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CALOTROPIS PROCERA AS A BIOINDICATOR OF HEAVY METALS POLLUTION IN KATSINA METROPOLIS, KATSINA NIGERIA

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ABSTRACT: *Bio-accumulation of some heavy metals was evaluated by using Calotropis procera as bioindicator plant in Katsina Metropolis. Calotropis procera, was identified and selected as a bioindicator for its availability in sub-Saharan Africa. The leaf samples were collected to assess the characteristics of accumulation and tolerance of Lead, Iron, Cadmium, Copper and Zinc in the plant. Samples were collected from five different locations (along major highways, residential and industrial areas in Katsina metropolis) by random selection. The samples were brought to the laboratory washed with deionised water, digested and analysed for Pb, Fe, Cd, Cu and Zn. The results show high concentration in some sampling sites especially at residential areas. The relative abundance of metals in the leaves follow the sequence: copper (30.91µgg^{-1}) > iron (21.18 µgg^{-1})> cadmium (20.00 µgg^{-1})> Lead (18.86)>Zinc (5.56). The levels of Zn in all the sampling sites were below the FAO/WHO recommended limits for metals in plants. High concentrations of Pb, Cu, Fe and Cd in all the samples indicate that the plant has the ability to accumulate such toxic metals and hence can be used as a bioindicator of heavy metals pollution in the study area.*

KEYWORDS: Calotropis Procera, Heavy Metals, Pollution, Bioindicator, Bioaccumulation, Relative Abundance, Nigeria

INTRODUCTION

Development in science and technology have brought improved standards of living but have unwittingly introduced pollutants such as; emission and effluent outflow from factories, refineries, waste treatment plants, oil or gases of varying quantity directly into the environment. The massive increase in chemical utilization due to recent development in science and technology has greatly increased different contaminants present in the atmosphere generally, regardless of its source. Introduction of heavy metal can occur in dissolved form as hydroxide, carbonate, sulphate, nitrate, phosphate and other minerals (Oklo & Asemave, 2012).

Bioindication refers to the use of animals and plants as instruments for assessing past, current and future conditions or processes. According to Kamran and Hosein, (2011) bioindicators are species or group of species that provide information about the long-term changes. Plant materials such as lichens, fungi, tree barks, tree rings and leaves of higher plants have been used for many years to detect the deposition, accumulation and distribution of metal pollution (Ahmet and Ugur, 1999). Tree barks and their leaves remain in the environment for a long period and are sensitive indicators of environmental contamination with heavy metals, sulphur and fluorine (Batagarawa and Lawal, 2010).

Plants can take up and accumulate heavy metals in quantities high enough to cause clinical problems to humans (Alam, 2003). Daily metal intake estimate does not take into account the possible metabolic ejection of the metals but can easily tell the possible ingestion rate of a particular metal. Dietary intake of food results in long-term low-level body accumulation of heavy metals and the detrimental impact becomes apparent only after several years of exposure (Oluyemi et al, 2008.; Orisakwe et al, 2012).

Bioaccumulation of these metals in man, animals and plants results in metal poisoning (Lawal et al, 2011).

Calotropis procera, a family of Asclepiadaecae is an Ayurvedic plant with important medicinal properties. It is known by various vernacular names like Swallow wort in English, tumfafiya in Hausa, madar in Hindi and Alarka in Sanskrit. It is found in most parts of the world with a warm climate in dry, sandy and alkaline soils. Calotropis is primarily harvested because of its distinctive medicinal properties **(**Shoaib et al, 2013).

Fig. 1. ***Calotropis Procera Leaaves***

The plant has medical uses, for many ailments; such uses are as forage, textile and food applications, and as fuel; furthermore, it is capable of accumulating heavy metals and metalloids; comparisons between leaf samples from polluted and non-polluted sites were already carried out by different authors.

Plants have been a rich source of medicines because they produce a wide array of bioactive molecules, most of which probably evolved as a chemical defense against predation or infection. The medicinal potential of *Calotropis procera* has been known to traditional system of medicine (Amit et al, 2014). However, previous studies indicated that the species of this plant is capable of accumulating many chemical elements which are often toxic to life.

Thus, there is the need to carryout extensive screening on the medicinal plants grown in the vicinity of Katsina metropolis.

The main aim of this research work is to determine the level of Heavy Metals Pollution in Katsina Metropolis using Calotropis procera as a bioindicator.

MATERIALS AND METHODS

Study Location

The area covered in this research was Katsina, a city in North-western Nigeria. It is the capital of Katsina state, one of Nigeria's 36 states. It is also the headquarters of Katsina Local Government Area. The city is located on the latitude 12° 59/ N and longitude 7° 36/ E with an average area of 142 km^2 and a population of 318,459 as of 2006. Five sites were chosen for this research work as indicated in figure 2; samples were collected from highways, industrial and residential areas in Katsina metropolis.

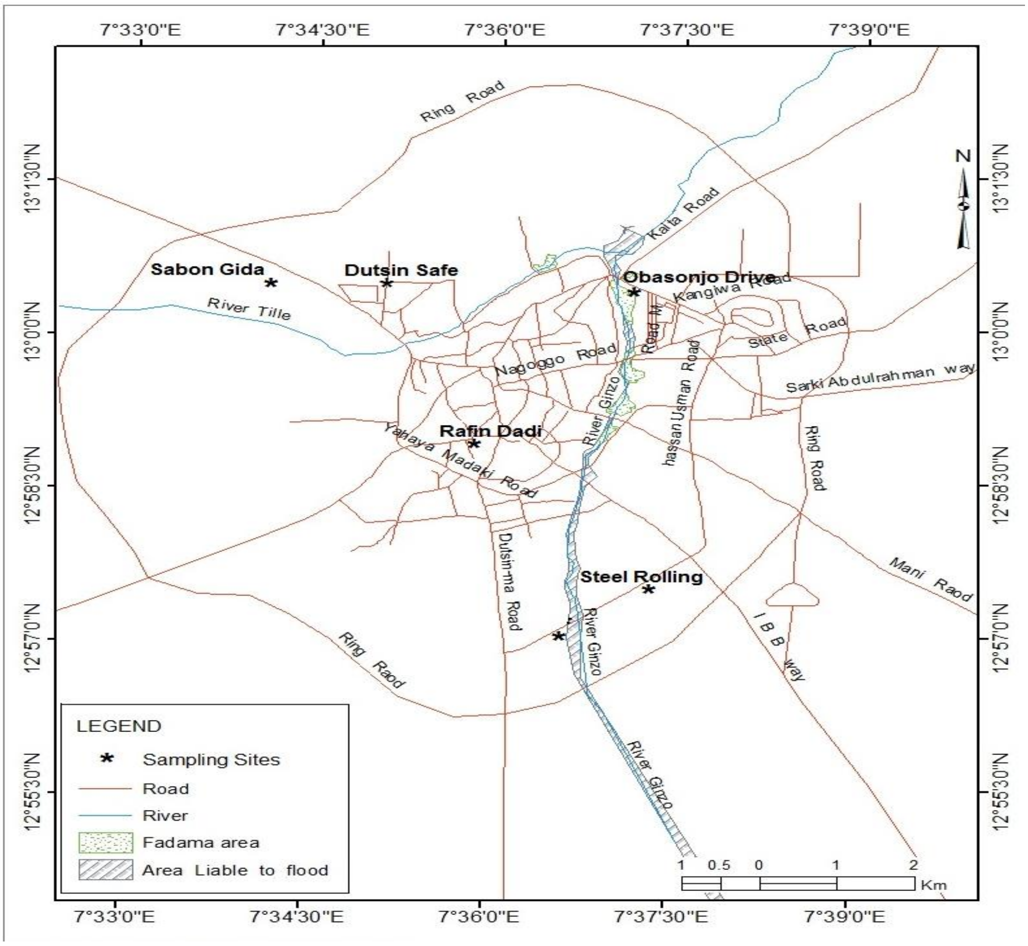

Fig.2. Map of Urban Katsina Showing Sampling Sites

Source: National Aeronoutic and Space Administration Spot Image, 2017

Sampling

Five sites (Along Shehu Musa Yar'adua Highway (site A), Along Katsina-Jibia highway (site B), Rafin dadi quarters (site C), Dutsin safe low cost (D) and Kofar Sauri Quarters (site E) within the city limits of Katsina were selected and a survey carried out to evaluate the existing levels of Pb, Fe, Cd, Cu and Zn in the selected sites (Fig.2). Twenty-five healthy and mature leaves of *Calotropis procera* at each sample location were collected to assess the characteristics of accumulation and tolerance of Pb, Fe, Cd, Cu and Zn in the specie. Only adult, whole and healthy plants were selected for the research.

Analytical reagents as recommended by WHO, (2007) were used for the present research work.

Preparation of the Digestion Mixture (3:1 HNO_3/$HClO_4$ Solution)

The procedure for the preparation of digestion mixture reported by Sweta Tiwari and Sudhir Kumar Pandey, (2016) was used. 150cm^3 HNO_3 was measured in a clean dry 250cm^3 beaker after which a 50cm^3 $HClO_4$ was added into the beaker. The mixture was stirred thoroughly and allowed to stand for fifteen minutes.

Sample Collection and Preparations

The procedure for sample collection and preparation reported by Oklo and Asemave, (2012) was used. Five samples were collected from the specified sampling sites. At each of the five sampling sites (site A, B, C, D and E), twenty-five leaves were randomly collected from different plants, placed in labeled polyethylene bags and then taken to laboratory for further preparations. In the lab, the five samples were separately washed with tap water and rinsed with distilled water to remove adhering mud. They were further washed thoroughly 3–times with deionized water and allowed to drip and then shed dried in an isolated environment until they were brittle and crisp.

The dried samples were crushed into powder using a clean wooden mortar and pestle and then sieved resulting in a fine powder. Each sample was divided into three portions and kept in a well labeled screw-capped plastic container, ready for digestion (Lawal et al, 2011).

Sample Digestion

Samples and blanks were digested as described by Abdullahi et al, (2009) and Sweta et al, (2016). Exactly 1.0 gram each of the powdered samples was accurately weighed into a separate conical flask. 20cm^3 of the digestion mixture (HNO_3: $HClO_4$ v/v 3:1) was added to each flask and the mixture was left overnight at room temperature.

Thereafter, the mixture was heated on a hot plate at 60^{o}C until a yellow straw solution was obtained. Then, the temperature was increased to 120^{o}C until there was a complete dissolution of the sample. The solution was then allowed to cool down to room temperature after which it was filtered through an acid washed whatman filter paper into a 100cm^3 volumetric flask and then diluted to the mark with deionised water. The filtrate was transferred into an air-tight screw-cap plastic jar and analyzed for Pd, Fe, Cd, Cu and Zn content using Atomic Absorption Spectrophotometer (BUCK scientific model, 210 VGP).

The results of each sample were the average of three sequential readings. Results were given in μgg-^{1} of the dry mass.

RESULTS AND DISCUSSION

Results

Concentration of the selected heavy metals, (Pb, Fe, Cd, Cu and Zn) in the leaves of *C. procera* at the five study sites was determined and presented in table 1.

Table 1: Mean Concentrations of Pb, Fe, Cd, Cu and Zn in the Leaves of C. procera at Different Locations.

Sample Site	Metal Concentration (μgg^{-1})				
	Pb	Fe	Cd	Cu	Zn
A	26.09±4.35	11.11±3.70	20.00±10.00	18.18±9.09	5.56±2.78
B	13.04±4.35	25.92±3.70	30.00±10.00	45.45±9.09	5.56±2.78
C	17.39±8.70	29.63±7.41	10.00±10.00	18.18±9.09	2.78±2.78
D	11.69±2.60	29.63±3.70	20.00±10.00	09.09±9.09	5.56±2.78
E	26.09±8.70	09.59±6.40	20.00±10.00	63.64±18.00	8.33±5.56

Discussion

Many heavy metals are generally added to the environment by aerial deposition from the roads with high density of traffic, industrial sources and other human activities. These pollutants reached to surrounding unindustrialized, residential and even to rural areas through the wind.

Table 1 shows the mean concentrations of Pd, Fe, Cd, Cu and Zn in the leaf samples of C. procera obtained from various locations in Katsina metropolis. The magnitude of these metals detected in the samples from different locations was; Cu (30.91) > Fe (21.18) > Cd (20.00) > Pb (18.86) > Zn (5.56) (fig. 2).

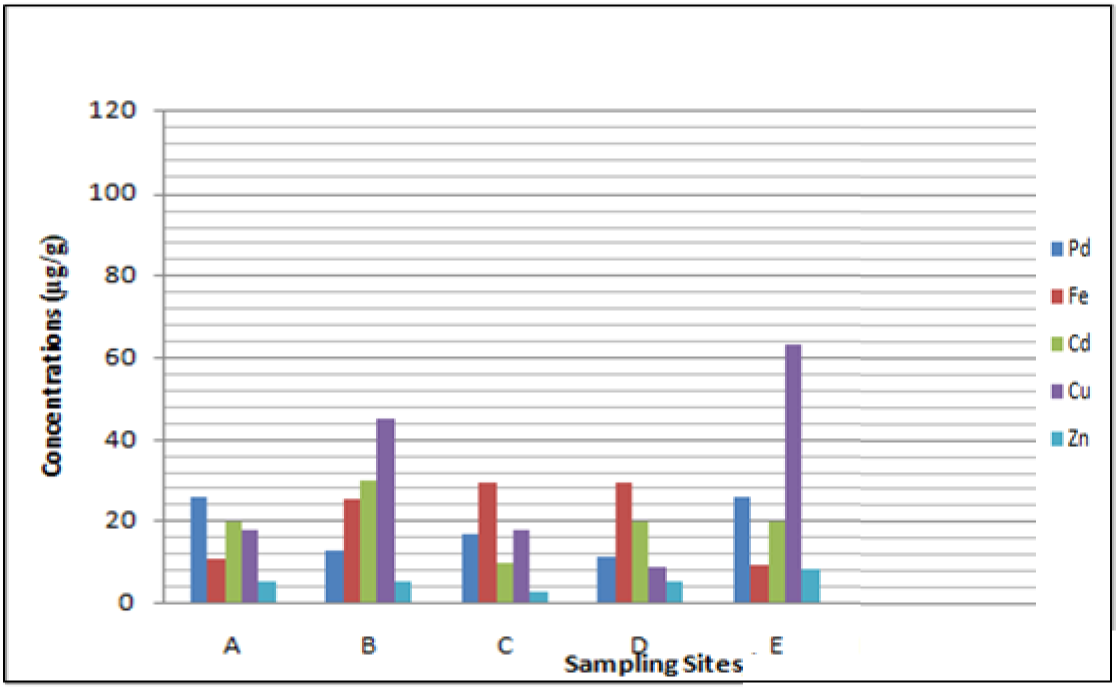

Fig.3: Metal Concentrations (µg/g) in Leaf Samples from the Five Different Sampling Sites.

Generally, from the result, the mean concentration of Pd ranged from 11.69-26.09µgg^{-1} with highest concentration from sample E. The mean concentration range of Fe was 9.59 to 29.63 µgg^{-1} with the highest concentration obtained from D, while the lowest concentration was obtained from E samples. The mean concentration of Cd ranged from 30 to 10µgg^{-1} with the highest concentration recorded in B samples and the lowest in C. The mean concentration of Cu ranged from 9.09 to 63.64µgg^{-1} with the highest concentration from E, and the least from D. The mean concentration of Zn ranged from 2.78µgg^{-1} in C samples to 8.33 µgg^{-1} in E.

Samples obtained from B show highest concentrations of Cd and Cu. High levels of Pb in A and E samples along the major highways could be attributed to automobile activities in these locations.

Furthermore, the high levels of Fe in samples C and D, can be attributed to the geological concentration of the metals in the soil (Lawal et al, 2011).

A health system, based on primary health care was adopted as the means of achieving the goal of health for all in the year 2000. Therefore, by implication, many rural and urban families living along the highways are exposed to high potential health risks associated with the metals (Oklo & Asemave, 2012).

CONCLUSION

The results of this study have indicated the presence of the heavy metals analyzed at varying degrees in all the samples of *C. procera* leaves from various locations in Katsina Metropolis. Samples from A (along Steel rolling industry) showed highest contamination of Pb and Cd which might be attributed to the industrial activities of the area and the ability of plants and their specific parts to accumulate these metals. The results also revealed the bioaccumulation ability for the study plant and hence by implication means that people should desist from using the plant as a traditional medicine as it may be dangerous to their health.

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