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HEAVY METAL ACCUMULATION IN SOME PLANTS GROWING AT POLLUTED SOILS IN LAFIA, NIGERIA

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ABSTRACT

An Assessment of heavy-metal accumulation in plants and soils of polluted areas in Lafia, Nasarawa State, Nigeria was carried out. Soil and plant samples were collected in replicates from areas situated near automobile workshop site, welder workshop site, and unpolluted soil (control) in Lafia. Plant and soil Samples were air dried, ground and sieved using 2mm sieve. The heavy metals investigated in the samples include Pb, Cu and Zn. Results showed the absence of Cu and Pb in stems and leaves of *Sida acuta* at automobile workshop site. As for *Vernonia ambigua*, all the three metals were observed (Zn, Pb and Cu). Also, the same heavy metals were prominent in the leaves and stems of *Hyptis suaveolens* at welder workshop site. The heavy metal concentrations in both plants and soils at the polluted and control sites range from Zn > Pb > Cu. There were variations in the levels of the heavy metals from the different sampling locations. These plants could be said to have shown varying degrees of tolerance to heavy metal pollution in the study sites. Phytoremediation should be encouraged in order to prevent the effects of waste related problems in the environment.

Keywords: *Hyptis suaveolens*, Lafia, Phytoremediation, *Sida acuta*, *Vernonia ambigua*

INTRODUCTION

The challenge of heavy metals and other pollutants is increasing every day across the world. These heavy metals have been released into the environment through waste engine oil and other petroleum products without adequate remediation techniques put in place. Plants have been direct recipients of these environmental pollutants. Waste oil pollution is a major cause of several environmental problems posing threats to human, plants and even soil microbes which play vital roles in soil fertility (McGrath et al., 1995). Contamination of soil by waste engine oil has gained widespread attention across the world particularly developing countries. This global environmental challenge needs appropriate clean-up techniques to be implemented (Bundy et al., 2002). Automobile and welder workshops situated within the towns and cities have been known to be the channels of heavy metals in soil, which need to be regulated (Erdei, 2005).

Heavy metals are naturally toxic to non-tolerant plants resulting in several defects such as chlorosis, stunted growth, yield reduction, metabolic disorders and poor nutrient uptake (Anoliefo and Vwioko, 1995; Guala et al., 2010; Okonokhua et al., 2007). Plants to be regarded as phytoremediators of these heavy metals must be able to grow massively in polluted soils (Ghosh and Singh, 2005). Therefore, there is need for investigations into the heavy metal contaminants level in some of the plants growing at polluted sites in our immediate environment. This will elucidate the phytoremediation potential and tolerance of the plants to these heavy metals (Dedeke and Akomolafe, 2014). The aim of this research is then to determine the heavy-metal accumulation in plants and soils of polluted areas in Lafia, Nasarawa State, Nigeria.

MATERIALS AND METHODS

Study Sites Description

Plant and soil samples were collected from areas situated near automobile workshop site (AWS), welder workshop site (WWS) and unpolluted soil (control) in Lafia, Nasarawa State, Nigeria. Geographical coordinates of these sites were taken using a GPS device. Plants found growing around these sites were identified using taxonomic floras and collected in 3 replicates. Two different species of plant were collected from each site. The same species of plants were collected from control site.

Heavy-metal analysis of samples

Plants were collected from each polluted and control sites, separated into leaves and stems, air dried and pounded into powdery form using mortar and pestle. The soils were also collected at the same sites, dried and sieved using 2mm sieve. The powdered samples were taken to laboratory for analysis to determine the level of heavy metals present. The heavy metals that were determined include Pb, Zn, and Cu. The heavy metals contents of the plant and soil samples were determined

following the methods described by Ayodele and Gaya (1998) as follows:

The samples (1.0 g) were placed separately in 25 ml beakers. Afterwards, about 10 ml of concentrated HNO3 (analytical grade, 69%) was poured into the beaker. A watch glass was place at the mouth of the beaker and the beaker was placed on a magnetic stirrer/hot plate. Initially, the temperature was kept at about 40 °C for one hour to prevent vigorous reactions. Then the temperature was maintained at 140 °C for another 3 hours. After the digestion is completed, all the samples were completely dissolved in the acid. Then the mixture was cooled to room temperature. The mixture was hereafter diluted using double distilled water for Atomic Absorption Spectrophotometer (AAS) detection of heavy metals. The samples were filtered by filter paper (Whatman No.1 grade). The filtrates were stored at 4 °C until the metal determination by AAS.

Statistical Analysis

The heavy metals concentrations in leaves, stems and soils in each contaminated sites and control were subjected to non-parametric Kruskal-Walis test for significance differences at $P \leq 0.05$.

RESULTS AND DISCUSSION

From this study, heavy metals contents of plants growing in some polluted soils in Lafia, Nigeria were investigated. The geographical coordinates of the sampling locations and plants identified are presented in Table 1. A total number of three (3) plant species were identified in the two different polluted sites studied and control.

Table 1: The geographical coordinates of sampling locations

Name of Site	Latitude (N)	Longitude (E)	Elevation (m)	Plants identified
WWS1	08.47976^0	008.56475^0	178m	*Hyptis suaveolens*
WWS2	08.54083^0	008.53110^0	164m	*Vernonia ambigua*
AWS1	08.51226^0	008.50382^0	175m	*Sida acuta*
AWS2	08.51320^0	008.52057^0	181m	*Vernonia ambigua*
Control 1	08.48953^0	008.50317^0	144m	*Sida acuta, Vernonia ambigua*
Control 2	08.48077^0	008.50545^0	189m	*Hyptis suaveolens, Sida acuta*

At AWS, there were significantly higher concentrations of Zn in both stems and leaves of *Sida acuta* compared with Cu and no Pb was found (Figure 1). The indiscriminate disposal of spent automobile engine oil is a common source of soil contamination in developing countries like Nigeria. This is because there is no enforcement and strict adherence to environmental laws and regulations (Ogbo et al., 2009). The potential for accumulation of heavy metals in plants is a factor of genetic make-up of the plant species and their efficiency is determined by either plant uptake or soil to plant transfer factors of the metals involved (Khan et al., 2008).

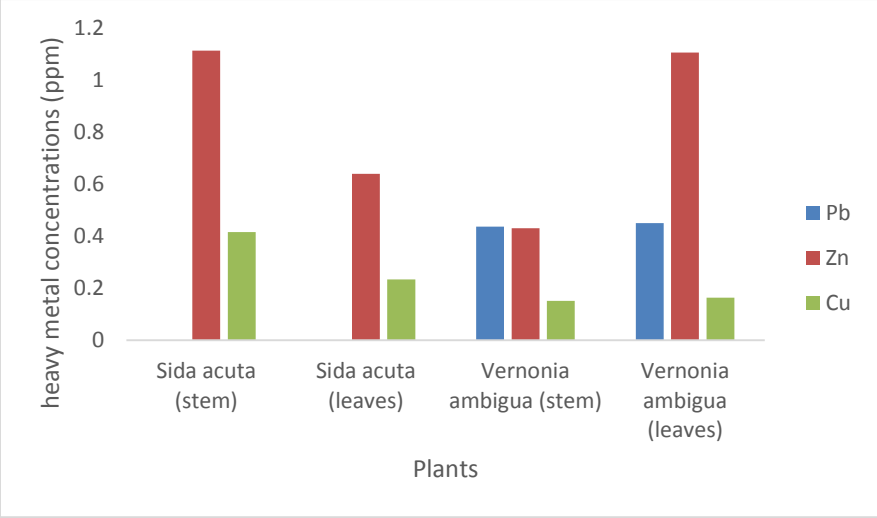

Fig 1: Heavy metal concentration in plants at AWS

However, in the stems and leaves of *Vernonia ambigua*, Pb was discovered though at a concentration lower than that of Zn. The concentrations of Zn in leaves and stems of *Sida acuta* at Control Site 1 are significantly higher than Cu with no traces of Pb ($P \leq 0.05$). In *Vernonia ambigua*, Zn still had the highest concentrations followed by Pb in both leaves and stems, though the differences between the metal concentrations are not significant (Figure 2). The concentrations of Pb and Cu in the soil of AWS are significantly higher than in control site. The exception is that Zn of the control soil is significantly higher than AWS ($P \leq 0.05$) (Table 2).

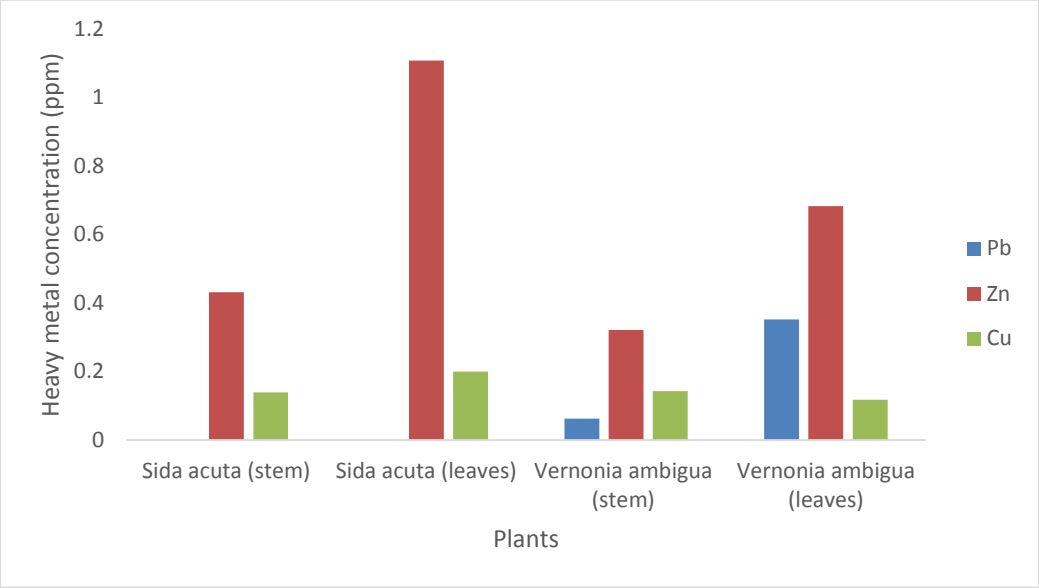

Fig 2: Heavy metal concentration in plants at control site1

Table 2: The heavy metal concentrations (ppm) in the soils at AWS and control sites

	Pb	Zn	Cu
AWS	0.106 ± 0.02	2.95 ± 0.49	0.96 ± 0.06
Control	0	14.33 ± 1.40	0.19 ± 0.03

Value represents mean ± standard error

Heavy metal concentrations in leaves and stems of *Hyptis suaveolens* at WWS ranged from Zn > Pb > Cu and the differences between them are significant ($P \leq 0.05$). In *Vernonia ambigua*, the heavy metal concentrations followed the same range as *Hyptis suaveolens* with the exception that the differences are not significant and no trace of Pb in the stem (Figure 3).

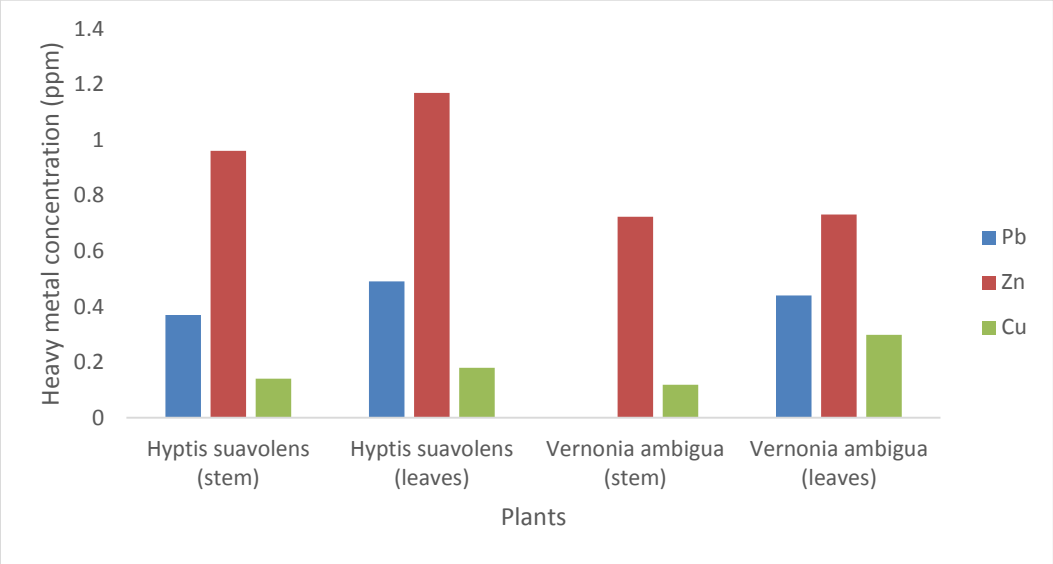

Fig 3: Heavy metal concentration in plants at welder site

Also, the heavy metal concentration in leaves and stems of *Hyptis suaveolens* at control site ranged from Zn > Pb > Cu and the differences between them are significant ($P \leq 0.05$). However, for leaves and stems of *Vernonia ambigua*, there was no Pb discovered. The concentration of Zn was still higher than Cu, though the differences are not significant (Figure 4).

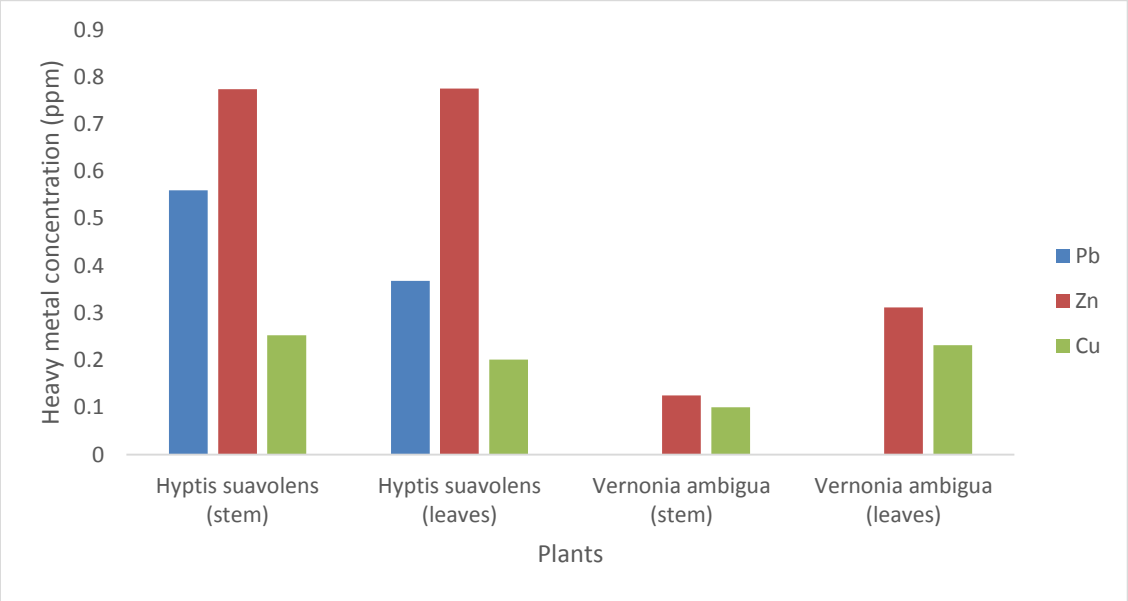

Fig 4: Heavy metal concentration in plants at control site 2

The Zn and Cu concentrations in the control soil are significantly higher than that of WWS with no Pb found (Table 3). The results revealed that Zn was more prominent in all the plants and soils in this study. Similarly, the presence of these heavy metals in the control soils and plants could imply that the control environments were not totally free from pollutants.

Table 3: The heavy metal concentrations in the soils at WWS and control sites

	Pb	Zn	Cu
WWS	0.01 ± 0.01	0.74 ± 0.46	0.15 ± 0.03
Control	0	14.33 ± 1.40	0.19 ± 0.03

Value represents mean ± standard error

It has been reported that higher concentration of Pb in soils affect soil productivity while lower concentration of Pb poses threats to some important metabolic processes such as photosynthesis, transpiration etc. in plants (Bhattacharyya et al., 2008). *Sida acuta* has been described as an aggressive competitor in nutrient-depleted soils and waste lands. Its phytoremediation efficiency is proved by its ability to accumulate heavy metals in polluted soils. This further justifies its presence in the polluted soils investigated in this study. This observation is also confirmed by the report of Oseni et al. (2018) that *Sida acuta* is a good candidate for phytoremediation of heavy metals particularly Pb.

The dark leaf spots observed on some of the studied plants could be as a result of disposal of the waste automobile engine oil in the soil at the AWS. In WWS, the concentration of pollutant could be as a result of accumulation of metal in soil and uptake by the plant. Among various plant organs, leaves by their structures and position on plants are the main beneficiary of pollutants. Also, the ability of each plant species to absorb and adsorb pollutants through the leaves differs depending on their intrinsic biological characteristics (Singh and Verma, 2007). The heavy metal sensitive species act as indicators of pollution while tolerant ones help in remediating pollution (Lakshmi et al., 2009). According to Dedeke and Akomolafe (2014), plant species that are able to survive and grow well in polluted soils are good candidates for phytoremediation. From this study, *Hyptis suaveolens*, *Sida acuta* and *Vernonia ambigua* are better described as heavy metals tolerant plants which could be good candidates for remediation as a result of their natural massive growth in these polluted soils.

CONCLUSION

The study revealed the level of Zn is the highest in plants and soils of these polluted sites in Lafia, Nigeria. The heavy metal concentrations in both plants and soils at the polluted and control sites range from Zn > Pb > Cu. There were variations in the levels of the heavy metals from the different sampling locations. Phytoremediation should be encouraged to prevent the effects of waste related problems in the environment. Furthermore, these automobile workshops soil should be cemented with construction of proper drainage for waste oils.

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