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Determination of the Levels of some Heavy Metals in Urban Run-Off Sediments in Ilorin and Lagos, Nigeria

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ABSTRACT: The concentrations of zinc, cadmium, lead and iron in run-off water sediments on paved roads in Ilorin and Lagos areas of Nigeria were determined using Atomic Absorption Spectrophotometric technique. Zinc, iron and cadmium were found in very high concentrations in the Urban sediment from these cities whilst for most of the locations, lead was found to be below the detection level. Iron has the highest mean concentration while lead had the lowest level. A significant correlation was obtained between iron and zinc in Lagos (r =0.8820) and in Ilorin (r = 0.9937) at 95% probability level. These results suggest a probable common source for iron and zinc. The average concentrations of iron and lead were higher in Lagos than in Ilorin.@ *JASEM*

Heavy metals are omnipresent in the environment, occurring in varying concentrations in air, bedrock, soil water and all biological matter. Lead, cadmium, vanadium and arsenic, which occur sometimes either naturally in crude oil or as additives during processing could eventually be released into the atmosphere during the combustion of petroleum products. Others such as iron, nickel, chromium, antimony and zinc, which are important additives in the manufacture of components of motor vehicle parts, are also emitted as a result of wear and tear. The heavy metals in urban road sediments take their origin from sources such as vehicles, road wear, activities of roadside artisans (battery charging, vehicle repairs, iron-bending, vehicle painting and panel beating) and emissions and /or discharges from industries. The metals come mainly from vehicular activities such as tyre wear (Zn, Pb, Cr, and Ni) and wear of break linings (Ni, Cr, and Pb) Muschack, 1990), wear of studded tyres (Fe,Ni, Mo, Cr, Co, Cd, Ti and Cu), corrosion of bushings, brake wires and radiators (Cu, Fe, Ni, Cr and Co), and the various types of de-icing chemicals and friction materials used on road surfaces for slipperiness control especially in temperate countries (Viklander, 1998).

These elements eventually settle down on soil surfaces. In fact it has been shown that considerable amounts of toxic metals arising from human activities are accumulated in soil (Agirtas et al, 1999). With rains, they are percolated into the soil and are eventually translocated into plants and into man through consumption of these plants (Ogunsola et al, 1993). They thus enter the food chain as a result of their uptake by edible plants (Kilicel, 1999). Toxic heavy metals can also be taken directly by man and other animals through inhalation of dusty soil.

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It has been know since ancient times that the symptoms of metal toxicity are usually non-specific and retrospective rather than early or prospective. Alterations in vital signs become manifested only after the intoxication process has advanced to the stage where the homeostatic mechanism can no longer maintain the body functions within the accepted normal range (Nriagu, 1988).

The present study was therefore undertaken in order to evaluate the heavy metal content in the street sediments of Lagos and Ilorin. This should give an indication of the extent of pollution of the environment by these heavy metals and the eventual potential health implications. There is currently little information in this area. Lagos has Ikeja as the capital, and it is also the economic capital of Nigeria. Ilorin is an ancient and medium-sized town located in the middle-belt of Nigeria.

The heavy metals (zinc, cadmium lead and iron) investigated are in the list of metals considered important by the Global Environment Monitoring system (GEMS) of the United Nations Environment programme (UNESCO/WHO/UNEP, 1992).

MATERIALS AND METHODS

Sampling: Collection of samples was conducted between May and October , 2000 in both Lagos and Ilorin cities. The sediment sampling points in are as shown in figure 1 for Ilorin which is on a latitude of 08 26 N and longitude of 04 29 E. in Ilorin in the year 2000 it rained for nine of the twelve calendar mouths and within the sampling period an average of 148.33mm of rain was recorded in Il0rin. Four sampling points were chosen at Ilorin with the University of Ilorin as control.

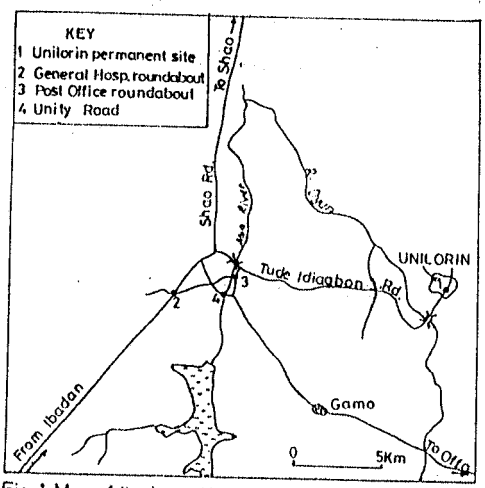

Fig. 1 Map of Ilorin and its environs showing sample locations (1 - 4). Source: Author's Fieldwork 1999.

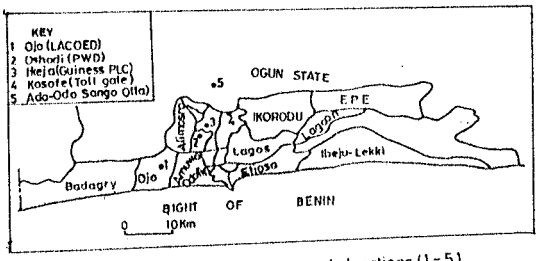

Fig 2 Map of Lagos state showing sample locations (1 - 5)
Source: Author's Fieldwork 1999.

Five sampling points were selected in Lagos as shown in figure2. samples were taken the next day of the rain. Sampling locations were chosen based on both human and vehicular traffic load coupled with human activities in the area. The rainfall pattern for Ikeja was used for comparison with that from Ilorin. Ikeja is on latitude 06° 35' N and longitude 03° 20'E and it was noticed from metreological data collected from Oshodi that it rained through out the twelve calendar years of the sampling period in Lagos

Five sediment samples were randomly collected at each sampling site depending on the total area of the road covered. These samples were then mixed together for each location to form composite samples. The sediments were collected in polythene bags and dried in laboratory for two weeks to prevent loss of volatile materials while removing moisture. The sediment samples were sieved and fractions with particle diameter less than 2mm were retained for subsequent treatment/analysis.

Analysis: one gram (1.0g) of the sieved sediment samples were digested in a mixture of percloric acid, nitric acid and sulphuric acid following standard procedures. (IITA, 1979) Filteration of the resulting solution was carried out in order to remove insoluble materials. The filerate was then made up to mark in a 100ml volumetric flask, with doubly – distilled water.

The metals (Zn, Cd, Pb and Fe) were analysed using Sp-9 Pye Unicam atomic absorption spectrophomter coupled with pm 8253 single-pen recorder. The concentrations were read off from a calibration curve prepared with a set of standard solutions.

All analyses, digestion and spectrophotometric measurements, were carried out in quadruplicate.

RESULTS AND DISCUSSION

The mean concentrations of the heavy metals obtained in the sediment samples collected at selected points in Ilorin and Lagos are summarized in Tables 1 and 2 respectively. All the heavy metals investigated exhibited relatively high levels in both cities. In Ilorin, iron had the highest mean concentration ranging from 1144mg/kg at the University of Ilorin main campus to 2427mg/kg at the General Hospital Roundabout. Zinc level was also high, ranging from 53.00mg/kg at the University of Ilorin site to 171.00mg/kg at the General Hospital Roundabout. Cadmium was detected at the locations in except at the University of Ilorin campus where the cadmium level was below detection limit. The highest cadmium concentration occurred at the Unity Road sampling location. These results could be attributed to the relatively long distance of the University from the center of the city. Other areas located within the heart of the city had considerably high level of zinc and cadmium. The lead level was generally below the detection limit at all locations with exception of the Unity Road where it was 12.00mg/kg.

Table 1: Mean concentrations (mg/kg) of Zn, Cd, Pb, Fe in road sediments in Ilorin

Sampling points	Zn	Cd	Pb	Fe
A	54.00 ±6.00	<0.01	< 0.01	1144.00± 25.00
B	171.00±7.00	43.00± 1.00	< 0.01	2427.00± 85.00
C	119.00±9.00	32.00± 0.00	<0.01	1818.00± 59.00
D	53.00± 3.00	50.00± 1.00	12.00± 1.00	960.00± 15.00

A = University of Ilorin Permanent Site
B = General Hospital Roundabout
C = Post Office Roundabout
D = Unity Road

All sampling locations in Lagos also indicated high levels of heavy metals in the road sediments. Iron had the highest mean concentration among all the heavy metals and its value ranged from 729mg/kg at PWD, Oshodi to 3957. 00 mg/kg on Oba Akran Avenue, Ikeja. Lead was detected in only two locations in Lagos; 78.00mg/kg at PWD, Oshodi and 122.00mg/kg at Ado-Odo Sango Otta. It is interesting to note that the cadmium levels in Ilorin sediments were generally within the same range as those in Lagos sediments. This could be due to higher rainfall density in Lagos a coastal town, which probably caused a regular washing of the roads since the vehicular activities are so obviously much more in Lagos than Ilorin at a glance.

In areas where lead was detected in Lagos, the mean concentration was relatively higher than that obtained in Ilorin. The higher traffic density and industrial activity in Lagos could account for this. A comparison of the average concentration of each of the two metals in the two cities using the test of differences in mean at 95% probably level shows that there is significant difference in the average level of lead and iron between the two cities. The average concentration of each of the two metals was higher in Lagos than in Ilorin. In the US, reuse of sediment is regulated (USEPA, 1974). The USEPA maximum permissible levels of lead zinc are 50mg/kg and 75mg/kg respectively: those of cadmium and iron are not available. It is therefore evident that the USEPA level for lead was exceeded in two locations in Lagos while that of zinc was exceeded in two locations in Ilorin.

The analytical results gathered in Tables 1 and 2 were subjected to linear regression analysis in order to find possible associations between the various metal pairs. Pearsons' correlation coefficients obtained from the statistical computation for heavy metal concentrations in both Ilorin and Lagos are given in Table 3. The linear regression data were obtained by calculating the person's correction coefficient, r, with the aid of SPSS statistical package (Horsfall et al, 1999). A significant correlation was obtained between iron and Zinc in Ilorin (r = 0.8820) and in Lagos (r =0.9937) at 95% probability level.

Table 2: Mean concentrations (mg/kg) of Zn, Cd, Pb, Fe in road sediments in Lagos

Sampling points	Zn	Cd	Pb	Fe
A	18.00 ±1.00	42.00±2.00	< 0.01	914.00± 12.00
B	32.00±2.00	26.00± 1.00	78.00±4.00	727.00± 11.00
C	72.00±2.00	< 0.01	<0.01	3957.00± 28.00
D	11.00± 3.00	<0. 01	<0.01	1139.00± 13.00
E	38.00±3.00	36.00±1.00	112.00±1.00	1059.00±12.00

A = Lagos State College of Education (LACOED) Campus, Ijanlkin
B = Public Works Department (PWD), Oshodi
C = Oba Akran Avenue , Ikeja
D = Lagos – Ibandan Expressway (Kosofe Toll Gate)
E = Ado-Odo, Sango Otta

Table 3: Person's correlation coefficient, r for the possible pairs of heavy metals in roads sediments in Ilorin and Lagos

Metal Pairs	Lagos	Ilorin
Cd/Fe	-0.6235	0.2727
Cd/Pb	0.4976	0.5654
Cd/Zn	-0.3635	0.3784
Fe/Pb	-0.4193	-0.6237
Fe/Zn	0.8820	0.9937
Pb/Zn	0.0285	-0.53361

These results suggest a probable common source of iron and zinc, in the two cities. The use of leaded petrol, tyre wear and emission from vehicular and roadside artisans' activities may account for some of these metals present in the sediments. This result presented is a part of a comprehensive study, which at a later time will consider the characteristics, and the effects of the sediments on the environment.

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