern Africa (Petrea *et al*., 1999). The specific countries where the species is found are Botswana, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia, Zimbabwe, and Nigeria. It grows in semi-arid areas receiving lowest annual rainfall of 250 mm and highest rainfall of 1270mm with attitude of 0 – 1900 m.The species grows naturally in all types of woodlands from sea level to about 1700 m above sea level (Ochokwu *et al.*, 2014).

In Nigeria, they are found in Northwest, Katsina State in Kankia, Daggish in the middle belt of River Benue (Ochokwu *et al.*, 2014). In north-eastern Nigeria, they are found in Tula area of Kaltungo local government Gombe State, Kali hills of Zah district of Michika local government area of Adamawa State and Ningi in Bauchi State (Ochokwu *et al.*, 2014) and are available in most of the Northeast markets especially in rural areas.

Heavy metals are chemical elements with specific gravity of at least five (Winter, 2014) . Fifty-three of the ninety naturally occurring elements are heavy metals (Weast, 1984). Of these, Fe, Mn and Mo are important as micronutrients, while, Co, Cr, Cu, Ni Va and Zn are toxic elements, but have importance as trace elements. Ag, As, Cd, Hd, and Pb have no known function as nutrients, and seem to be toxic to plants and microorganism. The majority of the heavy metals are toxic to the living organism and even those considered as essential can be toxic if present in excess. The heavy metals can impair important biochemical process posing a threat to human health, plant growth and animal life (Jarup, 2003).

Heavy metals become toxic when they are not metabolized and as such classified as toxic heavy metals or simply toxic elements. Toxic elements have no known beneficial effect in humans. Their accumulation over time does cause serious illness (Charles, 2007) .

Due to the increasing consumption of this plant by humans for medicinal purposes, there is need to assess the level of heavy metals and trace element in the edible components of the plants and compare with acceptable maximum permissible level of consumption for the heavy metals.

MATERIALS AND METHODS

Study Area

The study area is Tula, Kaltungo Local Government, Gombe state. Kaltungo LGA shares boundaries with Yemaltu-deba and Akko LGA to the north, Balanga to the south and east, and Billiri and Shangom to the west as shown in (Figure 3). It lies between longitude 11º 50' 22.58"E to 11º 51' 17.74"E and latitude 11º 28' 07.71"N to 11º 28' 39.69"N.

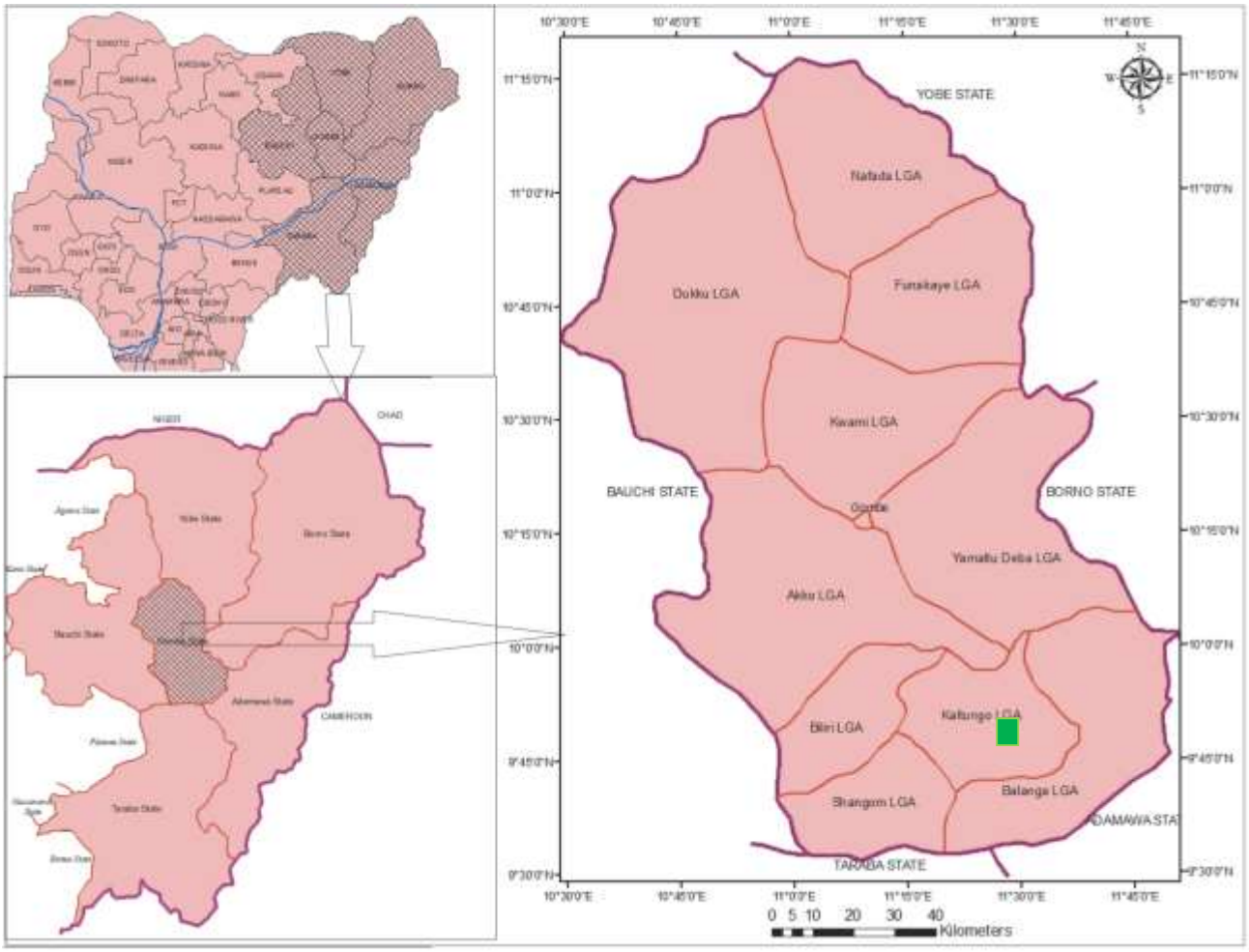

Fig. 1: Map of Nigeria showing the location of the study area (Ikusemoran et al 2018)

Sample collection

The fruit (pulp & seed), leaf, bark and the soil samples of *Azanza garckeana* were collected from uncultivated farmlands of the study area. The voucher specimens was deposited to the Herbarium in the Biological Science laboratory at the Ahmadu Bello University Zaria, Nigeria, for identification.

Sample preparation

The plant sample were dried at room temperature and grinded using AGTE – MOTAR, then pulverized using Mesh of aperture 250microns into uniform powder. To avoid contermination, for each sample the AGTE – MOTAR was washed with liquid soap and water and allowed to dry then wiped with Acetone. Chemical test was carried out on the samples extract from the powdered specimens using standard procedures to identify the constituents in each of the collected samples.

Sample Preparation For AAS

The following steps were used in the preparation for AAS analysis:

Step 1: Digestion

For digestion the following materials are needed; Beaker, electrical weighing balance, Conical flask, Filter paper, Funnel, Hot plate/Heating mantle, Maskin tape, Pen, Distilled water, Hand gloves, Nose mask, Fire wood cupboard, Lab coat, Sample bottles, Wash bottle, Spatula, and the solvents (Hcl, Nitric, Perchloride) acids.

Step 2: Preparation of Digestion

2 g of each of the raw sample were weighed using weighing balance, and placed into a 100 ml beaker, and an I.D was given to them using a masking tape and Pen. 10 ml of concentrated Hcl and HNO_3 in the ratio 2:1 was added and the mixture was heated for 1 hour at 100 ^{0}C using a hot plate. The mixture was allowed to cool for 20 minute, then 5 ml of distilled water was added and stir using Spatula. The solution was cooled further and filtered through whatman No. 42 filter paper into a 50 ml volumetric flask. The filtrate was made to the mark using distilled water prior to analysis.

Heavy Metals Analysis

An analytical technique was used to determine the concentration of six elements; Ca, Co, Cr, Mn, Ni, and Pb. It was done in replicates using Atomic Absorption Spectrometer model; AA-6800 Shimadzu Japan. The calibration of the

instrument using standards and blank were frequently done between samples to ensure stability of the base line. Each of the samples in liquid form was aspirated into the machine and created a fine aerosol spray for introduction in to the flame where atoms of interest were selected. The monochromator isolated the analytical lines of the photons which were passed through the flame to the detector. Computer was used to display the result for the data of the intensity of photon detected in the unit of part per million (ppm).

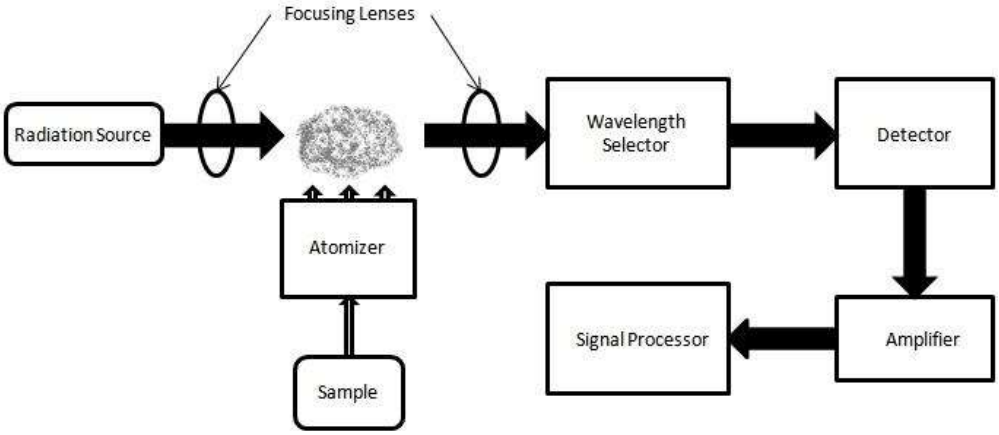

Fig 1: Block diagram of AAS technique

Permissible Level of the Studied Heavy Metals

The permissible level of some of the toxic elements set by the World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA) are compared with the present study and presented in Table 1 below.

Table 1: Comparison of heavy metal concentrations with the world average permissible limit

S/No	Toxic metals	Average Values in this study (ppm)	Maximum Limit (ppm) WHO	Maximum Limit (ppm) FEPA
1	Cadmium (Cd)	0.002	0.003	0.01
2	Cobalt (Co)	0.372	Not Found	Less than 0.5
3	Chromium (Cr)	0.264	0.05	0.05
4	Manganese (Mn)	0.791	0.05	Less than 0.5
5	Nickel (Ni)	0.200	0.07	Not Found
6	Lead (Pb)	0.237	0.01	Less than 0.5

RESULTS AND DISCUSSION

Elemental analysis

After the analysis of the samples, the concentration of the Cadmium (Cd), Cobalt (Co), Chromium (Cr), Manganese (Mn), Nickel (Ni) and Lead (Pb) were determined in the samples of leaves (LV1A, LV2A, LV3A), Seeds (SD1B, SD2B, SD3B), pulps (PD1C, PD2C, PD3C), bark (BK1D, BK2D, BK3D) and soil (SL1E, SL2E, SL3E) respectively. From Table 1, the average concentration of Cd in this study was found to be 0.002 ppm, which is below the recommended value set by (WHO, 2006) and (FEPA, 1991) with a value of 0.003 ppm and 0.01 ppm respectively, Co has the average concentration of 0.372 ppm which is below the recommended value less than 0.5 ppm as reported by (FEPA, 1991), Cr recorded the value of 0.264 ppm and this value is found to be above the recommended value of 0.05 ppm as set by (WHO, 2006) and (FEPA, 1991) respectively, the concentration of Mn is found to be 0.791 ppm which is above the recommended values of 0.05 ppm and less than 0.5 ppm as reported by (WHO, 2006) and (FEPA, 1991), Ni concentration is found to be 0.200 ppm and this value is also above the safety limit of 0.07 ppm set by (WHO, 2006), finally the concentration of Pb is found to be 0.237 ppm which is higher than recommended value of 0.01 ppm (WHO, 2006) and less than 0.5 ppm (FEPA, 1991).

Concentration of heavy metal in leaves

Table 2 and Figure 3 shows the concentration of Cd, Co, Cr, Mn, Ni, and Pb in the unit of ppm. For the leaves samples Cd has the lowest concentration in the leaves sample with a value of 0.002ppm for all the samples, Co have the highest concentration with a value range of 0.324 to 0.334ppm, Cr ranges from 0.067 to 0.171ppm, Mn is within the range 0.240 to 0.252ppm, Ni is within 0.010 to 0.017ppm and lastly Pb is below detection limit (BDL) in LV1A, LV2A but has the value 0.112ppm in LV3A.

Table 2: Elemental concentration in leaves

S/No	Elements	LV 1A	LV 2A	LV 3A	Mean ± Error	Range
1	Cd	0.002	0.002	0.002	0.002 ± 0.000	----
2	Co	0.334	0.333	0.324	0.330 ± 0.003	0.324-0.334
3	Cr	0.067	0.171	0.069	0.103 ± 0.034	0.067-0.171
4	Mn	0.252	0.251	0.240	0.248 ± 0.004	0.240-0.252
5	Ni	0.014	0.017	0.010	0.014 ± 0.002	0.010-0.017
6	Pb	BDL	BDL	0.112	0.037±0.028	----

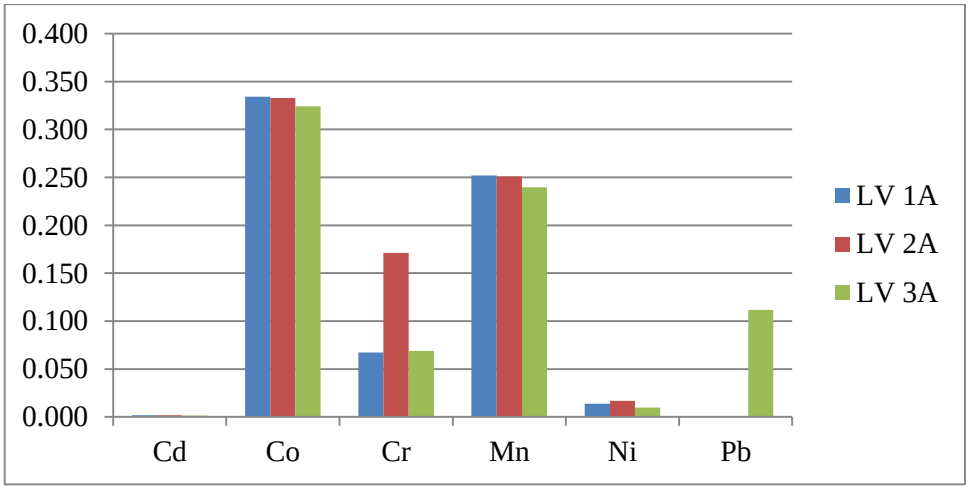

Fig. 3: Concentration of LV1A, LV2A and LV2A

Concentration of heavy metal in Seeds

Table 3 and Figure 4 show-the concentration in ppm of Cd, Co, Cr, Mn, Ni, and Pb. Cd concentration in sample SD 1B and SD 3B were below detection limit whereas for sample SD 2B the concentration is 0.001ppm. Co is within the range of 0.308 to 0.372ppm, Cr ranges from 0.133 to 0.181ppm, Mn has the highest concentration in the seed, ranging from 0.774 to 0.783ppm, Ni ranges from 0.008 to 0.012ppm, and the Pb is within the range of 0.015 to 0.084ppm.

Table 3: Elemental concentration in Seeds

S/No	Elements	SD 1B	SD 2B	SD 3B	Mean ± Error	Range
1	Cd	BDL	0.001	BDL	0.003 ± 0.000	----
2	Co	0.317	0.372	0.308	0.332 ± 0.020	0.308-0.372
3	Cr	0.181	0.133	0.177	0.165 ± 0.015	0.133-0.181
4	Mn	0.783	0.776	0.774	0.778 ± 0.003	0.774-0.783
5	Ni	0.008	0.012	0.009	0.010 ± 0.001	0.008-0.012
6	Pb	0.084	0.024	0.015	0.014 ± 0.022	0.015-0.084

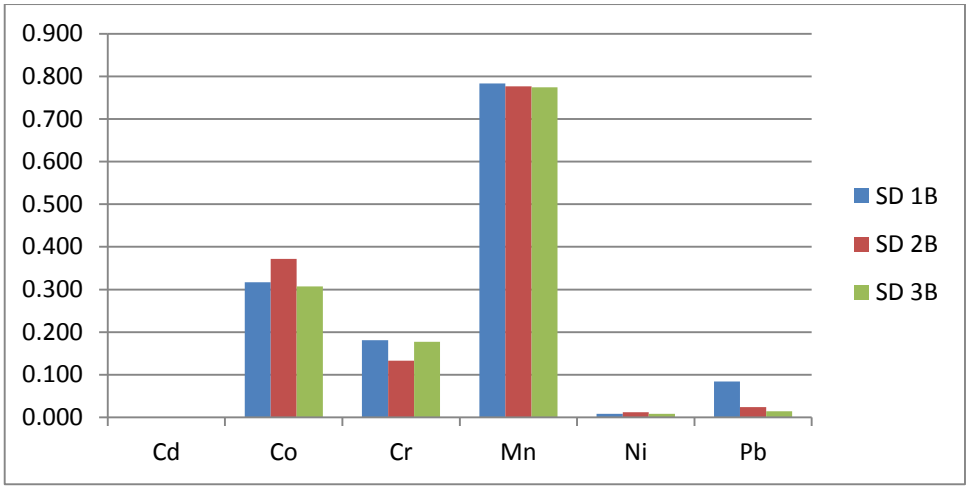

Figure 4: Concentration of seeds 1A, 2A and 3A.

Concentration of heavy metal in Pulps

Table 4 and Figure 5 presents the concentration in ppm of Cd, Co, Cr, Mn, Ni, and Pb in the Pulps samples. A value of 0.001ppm is found for sample PD3C, whereas sample PD1C and PD2C were all below the detection limit. Cobalt is within the range of 0.010 to 0.017ppm, Cr ranges from 0.121 to 0.264ppm, Mn have the highest concentration with a range from 0.781 to 0.791ppm, Ni is within 0.009 to 0.020ppm, and lastly the Pb ranges from 0.006 to 0.155ppm.

Table 4: Elemental concentration in Pulps

S/No	Elements	PD 1C	PD 2C	PD 3C	Mean ± Error	Range
1	Cd	BDL	BDL	0.001	0.003 ±0.000	----
2	Co	0.014	0.017	0.010	0.014 ± 0.002	0.010-0.017
3	Cr	0.264	0.125	0.121	0.170 ± 0.047	0.121-0.264
4	Mn	0.791	0.785	0.781	0.786 ± 0.003	0.781-0.791
5	Ni	BDL	0.009	0.020	0.0097± 0.006	0.009-0.020
6	Pb	0.006	BDL	0.155	0.054 ±0.051	0.006-0.155

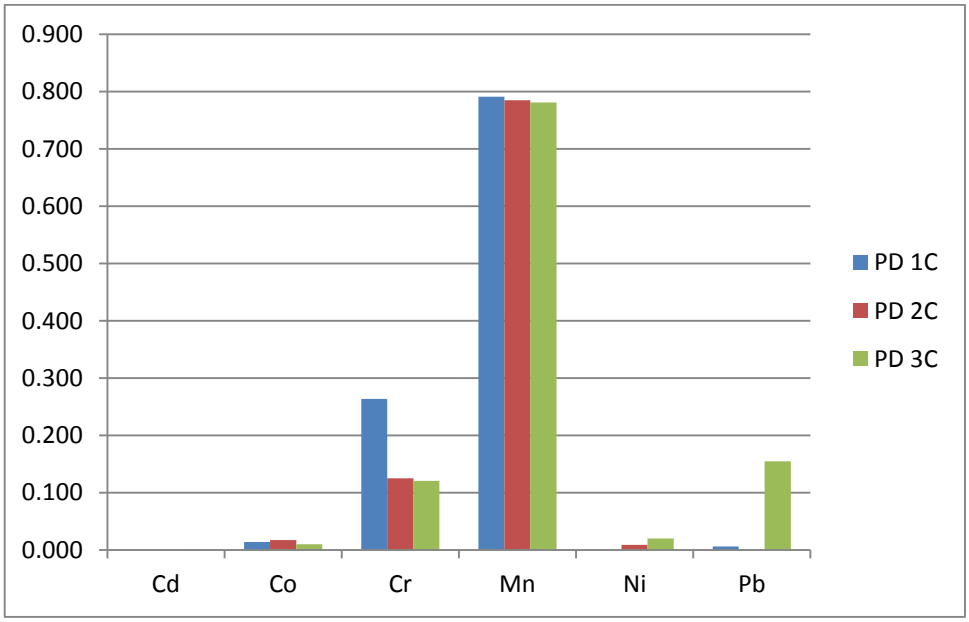

Figure 5: Concentration of Pulp 1C, 2C and 3C.

Concentration of heavy metal in Bark

Cd have the lowest value in the bark equal to 0.002ppm for all sample, Co have the highest concentration with the range 0.310 to 0.349ppm, Cr ranges from 0.154 to 0.197ppm, Mn concentration in the bark ranges from 0.258 to 0.271ppm, Ni is within the range of 0.002 to 0.021ppm, and the Pb ranges from 0.167 to 0.237ppm as shown in table 5 and figure 6.

Table 5: Concentration of Bark 1D, 2D and 3D.

S/No	Elements	BK 1D	BK 2D	BK 3D	Mean ± Error	Range
1	Cd	0.002	0.002	0.002	0.002 ± 0.000	0.002-0.002
2	Co	0.337	0.349	0.310	0.332 ± 0.011	0.310-0.349
3	Cr	0.159	0.154	0.197	0.170 ± 0.014	0.154-0.197
4	Mn	0.271	0.264	0.258	0.264 ± 0.004	0.258-0.271
5	Ni	0.019	0.021	0.002	0.014 ± 0.006	0.002-0.021
6	Pb	BDL	0.237	0.167	0.135 ± 0.070	0.167-0.237

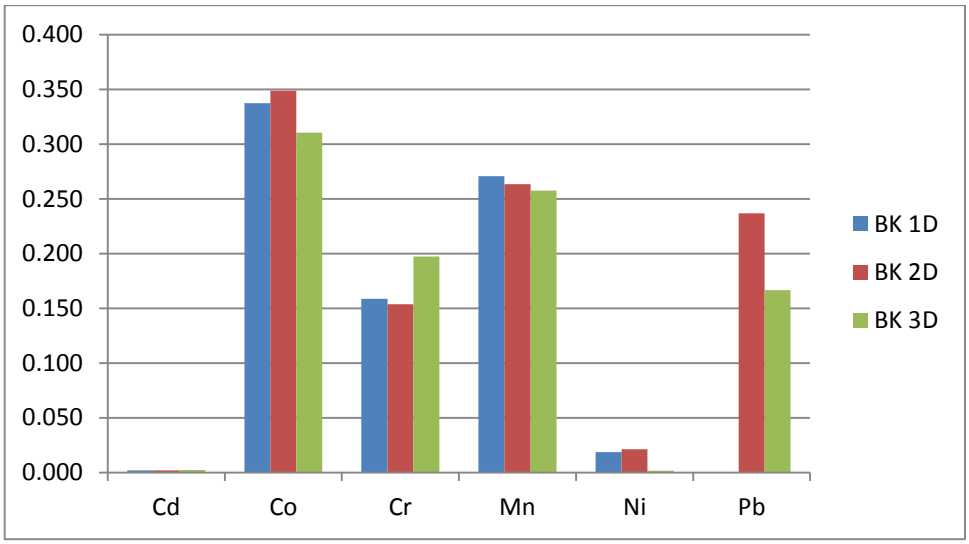

Figure 6: Concentration of Bark 1D, 2D and 3D.

Concentration of heavy metal in Soil

The concentration in ppm of Cd, Co, Cr, Mn, Ni, and Pb in the soil samples were determined and were presented in table 6 and figure 7. Cadmium and Manganese have equal and lowest concentration in the soil ranges from 0.001 to 0.002, Cobalt have the highest concentration with the range of 0.323 to 0.337, Chromium ranges from 0.033 to 0.130, Nickel is within 0.002 to 0.012 range, and the Lead finally have 0.089 to 0.111 ranges in the soil sample.

Table 6: Concentration of Soil 1E, 2E and 3E.

S/No	Elements	SL 1E	SL 2E	SL 3E	Mean ± Error	Range
1	Cd	0.001	0.002	0.001	0.001 ± 0.000	0.001 - 0.002
2	Co	0.333	0.323	0.337	0.331 ± 0.004	0.323 - 0.337
3	Cr	0.122	0.130	0.033	0.095 ± 0.031	0.033 - 0.130
4	Mn	0.001	0.002	0.001	0.001 ± 0.000	0.001 - 0.002
5	Ni	0.002	0.012	0.010	0.008 ± 0.003	0.002 - 0.012
6	Pb	0.089	0.111	0.094	0.098 ± 0.006	0.089 - 0.111

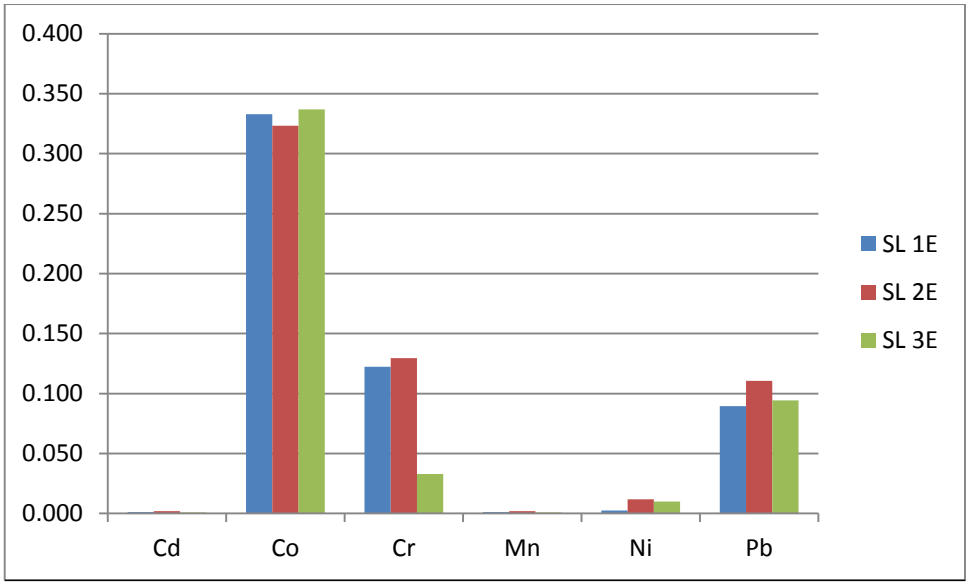

Figure 7: Concentration of Soil 1E, 2E and 3E.

CONCLUSION

Plant samples and the cultivated soil samples have been collected from Tula area of Kaltungo Local Government Gombe State. All the samples were analyzed for toxic heavy metals concentration (Cd, Co, Cr, Ni, Mn and Pb) using AAS method. The concentration was found in ppm. Some of the targeted heavy metals are found to be within the recommended values set by WHO and FEPA while some are above.

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