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Trace metals in airborne Harmattan Dust in Ahmadu Bello University Zaria, Nigeria

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ABSTRACT

The levels of Pb, Fe, Cd, Ni, Mn and Cr were determined in dust samples collected weekly for sixteen weeks from December 2009-April 2010, from a commercial area (Community market) and a residential area (Akenzua postgraduate hostel) in Ahmadu Bello University Zaria, in order to determine its pollution status with regards to air. Flame AAS technique used for the analysis indicated the order of relative abundance to be Fe>Pb>Ni>Cd>Mn>Cr for commercial area; Fe>Pb>Ni>Mn>Cd>Cr in residential area. Analysis of variance with t-test showed that there was no significant difference between metal concentrations within the study area. The deposition rates for the residential area showed a mean of 1.76g/m^2 and the commercial area showed a mean of 2.46g/m^2. Analysis with t-test showed no significant difference between deposition rates for commercial and residential area. The enrichment factor analysis showed anthropogenic activities as a major source of these metals in the dust.

Keywords: Harmattan dust, trace metals, deposition rates, Enrichment factor, campus atmosphere

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INTRODUCTION

Particulate Matter (PM) is the sum of all solid and liquid particles suspended in air which may contain dust, pollen, soot, smoke and liquid droplets [1]. The components and quantity of street dusts are environmental pollution indication in big cities [2] as a source of outdoor air pollutants [3]. Knowledge of the composition of atmospheric dusts is pertinent to understanding its impact on human health [4]. The urban environment is composed of varying concentrations of trace elements from a vast array of anthropogenic sources [5] as well as from natural geochemical processes [6]. Street dusts can be grouped into: elements geochemically associated in nature,which are related to re-suspension of soil particles and their main sources are building, construction, renovation and weathering of building materials. Elements of anthropogenic origin are from petrol and diesel operated generating machines, coal combustion and domestic heating systems [7].

Most trace elements especially the heavy metals remain in the soil nearly indefinitely. These metals remain bound to organic matter unless they are remobilized mechanically as wind-blown dusts [8]. Human exposure to metals and their compounds in the environment are through food, drinks and water. Other forms of uptake are via skin contact. However, over a period of time, adverse toxic effects may occur as a result of long-term low level exposure [9].

The major risks to human health include not only premature mortality from acute pollution episodes, but also aggravation of existing respiratory and cardiovascular disease, damage to lung tissue, impaired breathing and respiratory symptoms, and alterations to the body physical and immune systems defenses against inhaled particles. Populations at general risk include children, people of all ages with asthma and elderly persons with illnesses such as bronchitis, emphysema, and pneumonia. Particulate matter causes health effects by deposition in the lungs where it interferes with the respiratory process. The health risk from an inhaled dose of PM appears to depend on the size, composition and concentration of the PM [10;11].

A battery of scientific studies has linked PM with health problems, including premature death, respiratory-related diseases, the exacerbation of asthma, acute respiratory symptoms [10].This study reportsthe dust deposition rates and some heavy metalsin dust collected fromresidential and commercial areas of Ahmadu Bello University Zaria.

MATERIALS AND METHODS

2.1 Sample collection

Dust sampling was carried out according to methods described by Changling*et al.,* [12] with modifications. It consisted of the use of a bowl of 30cm height and 25cm diameter filled with double distilled water to within 10cm of the top and was placed 6m above ground level on top of building roof. To prevent birds from drinking the water and polluting the sample, a similar bowl was placed on the same roof filled to the top with tap water. Here the birds find it easier to drink since they can stand on the tip of the bowl. They therefore avoid the collecting bowl.The water level was maintained daily and sampling was conducted weekly for the Harmattan seasons of 2009 and 2010. Samples collected were subjected to the determination of the deposition rates and heavy metals (Pb, Fe, Cd, Cr, Ni andMn) concentrations.

2.2 Analyses

The water samples from the bowls were evaporated in large glass beakers. In some samples contaminated with insects were removed by floatation procedures and decanted from the water filled beakers before analysis. Samples were dried at about 105^0C and the weights were recorded. 0.05g of the samples was digested with nitric acid and hydrogen peroxide as described by Csuros and Csuros [13], and subsequently analysedwith shimadzu AA-680 AAS using an air – acetylene flame. Each analysis run were carried out in duplicates.

RESULTS AND DISCUSSION

3.1 Dust deposition

The results of the mean dust deposition rates (Figure 1) indicated variations between the weeks of the Harmattan seasons of 2009 and 2010 in Ahmadu Bello University (ABU) environ. Figure 1 showed the dust deposition rates at residential (RS) and commercial (CM) areas within the campus for 16 weeks of study. Generally, there was a higher CM-dust deposition rate than those of RS-dusts in all the Harmattan weeks studied except for a few weeks (weeks 3, 12 and 14). However week 12 and 16 presented the highest mean deposition rates of 5.455g/m^2 and 4.965g/m^2 for RS and CM respectively. On the whole, a total and average deposition rate of 28.165g/m^2 and 1.76g/m^2 were recorded at RS and 39.37 and 2.461g/m^2 at CM areas respectively. The higher deposition rates of CM to RS may be due to vehicular movements, human movements trampling the ground, road side kitchens, open air waste incineration and wood burning [14].

Statistical analysis with student t-test indicated no significant difference at $p \leq 0.05$ for the deposition rates over the period studied.

The results of the deposition rates were relatively lower than the results reported by Dimari*et al.*,[14] for 2006/2007 Harmattan season in Maiduguri with a mean of 26g/m^2. This may be due to the distance of the study area (ABU, Zaria) from the dust source region of the Sahara, the difference in sampling stations [14] and the effect of climate change [15;16] .

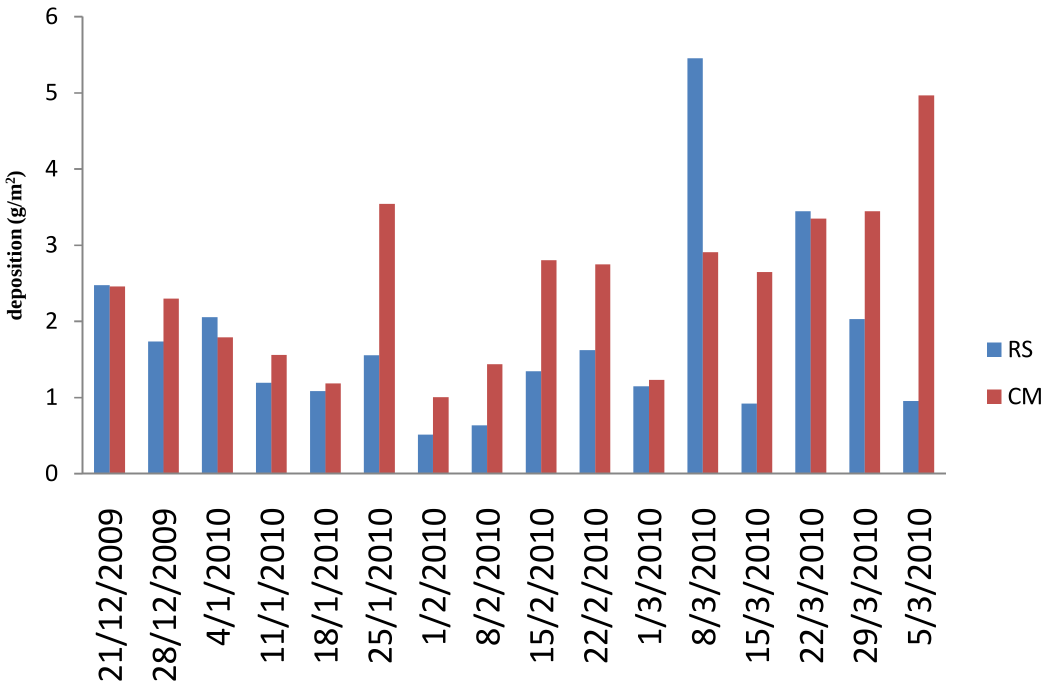

Fig 1: dust deposition rates at residential (RS) and commercial (CM) for the 16 weeks of study

Table 1: Trace metal levels of dust samples in ABU environ (µg/g)

Metals	range	mean	EF
PbCM	0.33-1.33	0.47±0.32	177.67
PbRS	17-0.83	0.45±0.30	170.77
FeCM	3.55-6.25	5.04±0.82	1
FeRS	2.58-6.25	4.54±1.04	1
CdCM	0.12-0.25	0.16±0.03	8675
CdRS	0.10-0.25	0.14±0.06	9492
NiCM	0.40-0.93	0.60±0.16	208.7
NiRS	0.27-0.67	0.57±0.14	175.53
MnCM	0.07-0.22	0.15±0.06	2.50
MnRS	0.13-0.25	0.19±0.03	1.73
CrCM	ND	ND	ND
CrRS	0.04-0.07	0.009±0.02	2.50

The levels of the metals in the dust samples as presented in Table 1 showed a general mean increases in heavy metal level of CM than RS with the exception of Mn which gave a contrary result. This may be as a result of the activities going on in the area or wind force and direction[17], also source and route of Harmattan dust movement contribute to the presence and levels of metals in the dust [18]. The levels of all elements determined were less than one except iron and lead, this may be as a result ofresuspensionof road dust and/or their extensive use in accumulators and car batteries, galvanization of iron, in alloys and also additives in petrol. The order of appreciation of metals in dust samples were similar to that reported by [19] in respect of Fe>Pb and similar order were obtained in the work of [20] in respect of Fe>Pb>Ni.

Enrichment factor (EF) is a better indication of environmental pollution than gross elemental concentration [19] this can be seen from Table 1. The EF was calculated using wedepohl's value [20]. The crustal type elements were less enriched while anthropogenic elements Pb, Cd, Ni were highly enriched,this supports the findings of [20]. Statistical analysis with t-test showed no significant variation ($P<0.05$) between levels of elements in dusts from RS and CM except for manganese.

Table 2: Pearson Correlation coefficient (r) between values of heavy metals in dust samples collected at residential (RS) and commercial (CM) area of Ahmadu Bello University Zaria

		Pb	Fe	Cd	Ni	Mn	Cr	
Heavy metal concentration in CM-dust	**Pb**	1	0.143	-0.203	-0.182	-0.081	0.340	Heavy metal concentrations in RS-dust
	Fe	-0.015	1	0.635	0.161	0.521	0.297	
	Cd	0.177	0.444	1	0.266	0.153	-0.048	
	Ni	0.353	-0.264	-0.213	1	0.295	-0.565	
	Mn	0.073	-0.344	-0.641	0.596	1	0.093	
	Cr	0	0	0	0	0	1	

Correlation coefficient values (r) of trace elements in the dust samples from the study area were presented in Table 2. Correlation coefficient of 0.5 was taken significant. Ni-Mn, Fe-Cd, Fe-Mn were strongly correlated. These observations points out a high likelihood of association of these metals from source composition and/or emission origin. However negative correlations were indicated in some elements.

CONCLUSION

This study showed the presence and level ofPb, Cd, Ni, Fe, Ni, Mn, Cr in Ahmadu Bello University dust. Enrichment factor analysis showed anthropogenic activities as major sources of these elements in the dust, this was noticed in Pb, Cd and Ni which showed a high enrichment factor, an indicative of the fact that they are anthropogenic in origin. This shows that Harmattan dust constitutes danger to human being and the environment as carriers of metals. The results from parameters studied showed that there was little or no difference in the dust from the two study area.

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