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# Heavy Metal Concentration in Leaves of Roadside Trees in Umuahia Urban, Nigeria

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**Abstract** The study assessed lead and nickel levels in leaves of roadside trees in Umuahia urban. Leaves were collected during the dry season from five dominant trees, *(Anarcadium occidentale, Azidirachta indica, Citrus sinesis, Magnifera indica* and *Psidium guajara)* along a high traffic route (SS1) and a low traffic route (SS2). Mean concentration of Pb at SS1 and SS2 was 12.09mg/kg and 0.05mg/kg respectively. Mean Ni values at SS1 and SS2 were 2.26mg/kg and 0.09mg/kg respectively. Significant differences were observed for Pb and Ni concentrations of roadside leaves between the two locations. This suggests that traffic volume may influence the levels of Pb and Ni and possibly other automobile derived heavy metals and pollutants. With increasing urbanization, the concentrations of these metals might increase and possibly create health hazards. The study further emphases the important roles vegetation can play in monitoring and mitigating air pollution.

**Keywords** Heavy Metals, Roadside Trees, Vehicle Traffic, Air Pollution, Bio-indicator

## 1. Introduction

The urban atmosphere is subjected to large inputs of contaminants the composition of which reflects the contribution of different sources[1]. These sources are mainly anthropogenic and include asphalt, weathered street materials, biomass combustion, industries and automobiles [2]. The contribution of urban atmospheric contaminants by automobiles appears to be more significant particularly in developing countries[3, 4]. Heavy metals such as Cu, Ni and Cr are basic components of automobile engines, transmission systems and brakes while Pb is contained in engine oil and fuel[5]. In most developing countries including Nigeria, vehicle emissions standards, even if they exist are not adequately enforced and in addition, the use of leaded fuel continues to persist.

Pollution of the urban atmosphere by contaminants arising from automobiles and other sources is considered a real and serious problem[6]. This is because these contaminants have various effects including acceleration of the deterioration of materials, reduction in visibility and interference with human comfort and health[7, 8], as well as physiological damage in plants[9, 10]. Plants are immobile and their leaves are in constant exchange of gases with the atmosphere through transpiration. Their leaves particularly, and the other parts trap and accumulate atmospheric contaminants[10]. This is why they are considered good candidates for bioindicating and monitoring of air pollution[11, 12]. Several studies have indicated the higher concentrations of heavy metals in leaves and tissues of roadside vegetation[5, 16, 18 and 20]. In this study, leaves of roadside trees in Umuahia, South East Nigeria were assessed for their heavy metal (lead and nickel) concentration. So far, heavy metal levels in roadside plants have not been assessed in the study area. If this is done, it will provide a means of identifying spatial contrasts and the effects of vehicular traffic volume on heavy metal content of roadside plants. The study also provides a mechanism for biomonitoring air pollution.

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## 2. Materials and Methods

The study area is Umuahia. It is the administrative capital of Abia State, South-Eastern Nigeria. Umuahia is a rapidly expanding urban area with a population of about 359,230 persons[13]. Rapid growth and development in the study area is associated with increasing human and vehicle population, road congestion and possibly air pollution. The estimated vehicle traffic volume for ST1 and ST2 during the study period was 480 vehicles per hour and 32 vehicles per hour respectively. The climate is humid-tropical and the vegetation is of tropical forest type[14, 15].

### 2.1. Sampling Procedure

Dominant tree species name *Anacardium, occidentale, Azidirachta indica, Citrus sinensis, Magnifera indica* and *Psidium guajava* were selected for screening from Bende

road (SS1) a high traffic street located in the city and a low traffic road in Ohia (SS2) at the out skirts of the city. Six mature leaves were collected from the side of each tree facing the road. Samples were collected in late November, 2012 during the dry season to avoid rain washing out the heavy metals. Heavy metal load of plant leaves is known to correlate more with surface levels than with that of the soil[10]. In practical terms, sampling of leaves is the simplest and least harmful to plants and leaves are the plant parts most sensitive to pollution[5].

Heavy metals analyzed were Pb and Ni. These metals are products of automobile combustion and use. They are therefore likely to have higher accumulation along roadside environments[16, 5]. The metals have also been assessed in different studies including[18, 16, and 19].

### 2.2. Sample Analysis

Plant digestion and analysis was done using the method described by[17]. Plant samples were air dried at $80^0$c in an oven for 24 hours after washing with distilled water. Dried samples were pulverized in a hammer mill to pass through a 0.4 mm screen. 1g of the pulverized materials was placed in a 50m kjedahl flask to which 25ml of concentrated $HNO_3$ (Nitric acid) was added. The dried plant materials were thoroughly wetted after swirling, before adding 4ml of per chloric acid and 2ml of concentrated $H_2SO_4$.

The mixture was warmed gently on a digestion rack until white fumes appeared. After it was heated strongly for one minute, the digest was allowed to cool. 40ml of distilled water was added and after boiling for another minute and filtered into a volumetric flask, that was made up to the mark with distilled water. The concentrations of the heavy metals of interest were estimated by Atomic Absorption Spectrometer (AAS) using Spectra AA 220 FS.

## 3. Results and Discussions

The results of analysis of Pb and Ni concentration of the various trees at SS1 and SS2 are presented on Table 1.

The results of the laboratory analysis of Pb and Ni concentration in road side leaves are shown on Table 1. At SS1, Pb concentration in leaves ranged from 0.01mg/kg in *Citrus sinensis* to 24mg/kg in *Anacardium occidentale* with a mean of 12.90mg/kg. At SS2 Pb concentration was 0.01mg/kg in all the plants. Ni concentration at SS1 ranged from 0.50mg/kg in *Magnifera indica* to 4.15mg/kg in *Psidium guajara* with a mean of 2.26mg/kg while at SS2 Ni concentration in leaves ranged from 0.01mg/kg in other trees to 0.40mg/kg in *Magnifera indica* with a mean of 0.09mg/kg.

Statistical analysis using t-test showed a significant difference in the concentrations of Pb at the high traffic route SS1 and low traffic route SS2 at $p<0.05$ where mean Pb concentrations at SS1 = 12.90 and SS2 = 0.01 at $p<0.05$. Significant difference was also found in Ni concentrations at both locations at $p < 0.05$ where mean ST1 = 2.26mg/kg and mean ST2 = 0.009mg/kg.

As expected, Pb and Ni concentration of leaves of the road side trees studied were significantly lower at the low traffic route SS2. Similar trends have been reported by other researchers such as[16, 20 and 19]. These studies generally showed decreasing concentration of heavy metals with increasing distance from highways or high traffic routes. The higher concentration of Pb and Ni in plant leaves at ST can be most likely attributed to higher volume of traffic on this route. Pb concentration in *Azidiractha indica* was however higher than what was obtained by[16 and 20] but lower than the results in[5] for composite values for different plants. A similar trend was also obtained for Ni[5]. Automobiles are major contributors of heavy metals pollution in urban areas[21, 22 and 4]. Roadside pollution levels may also be influenced by other factors including roadway width, vehicle type and condition and vehicle speed[23, 24].

Plant related factors can also introduce variations in leaf concentration of Pb and Ni in the various plants. Such factors may include low exposure to and low uptake of metals[5]; plant resistance[25] and differences in leaf curticle[26, 27]. *Anarcadium occidentale* which accumulated the highest amount of Pb and *Psidium guajava* with the highest Ni concentration have been reported to have good potentials for bio-monitoring of urban air pollution[28].

Urban vegetation also plays other crucial environmental roles including serving as air pollutant sinks and reducing heat island effect[6, 29, and 28] and improves urban design by adding aesthetic value[30]. Trees and other vegetation types will therefore contribute to the mitigation of global warming as well as reduce discomfort. Increase in vehicle ownership in the study area as is the case presently, will only continue to increase road congestion and vehicle related air pollution. This will have adverse health impacts[31].

**Table 1.** Pb and Ni concentration in selected roadside trees at SS1 and SS2

| S/N | SAMPLES | Pb(mg/kg) | | Ni (mg/kg) | |
|---|---|---|---|---|---|
| | | SS1 | SS2 | SS1 | SS2 |
| 1 | *Azidirachta indica* | 16.50 | 0.01 | 2.60 | 0.01 |
| 2 | *Anarcadium. occidentale* | 24.50 | 0.01 | 2.40 | 0.01 |
| 3 | *Psidium. guajava* | 20.00 | 0.01 | 4.15 | 0.01 |
| 4 | *Magnifera.indica* | 3.50 | 0.01 | 0.50 | 0.04 |
| 5 | *Citrus. sinensis* | 0.01 | 0.01 | 1.65 | 0.01 |
| | | R= 0.01 - 24.50 | R= 0.01 – 0.01 | R=0.50 – 4.15 | R=:0.01 – 0.04 |
| | | M=12.90 | M=0.01 | M=2.26 | M=0.09 |

R= range; M= mean

# 4. Conclusions

Heavy metal (Pb and Ni) concentration was shown to be high on road side leaves of some trees in a high traffic route in Umuahia urban. Higher concentrations were observed in the urban route in comparison to a low traffic route at the outskirts of the city. The study indicates that traffic volume may influence heavy metal concentration in leaves of road side plants. This may have adverse health implications for urban residents, road users and vegetation. The findings of this study confirms results of other similar studies.

Roadside vegetation can be used to biomonitor traffic related air pollution in the study area. If the air pollution tolerance of trees in the study area is determined it will help in selecting appropriate plant species for biomonitoring, urban heat island reduction and mitigation of air pollution. To reduce and manage traffic related air pollution in the study area, private automobile use and vehicle traffic volume needs to be decreased. This can be achieved by encouraging the use of sustainable transport systems especially, mass transit.

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