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INVESTIGATION OF HEAVY METAL STATUS IN NEEM TREE (Azadiractha Indica) BARKS EXISTING ALONG SOME SELECTED MAJOR ROADS IN IBADAN, OYO STATE.

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ABSTRACT

This study investigated the heavy metals status in the barks of Azadiractha indica and soil samples collected from four selected major roads with control far away from major roads in Ibadan. Heavy metals in barks were determined after digestion using Atomic Absorption Spectrophotometer (AAS).Bark metal concentration (mg/kg) from the sites ranged from: Pb (3.00 - 66.50), Cd (0.50 - 37.00), Cu (1.50 - 8.00), Zn (6.40 - 810.50), Fe (61.00 - 906.00). The heavy metal level in control sample was far lower than those found at other sites suggesting environmental contamination within the study locations. Pb was found to be higher than FAO/WHO maximum limits in all sampled site except in the control site, Cd and Cu was found below limit in all sites, Zn was found below limit in all sites except in site E and Fe was found above FAO/WHO maximum limit in all sites except in site A and D.

Keywords: Azadirachta indica, heavy metal, Maximum limits, Contamination.

1. INTRODUCTION

The impact of humans as well as natural factors on the environment has become glaring for all to see, this is clearly evident from the cases of environmental degradation, atmospheric and water pollution which abound in literature. Heavy metals contribute significantly to environmental pollution as a result of anthropogenic activities such as mining, energy and fuel production, industrial effluent, dumping and military operation, thus,increasing anthropogenic activities contribute to the emission of various pollutants into the environment and different types of hazardous substances are consequently released into the atmosphere (Onder *et al*., 2006; Kho *et al*., 2007; Oklo & Asemave, 2012). Road side soil pollution has been attributed to vehicular emission and traffic congestion, most heavy metals are released as a result fuel burning, tyres wearing, oils leakage and battery corrosion (Akan *et al*, 2013). The current levels of exposure to excessive emissions of heavy metals in form of particulates and elemental deposition (Wong *et al* 2003) from the atmosphere particularly in urban areas are sufficient to cause health effects, which constitute major environmental issues in many countries (Dockery 2009; Kampa&Castanas 2008).Particulate matter in form of dusts containing heavy metals such as lead, vanadium and manganese from vehicle exhaust is inherently toxic (Ipeaiyeda and Dawodu, 2014). Exposure to lead and cadmium especially has been identified as the main threats to human health from heavy metal (Jarup, 2003), while research from other studies showed heavy metals can be harmful to roadside plants, animals, and human settlements situated closer to a roads (Akbar *et al*., 2006).

The presence of trees in urban settlements can improve the quality of air through respiration and the uptake of gases and particles thus, the urban trees are important to man and the environments, and can be damaged when exposed to trace elements (Beckett et al., 2000).The use of tree barks in particular, as a biomonitor for environmental pollution may be necessary to accumulate data on long term contamination (Ipeaiyeda and Dawodu, 2014), however, where the tree is of medicinal importance the issue of food quality and security needs to be considered as Lawal *et al*., (2011) opined that the widespread and growing use of medicinal plants has created public health challenges in terms of quality, safety and effectiveness.

Various plants have been used as bio-indicators to access the impact of a pollution source on the vicinity which is due to high metal accumulation of plants (Onder and Dursun, 2006)

Neem Tree (*Azadirachta indica*) is tropical evergreen tree native to tropical South East Asia, Africa and other southeast countries. It is a fast growing tree that can survive drought and poor soil conditions and is considered an annual plant and can grow to more than 30 meters high. Neem tree is a known medicinal plant (Heinrich, 2005), and in Nigeria where it is also known as Dongoyaro (Oklo & Asemave, 2013), Neem extracts have been widely used for decades to treat many health problems (Sofowora, 1982). Pure Neem leaves and barks are used locally in producing natural medicines and herbal cosmetics and have been used in the treatments of skin diseases, such as chickenpox (Sofowora, 1982). Thus, Neem constitutes a vital role in human health due to its bark and leaves which are medicinal to people who believe in herbs, however, metals accumulation in Neem trees poses a direct threat to human health.

The suitability of Neem tree as a bio-indicator has been demonstrated in different studies (Lawal *et al*, 2011; Oklo and Asemave, 2013; Ojekunle*et al*., 2015), this study aims to investigate the levels of Pb, Cr, Zn, Cu and Fe in Neem tree *(Azadirachta indica)* barks grown along Ibadan metropolitan in comparison to the WHO/FAO standards for heavy metals in medicinal plants as well as the levels in the soils around the trees.

2. MATERIALS AND METHODS

2.1 Sample Collection

Neem barks from Federal College of Forestry, Jericho (Site A) which is considered remote from environmental contamination, Alalubosa-Aleshinloye Road (Site B), Best way- Iwo-Road (Site C), Queen Elizabeth road, U.C.H (Site D), and Benjamin- Eleyele Road (Site E) were collected and labelled appropriately in different envelopes, the samples were collected in September 2014, and identified at the Forestry Research Institute of Nigeria. Soil samples were also taken at 0-20cm depth randomly from all sampled sites, labelled and stored appropriately.

2.2 Sample Preparation

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The Neem barks samples were washed with deionised water to remove dust particles and then oven dried at 105^{o}C (Majolagbe *et al.*, 2010) after which the dried samples were pulverised using mortar and pestle and stored in polythene nylon in readiness for digestion and heavy metal analysis.

The soil samples were sieved using a 2mm mesh size sieve, air dried for one week in preparation for acid digestion and heavy metal analysis. Soil pH was done using potentiometric method in aqueous suspension using a double glass-calomel electrode.

2.3 Heavy Metal Analysis

5g of grinded bark were ashed in a muffle furnace at 450 ^{o}C, and subsequently dissolved with 5ml of 2M HNO_3on cooling, and the filterate made up to 100ml mark with distilled water. The digest were analysed for Copper (Cu), Cadmium (Cd), Lead (Pb), Zinc (Zn), and Iron (Fe) using Flame Atomic Absorption Spectrometer Buck Scientific 210 model.

Soil samples were digested using the EPA 3050B method involving a sequential addition of nitric acid, hydrogen peroxide and hydrochloric acid. The sample digest obtained was filtered into 100ml volumetric flask and made up to mark (USEPA, 1996), the sample extracts analysed for Cu, Cd, Pb, Zn and Fe.

2.4 Data Analysis

Data collected were compared with the critical level/permissible levels adopted by WHO/FAO standard, correlation analysis was done using Microsoft excel 2007 to investigate possible relationships between heavy metals in the soil and bark.

3. RESULTS AND DISCUSSION

3.1 Results of Heavy Metals in Soil

Table 1 presents the results of thepH of the soilas well as the soil heavy metal concentration. The pH of the soil from all the sites ranges from 4.60 - 7.75 indicating an acidic to neutral soil. The concentration of heavy metals in the soil from the sampled sites is as follows: Pb (17.50 - 466.25 mg/kg), Cd (0.50 - 32.50 mg/kg), Cu (7.00 - 62.50 mg/kg), Zn (188.00 - 260.50 mg/kg), Fe (190.00 - 11664.75 mg/kg). The background concentration of heavy metal analysed for in the control site were within the WHO permissible limit for soil heavy metal thus, no observable contamination. This however, is in sharp contrast with the levels observed in the other sites which show mild contamination with cadmium, copper and zinc in sites B, C and D, also there is a high level of lead contamination in site E while all the sites are heavily contaminated with iron exceeding the permissible limit in the soil. This high level of contamination observed in this location may be attributed to the high level of vehicular presence, industrial as well as commercial activities. This is in agreement with earlier studies by Bankole *et al.*, (2014) where high level of heavy metals was reported within the said location.

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Table 1. Soil pH and Heavy Metal Concentration

Soil Parameters	Site A	Site B	Site C	Site D	Site E	FAO/WHO Limit*
pH	7.45	6.05	7.75	6.90	4.60	------
Pb (mg/kg)	17.50	27.50	67.75	19.25	466.25	100
Cd (mg/kg)	2.00	0.50	32.50	5.50	1.50	3
Cu (mg/kg)	10.50	62.50	29.50	7.00	7.25	100
Zn (mg/kg)	245.25	189.00	260.50	224.50	188.00	300
Fe (mg/kg)	190.00	9204.25	11664.75	8101.50	6914.75	5000

*(FAO/WHO, 2007)

Heavy metal levels recorded in the soil samples from the sampled site shows varying degree which may be related to the levels of industrial or vehicular activities within the sampled areas, the trend of heavy metals observed in the sites follows the patternCd<Cu<Pb<Fe<Zn for site A, Cd<Pb<Cu<Zn<Fe for site B, Cu<Cd<Pb<Zn<Fe for site C, Cd<Cu<Pb<Zn<Fe for site D and Cd<Cu<Zn<Pb<Fe. This indicates a similar pattern of heavy metal presence in the soil in all the sites particularly the presence of large amount of zinc and iron with the latter exceeding the WHO permissible limit for iron in the soil. A similar study which shows the predominant presence of iron in road side dust albeit, without exceeding permissible limit, was also reported by Akan *et al.* (2013). The higher concentration of corresponding heavy metals in all the sites as against the control may indicate antropogenic source.Disposal of sewage water and industrial waste at any agricultural land elevate the level of heavy metals like Fe, Pb, Cd, Cu and Zn in receiving soils (Singh *et al.*, 2004) which may also adversely affect food quality, quantity and environmental safety (Mapanda, 2005; Singh *et al.*, 2010).

3.2 Results of Heavy Metals in Neem Bark

The heavy metal concentration in the Neem tree bark is presented in Table 2. The concentration of heavy metals accumulated in the barks ranges from 3.00 - 66.50 mg/kg for Pb, 0.5 - 37.00 mg/kg for Cd, 1.50 - 8.00 mg/kg for Cu, 6.40 - 810.50 mg/kg for Zn and 61.00 - 906.00 mg/kg for Fe.

Table 2. Heavy Metal Accumulation by Neem Barks at the Five Sites

Sites	Pb (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Fe (mg/kg)

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Site A	3.00	26.00	1.50	28.00	61.00
Site B	16.10	0.50	6.00	21.00	906.00
Site C	43.00	5.00	7.50	6.40	877.50
Site D	39.00	37.00	7.50	45.50	119.20
Site E	66.50	5.00	8.00	810.50	440.50
FAO/WHO*	3.00	100	73.00	100.00	425.00

*(FAO/WHO, 2007)

Comparison of the accumulated heavy metals with the FAO/WHO permissible limit for heavy metals in plants and vegetables shows that metal accumulation within the control site for all metals analysed was in the safe region, while lead accumulation was above the limit in all the sites. This is comparable to the findings of Akan *et al* (2013) where lead accumulation into the Neem barks exceeded the WHO/FAO limits for medicinal plant.Lead can cause Kidney damage, disruption of biosynthesis of haemoglobin and mental retardation in children (Majolagbe *et al.*, 2010), a case of lead poisoning due to mining activity was reported in Zamfara, Nigeria in 2010 where the major casualties are children (WHO, 2011), underlining the danger of environmental release of heavy metals. The accumulation of cadmium and copper in Neem barks from all the sites was within the safe limit for consumption. Large quantities of iron were accumulated in the barks from all of the sampled sites where the limit is exceeded in site B, C and E. This may indicate a common source of contamination when compared with the iron concentration in the soil around the sampled site. Zinc was also found to exceed the permissible limit in site E.

The trend of heavy metal accumulation in the Neem bark at Site A follows: Cu<Pb<Cd<Zn<Fe, Site B:Cd<Cu<Pb<Zn<Fe, Site C: Cd<Zn<Cu<Pb<Fe, Site D: Cu<Cd<Pb<Zn<Fe, Site E: Cd<Cu<Pb<Fe<Zn. This trend is slightly similar to that observed in the soil, and from this result also, it was observed that all the Neem barks from all the sites accumulated more of iron and lesser amounts of copper and cadmium, this is in agreement with the findings of Oklo and Asemave (2013) who observed a higher level of iron and lead uptake and a moderate to low amount of copper and zinc in all the different tree barks they analysed including *Azadirachta indica* though, the trend of metal uptake shows that more of zinc uptake by the Neem barks was observed in all samples in this study as against the moderate level reported by Oklo and Asemave (2013).The concentrations of all the metals in the barks of *Azadirachta indica* from the four sample points were found to be higher than the control site. This may be as a result of high traffic density, industrial and commercial activities which is a common along major roads in Ibadan.

3.3 Results of Correlation Analysis

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Table 3 shows the result of the correlation analysis between the heavy metal concentration in the soil from the sampled sites and the Neem barks from same sites.

Table 3.Correlation of Soil Metal Concentration and Neem Bark Metal Concentration

Sites	Correlation Coefficients
Site A	0.6679
Site B	0.9999
Site C	0.9988
Site D	0.9406
Site E	0.2832

This result indicate a slight positive correlation to perfect correlation in all of the site indication a common source of environmental pollution with heavy metal except in site E with poor positive correlation, this may suggest contamination from different sources within that site.

4. CONCLUSION

The results reported here confirm that the Neem (*Azadirachta indica*) bark obtained from the sampled sites from major road in Ibadan metropolis contained substantial amount of heavy metals, the result of this study also suggest that both soil and Neem barks may serve as an indicator of heavy metal pollution, however the accumulation of some heavy metal of importance especially lead into the bark of Neem, an important medicinal plant beyond the safe limit calls for serious concern especially in situations where these barks are collected for medicinal purposes without recourse to location. The levels of the heavy metals observed in Neem tree bark and soil sampled in all locations could be attributed to vehicle emission, anthropogenic and possible industrial activities thus, safety considerations should be made first before collecting these barks for medicinal purpose.

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