IMPACT OF VEHICULAR EMISSION ON LEVEL OF LEAD IN SOIL AND PLANTS ALONG HIGHWAYS IN LAGOS STATE

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Abstract: This study was designed to evaluate the levels of lead and the spatial distribution of the pollution caused by automobile exhaust emission associated with volume of traffic density in Lagos Metropolis. Lead concentration in soil and leafy plant samples was determined using Atomic Absorption Spectrophotometer. The mean lead concentration in soil samples obtained from high traffic area, medium traffic area and low traffic area ranged from 0.124 to 0.188 mg/g, 0.177 to 0.487 mg/g and 0.058 to 0.158 mg/g, respectively. There is a marked discrepancy in the capacity of the three soil depth profiles to retain lead and hence a steady depth wise decrease in the concentration of lead across the depth profile from topmost soil samples (0-10 cm) to innermost soil samples (20 - 30 cm). Lead concentration in the leave samples varied greatly from sampling points but ranged from 0.003 to 1.09 mg/g. Lead concentration in the dry leaves were higher than in fresh leaves. The concentration of lead in the leafy plant samples from the outskirt of Lagos city were lower compared to those from other sampling point indicating that vehicular emission was the main source of lead pollution.

Keywords: Concentration, contamination, lead, leaves, soil, traffic

Introduction

Lagos State is rapidly developing, and this has served as one of the lucrative states in Nigeria that has kept on attracting people both outside and within for greener pasture. This trend brings about population explosion leading to high numbers of automobiles owns by the populace which plight the various roads of the city there by creating a dense traffic culminating with Industrial and other anthropogenic activities, have make the emissions of lead, nitrite oxide, nitrous oxide, carbon monoxide, particulate matters and other gases which are liable to cause sickness to organisms in the environment. However, this research work tends to addresses lead pollution on soil and plant leaves that occurs around area of Lagos Metropolis, taking Lagos State University (LASU)/Inyanaba/Lasu Isheri and Environs as a case study considering the prevalence of high volume of traffic especially at the early morning hours and evening hours when people are accessing work places and likewise when returning back to their residences.

This research work is in agreement with the findings of some research works already done in other places which postulated that heavy metal contamination is a major problem of the environment especially of growing medium sized cities in developing countries primarily due to uncontrolled pollution levels driven by causative factors like industrial growth and heavy increase in traffic using petroleum fuels. Heavy metal contamination may also occur due to factors including irrigation with contaminated water, the addition of fertilizers and metal based pesticides, industrial emissions, transportation, harvesting process and storage (Radwan and Salama, 2006; Tuzen and Soylak, 2007; Duran *et al.*, 2007). Although, many researchers have studied Pb accumulation in soils and plants along the roadsides (Rodriguez *et al.*, 1982; Bingol *et al.*, 2010; Osma *et al.*, 2013; Pivic *et al.*, 2013).

Study reveals that the amount of Pb decreases as moving away from the road in the samples taken from the surface soils near the roadsides with heavy traffic, therefore the pollution may be sourced mainly from the motor vehicles (Haktanir *et al.*, 1995; Jaradatand 1999; Sisman *et al.*, 2002; Viard *et al.*, 2004; Kluge and Wessolek, 2012; Bilge and Cimrin, 2013). In a similar study made in Nigde, it was determined that zones of the first 20 m from roads are considerably risky areas in particular, in terms of Pb (Manzak, 2006). In a study performed in Galway city of Ireland, high levels of Pb accumulation had been detected in the roadsides with heavy traffic (Zhang, 2006).

Previous studies have also shown that pollutants are more likely to be captured by the plant canopy and eventually accumulated in or on the leaves. This is known as bioaccumulation which is been influence by the exposure time and the effects of climatic factors which are regarded as prime importance in the process respectively. As such, many plant species are useful for bio monitoring atmospheric deposition of pollutants. In the case of heavy metal containing aerosols, the elements are mainly accumulated on the leaf surface as reported (Shafaqat *et al.*, 2013).

In this study, it was aimed to determine the possible Pb concentration and spatial distribution of the lead(Pb) pollution caused by the motor vehicles due to volume of traffic density in relation to high, medium, and low traffic areas located in road sides of Lagos State University (LASU) and environs at the Ojo Local Government Area Council of Lagos State of Nigeria.

Materials and Methods

Study area

Ojo local government was carved out of the then Badagry local government on May 1989. The Latitude of the area falls in between 5 degree 30 min. and Longitude of 3 degree 00 min.

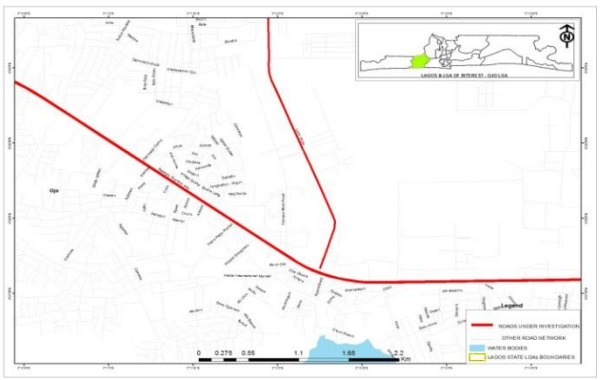

Fig. 1: Ojo Local Government, Lagos State showing sample area

Sample collection and preparation

Soil samples were collected in triplicate with the help of soil auger at soil profiles; 0-10 cm, 10 -20 cm and 20 – 30 cm, respectively from high, medium and low traffic areas, as well as from the outskirt of the city, Lagos State, Nigeria. The soil samples were air-dried, sieved through a 2 mm sieve, and poured into an opaque polyethylene bag which were labeled L1, L2, M1, M2, N1, N2 (High-Traffic-Area) constituted of six(6) different spots representing Inyanaba North and South in order of preference, Q1, Q2, R1, R2, S1, S2 (Moderate-Traffic Area) also of six(6) different spots representing Lasu Isheri North and South while, T1, T2, U1, U2,V1, V2 (Lower-Traffic Area) of six(6) different spots representing Campus Main Road North and South except the control area G, H, I (Outskirt of the Lagos city) representing Eleduwa which were from different three spots and kept in the laboratory for analysis.

Fresh and dry leaves of *Amaranthus hybridus* were also collected from the sampling sites at the peak period of high, medium, and low area of traffic two to three times and were air dried prior to analysis.

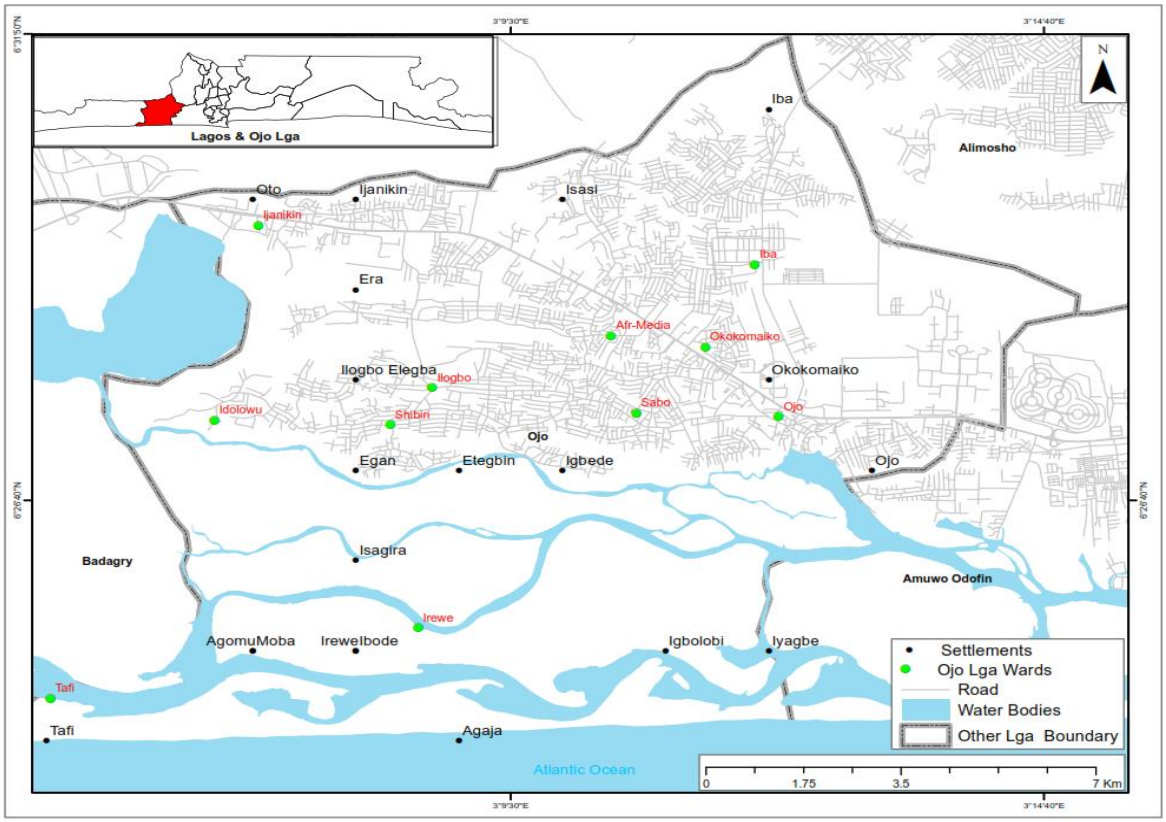

Fig. 2: Ojo Local Governments, Lagos State showing sample area

Analysis of metal in soil sample

Soil samples were air dried and sieved using a 2 mm sieve. 5 g of the sieved soil sample was weighed and poured into a 100 ml conical flask and 20 ml of concentrated nitric acid was added, swirl and allow to stand until visible reaction stooped. The conical flask was covered with a watch glass and then placed on a heater at a temperature of 120^0C for 30 min in a fume chamber. The content of the conical flask was allowed to cool, filtered through the ash less filter paper placed in a funnel with 50 ml standard flask rinsed with deionizer water. Lead concentration was then measured using atomic absorption spectrophotometer.

Analysis of metal in plant leaves

5 g of the cleaned wet leaves which was plugged from the high traffic area was placed in a 100 ml conical flask using HNO_3:H_2SO_4:$HClO_4$ and also Tri-acid digestion of dried plant sample was performed using HNO_3: H_2SO_4: $HClO_4$ (10:1:4 v/v). The supernatant liquid was then filtered and the filtrate was made up to the 50 ml with distilled water in a standard volumetric flask. Lead concentration was then measured using atomic absorption spectrophotometer.

Statistical analysis

Results are presented as mean and three replicate measurements were performed (n = 3).

Results and Discussion

The result of analysis of lead in soil samples obtained from high traffic areas were as presented in Table 1. Lead concentration for sample L1 ranged from 0.140 – 0.222 mg/g across the depth profile. The result obtained for sample M1 and M2 across the depth levels 0-10, 10-20 and 20-30 cm were 0.146, 0.124 and 0.101 mg/g as well as 0.214, 0.182 and 0.110 mg/g of Pb, respectively. The mean lead concentration of sampling sites LI, M1 and N1 were 0.188, 0.124 and 0.169 mg/g, respectively.

The results of analysis of lead in soil samples from moderately traffic area in Lagos state is as presented in Table 2. A range of lead concentration of 0.075, 0.152 and 0.303 mg/g were obtained for the surface, middle and inner soil profiles for sample Q1 representing Lasu Isheri North, respectively. Lead concentrations for samples R1 and S1 ranged from 0.176 – 0.666 mg/g and 0.286 – 0.633 mg/g, respectively across the depth profiles.

Table 1: Lead concentration in soil samples in high traffic area (mg/g)

Sample	Depth (cm)	Lead concentration (mg/g)	Mean lead concentration (mg/g)
L1	0–10	0.222	
	10 –20	0.201	0. 188
	20 -30	0.140	
M1	0–10	0.146	
	10 -20	0.124	0.124
	20 -30	0.101	
N1	0 -10	0.214	
	10 -20	0.182	0.169
	20 -30	0.110	

Table 2: Lead concentrations in soil samples in moderate traffic area (mg/g)

Sample	Depth (cm)	Lead concentration (mg/g)	Mean lead concentration (mg/g)
Q1	0-10	0.303	0.177
	10 -20	0. 152	
	20 -30	0. 075	
R1	0-10	0.666	0.405
	10 -20	0. 373	
	20 -30	0.176	
S1	0 -10	0.633	0.487
	10 -20	0.541	
	20 -30	0.286	

Table 2, revealed that sample Q1 recorded the minimum mean value of 0.177 whereas sample S1representing moderate traffic areas (Lasu Isheri South) has the maximum mean value of 0.487 lead concentration. Samples of soil from the outskirt of the town otherwise known as low traffic area which serves as the control were also analyzed and results were presented in Table 3.

Table 3: Lead concentrations in soil samples in low traffic area (mg/g)

Sample	Depth (cm)	Lead concentration (mg/g)	Mean lead concentration (mg/g)
T1	0–10	0. 101	0.058
	10 -20	0. 058	
	20 -30	0.015	
U1	0–-10	0. 100	0.071
	10 -20	0.052	
	20 -30	0.062	
V1	0 -10	0.280	0.158
	10 -20	0.134	
	20 -30	0.061	

Concentration of lead in sample T1 referring to Lower traffic area (Campus main road) varied slightly from 0.015 – 0.101 mg/g across the depth profile with a mean of 0.058 mg/g. 0.10, 0.052 and 0.062 mg/g were recorded across 0-10 cm, 10-20 cm and 20-30 cm depth profile for sample U1(Campus main road) respectively. Minimum and maximum lead concentrations of 0.061 and 0.280 mg/g were obtained at depth profile of 20-30 cm and 0-10 cm for sample V1(Lower traffic area), respectively. Mean concentrations of 0.071 and 0.158 were obtained for samples U1(Campus main road North) and V1(Campus main road South) respectively. Interestingly a general depth wise decrease in the concentration of lead was observed across the depth profile from the topmost soil samples to the innermost. This could possibly be because

The result of the analysis of both wet, dry leaves and soil samples obtained in study areas indicated that particulate lead emitted from automobile settles or adsorbed first on the topmost soil which is then leached into the soil down the aquafer by rainfall subsequently in the rain season, while at the absence of rainfall it tends to stay for longer period of time however the content of the lead can easily be blown by wind again..

The concentration of lead in wet and dry plant leaves found growing in the sampling sites were determined and presented in Table 4.

Table 4: Lead concentration in leaf samples (mg/g)

Sample	Dry Leaves	Fresh Leaves (mg/g)	Mean lead concentration (mg/g)
		High Traffic Area	
L1	1.503	0.389	0.946
M1	0.987	0.234	0.611
N1	2.029	0.142	1.09
		Moderate Traffic Area	
Q	1.139	0.256	0.698
R	1.014	0.322	0.668
S	0.891	0.701	0.796
		Low Traffic Area	
T	1.013	0.142	0.576
U	0.128	0.999	0.564
V	1.049	0.089	0.569
		Outskirt of the City (Control)	
G	0.102	0.222	0.162
H	0.001	0.004	0.003
I	0.007	0.003	0.005

The lead concentrations obtained from analysis of dry and wet leaves samples grown on sampling site L1 were 1.503 and 0.389 mg/g, respectively. 0.987 and 0.234 mg/g of lead were detected in dry and wet leaves of plants grown in sampling location M1 respectively. These values of lead in both dry and wet plant leaves of sampling location L1 and M1 were however, greater than those obtained from plant leaves grown from soils at the outskirt of the city (G, H and I) representing Eleduwa South, North and Southwest respectively which served as the control. Lead concentration (2.029 mg/g) in dry leaves obtained from sampling location N1 in high traffic area appeared to be greater than those obtained for dry and wet leaves from sampling location L1 and M1 as well as those of the control samples G, H and I.

Lead was also detected in both dry and wet leave samples from moderate traffic areas (QRS) representing Lasu Isheri on the map. For dry leaves, a minimum (0.891 mg/g) and maximum (1.139 mg/g) lead concentrations were recorded for S and Q, respectively. Nevertheless, minimum lead concentration of 0.256 mg/g and a maximum value of 0.701 mg/g were obtained for wet leaves from samples Q and S. It is interesting to note that the level of lead tends to be greater in dry leaves than in wet leaves. This could be because dry leave has rough and more surface area available for adsorption of particulate substances including dust and lead emitted from exhaust of automobiles than wet waxy leaves. This invariably implies that the degree of surface coverage for adsorption on dry leaves tends to be higher. It was observed also that the values of lead in the plant samples from moderately traffic areas appeared to be lower than values obtained in leaves samples for heavy traffic area and conversely greater than those obtained from leave samples from low traffic area indicating greater contribution of lead by particulate emission from exhausts of automobile than anthropogenic source of pollution.

Lead concentrations in plant leaves from low traffic areas (TUV) referring to the Campus main road on the map follow similar trend with those of moderate traffic area. Result of analysis of dry plant leaves from low traffic areas revealed a maximum and minimum lead concentration of 1.049 and 0.128 mg/g, respectively. Lead concentration was higher in sample U (0.999 mg/g) and lowest in sample V (0.089 mg/g) for wet leaves, respectively. The range of mean values (0.564 – 0.576 mg/g) of lead obtained from plant leaves in low traffic area were higher than the mean lead concentration (0.003 - 0.162 mg/g) obtained for the control samples (outskirts) but on the other hand lower than 0.668- 0.796 and 0.611 – 1.090 mg/g obtained from moderate traffic and high traffic areas respectively. It is worthy to note that lead concentration of wet plant leaves from samples at the outskirt of the city which serves as control for this research tends to be higher when compared with the corresponding lead concentration from the dry plant leaves. This revealed that lead in plant leaves was mainly of anthropogenic source.

Conclusion

The result of analysis of lead in soil and plant samples revealed that concentration of lead was higher on plant leaves and soil samples in the high traffic routes of Lagos State University (LASU)/Inyanaba/Lasu Isheri of Lagos Metropolis while the plant leaves and soil samples from the outskirt recorded the least lead concentration.

The study indicates a steady depth wise decrease in the lead concentration across the depth profile from 0-10 cm (top soil sample) to 20 – 30 cm (inner soil sample). This implies that traffic volume influences the lead concentration in both soil and plant leaves.

Competing Interests

Author has declared that no competing interests exist.

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