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Plant Leaves as Bio-Indicator for Lead (Pb) Pollution Along Road Sides and Industrial Areas in Ibadan Metropolis

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Abstract

Heavy metal pollution still poses a serious threat to human and the environment especially in urban settlement where industrial and vehicular activities are most prevalent. This study was carried out to investigate the level of heavy metal pollution in two local government areas in Ibadan metropolis using the leaves of plants as bio-indicators. Composite samples of *Tridax procumbens* (Tridax plant), *Chromolaena odorata* (Siam weed), *Pennisetum purpureum* (Elephant grass), were collected from different sites in industrial areas, along roadsides in these local government areas and control site during dry season and were digested according to standard procedures. The lead concentration in the digested samples were determined using Atomic Absorption Spectrophotometer. Result of the analysis shows a significant level of lead in the leaf samples. Leaves of *Tridax procumbens* were found to be the most tolerant specie and therefore the most suitable bioindicator for lead pollution among the three plant species selected.

Keywords: Lead; Bioindicator; Roadside plants; Tolerant specie.

1. Introduction

A variety of anthropogenic activities have been considered to be responsible for heavy metal pollution in the urban environment .The most important sources of anthropogenic heavy metals emissions are industrial production, the combustion of fossil fuels in vehicular traffic and energy production, sewage sludge disposal and fertilizer production [1, 2]. A higher level of lead in roadside environment have been associated with the traffic density [3]. Copper, cadmium and zinc also have been reported to correlate with vehicular traffic [4, 5]. Vehicular emissions along the busy roadways contain high levels of lead which are present in fuel as anti - knock agents [6, 7]. Along with lead, other heavy metals such as cadmium, copper and zinc are associated with the vehicular activity; since they are included in petrol, engines, tyres, lubricant oils and galvanized parts of the vehicles [8].

Plants have been used intensively as bio monitors and bio indicators of environmental pollutants in urban, rural and in remote areas [9, 10]. There are many reports on the interaction of heavy metals and plants on roadside [7, 11]. Some plants accumulate heavy metals to concentration that is non – toxic to them or may be toxic to other species [12]. Zhang, *et al.* [13], reported that higher plants growing along the busy roadways act as sink and effectively decrease the heavy metal concentrations in the atmosphere. Higher plants are also used as bio indicators and bio monitors of heavy metal pollution in the environment [11].

Leaves are the site of major physiological processes and are highly affected by air pollutants [14]. Plant leaves respond to subtle changes in the environment and therefore constitutes an excellent material to assess pollution levels. These changes are extensively used for monitoring pollution levels [15]. In the past few decades, leaves of higher plants have been used for biomonitoring heavy metals [16].

Several studies have reported the use of plants as bio indicators for heavy metals in the environment with major focus on higher plants as environmental pollution markers. In this study, common plants that grow as weeds along roadsides will be considered for two reasons; They are plants that quickly grow and thus they are exposed only for a very specific period of time to bioavailable pollutants. Secondly, they are easily found around the site investigated more easily than other higher plants.

Three common plants have been chosen for this study; *Tridax procumbens* (Tridax plant), *Chromolaena odorata* (Siam weed), *Pennisetum purpureum* (Elephant grass). *Tridax procumbens* is a common grass,*Chromolaena odorata* is a perennial herbaceous plant, and *Pennisetumpurpureum*, a perennial grass. These plants served as forage for grazing animals [17] and are also used locally for medicinal purpose [18-20].This study is aimed at investigating the capacity of each of these plants to accumulate lead; which has been widely reported as a very toxic heavy metals [21-23] and to find the most tolerant specie among them which can serve as reliable vegetal indicators to monitor environmental pollution by heavy metals. The result obtained were also compared with WHO permissible limits for forage and medicinal plants.

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2. Experimental

2.1. Study Sites

Ibadan is a big city being the capital of the old Oyo state, with high population density, industrial activities and highly traffic pattern in Southwest of Nigeria. It has a land mass of 27,46000square kilometers and a population of 5,591589 as at 2006 census.Samples were collected from two local governments in Ibadan, which are Ido local government and Egbeda local government areas.

2.2. Sample Collection and Preparation

The samples were collected during the dry season at different locations in the two local government areas of the city. Thirty composite samples were collected within the range of1-5meters away from the road sides of both industrial and high traffic areas and from the control site and carried with pre cleaned polythene bags. Samples were washed with distill water and air dried and later oven dried for 1 hour at 70^{0}C, and ground to fine powder for further analysis.

Table-1. Classification of plants species used for the study

Classification	***Pennisetum purpureum***	***Tridax procumbens***	***Chromolaena odorata***
Domain	Eukaryota	Eukaryota	Eukaryota
Kingdom	Plantae	Plantae	Plantae
Phylum	Spermatophyta	Spermatophyta	Spermatophyta
Subphylum	Angiospermae	Angiospermae	Angiospermae
Class	Monocotyledonae	Dicotyledonae	Dicotyledonae
Order	Cyperales	Asterales	Asterales
Family	Poaceae	Asteraceae	Asteraceae
Genus	Pennisetum	Tridax	Chromolaena
Species	*PennisetumTridax*	*Chromolaena*	
purpureum	*procumbens*	*odorata*	

2.3. Sample Digestion and Analysis

2g of each dried samples were weighed into digestion tubes. One tablet of selenium catalyst was placed inside the tube using 10mls of concentrated per chloric acid and 10 mLs of concentrated nitric acid (ratio 1:1). The tubes were placed inside a digestion block and slowly digested. The digest was filtered with filter paper, placed in sampling bottles and made up to 50mls with distilled water. Digested samples were analyze using the Atomic Absorption Spectrophotometer (AAS 220).

3. Results

Table-2. Mean concentration of lead (μg/g dry wt.) in each specie of plant at sampling points with traffic density

Serial	**SAMPLE**	***Tridax***	***Chromolaena***	***Pennisetum***	**Mean Traffic**
Number	**SITES**	***procumbensodorata***	***purpureum*density(v/hr)**		
1	ITA	1.60±0.42	0.00 ±0.76	0.00 ±0.04	587
2	ITA	2.00 ±0.44	0.00 ±0.02	0.00 ±0.72	566
3	ITA	2.60 ±1.80	0.00 ±0.10	0.00 ±0.38	725
4	ITA	0.00 ±0.46	1.80 ±1.20	0.00 ±0.02	1140
5	ITA	1.00 ±0.80	0.00 ±0.34	0.40 ±0.26	667
6	HTA	0.00 ±0.24	0.09 ±0.12	0.00 ±1.18	450
7	HTA	0.00 ±0.24	0.60 ±0.60	0.00 ±0.00	569
8	HTA	0.00 ±0.28	0.00 ±0.46	0.00 ±0.16	640
9	HTA	0.01 ±0.20	0.80 ±0.70	0.60 ±0.20	1250
10	HTA	0.01 ±0.00	0.00 ±0.04	0.00 ±0.18	400
11	CONTROL	0.00 ±0.02	0.00 ±0.05	0.00 ±0.04	Negligibe
Keys					
ITA	Industrial and high traffic areas				
HTA	High traffic areas				

Table-3. Comparison of the range of mean concentration of lead (µg/g dry wt.) at different sampling sites with WHO standard

SAMPLE	***TridaxChromolaena***	***pennisetum***	
SITES	*procumbens*	*odorata*	*purpureum*
HITA	ND-2.6	ND-1.80	
HTA	ND-0.01	ND-0.08	
CONTROL	ND	ND	
WHO	10.00	1.00	2.00
KEYS			
ITA	Industrial area		
HTA	High traffic area		
ND	Not detected		
WHO	World Health Organization		

Fig-1. Mean concentration of lead in ITA and HTA. TP (*Tridax procumbens*), *CO (Chromolaena odorata) and PP (Pennisetum purpureum)*

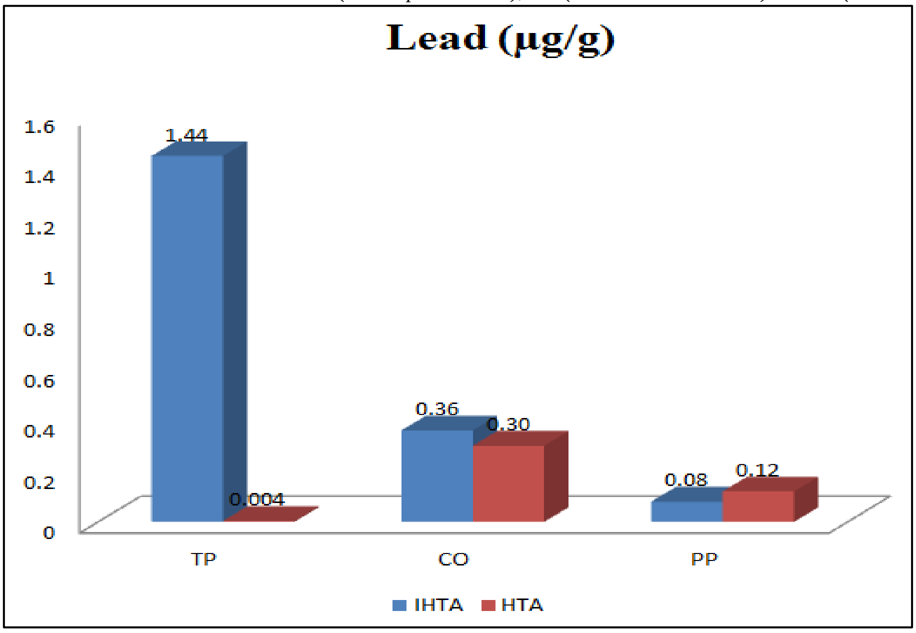

Table-4. Average mean concentration of lead (µg/g dry wt.) in each specie

PLANT SPECIES	**CONCENTRATION**
TRIDAX PROCUMBENS	0.72
CHROMOLAENA ODORATA	0.33
PENNISETUM PURPUREUM	0.01

4. Discussion

Table 2, Shows the distribution of sampling sites into industrial and high traffic density areas (ITA)and hightraffic density (HTA) areas only. The sampling points 1-5 (ITA) are areas with industrial activities and vehicular activities while sampling point 6-10 (HTA) are areas with only vehicular activities and no industrial activity. From the result in Table 2, it was observed that vehicular activities contribute little to the emission of lead in that environment. This could be due to the use of non-leaded petrol, since the use of non-leaded petrol the pollution of lead through the exhaust of vehicles has reduced. And from the table it shows that areas with industrial activities have higher concentration of lead. Table 3 shows the range of concentration of lead in the three species of plant used for the research work while fig.1 compares the mean concentration of lead in ITA and HTA. The concentration of lead in Tridax plants in ITA ranges from 0.00-2.6 µg/g dry wt. While in HTA it ranges from 0.00-0.01µg/g dry wt. Also for Siam weed the mean concentration of lead in ITA ranges from 0.00-1.80 µg/g dry wt. while for HTA it is 0.00- 0.80µg/g dry wt. Elephant grass however shows a different trend with higher concentration observed in HTA than ITA. Lead was not detected in any of the species of plant in the control area. The result obtained from all the sites for both medicinal and grazing plants are still within the permissible limits according to WHO standard [24, 25].The chart in figure 1 shows the differences in the mean concentration of lead in industrial areas (ITA) and high traffic areas in each species of the plant used. *Tridax procumbens* has high concentration in industrial areas (ITA) with maximum value of 1.44 µg/g compared to the concentration in high traffic areas (HTA) only with value of 0.004 µg/g. Table 4 shows the average mean concentration of lead in the three species of plant which are (*Chromolaena odorata*, *Pennisetum purpureum and Ttridax procumbens*).*Tridax procumbens* was observed to be the most tolerant specie having the highest capacity to accumulate lead which could be due to Its morphological characteristics and its ability to survive longer on the field than the others.

5. Conclusion

Industrial and vehicular activities are major sources of lead pollution in the areas under investigation. The concentrations of lead observed in all the samples analyzed were within WHO permissible limits for forage and medicinal plants, but may cause damage to grazing animals and human through the food chain and for medicinal application if limits are exceeded. The study have also revealed that leaves of some common plants also have the ability to accumulate lead and can actually be used as bio indicator for heavy metals pollution in the environment. Finally, *Tridax procumbens* is the most tolerant of the three species of plant investigated.

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