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Determination of Elemental Composition of Total Suspended Particles along Some Motor Ways in Sokoto, Nigeria

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ABSTRACT —— Heavy metals pollutant and total suspended particles in urban street dust has become a growing concern in recent years. In Nigeria, Street dust is one of the major way through which Heavy metals may find their way into soils and subsequently living tissues of plants and animals. In monitoring urban pollution, there is need to consider the materials that cause the occurrence of pollutants. Chemical and biological indicators are of interest when they provide information on the concentration of suspended particles and accumulation in the ecosystem. A range of metals and chemical compounds found in the suspended particles in the environment are harmful. Pollutants can attack specific sites or organs of the body and disease can develop as a consequence to such exposure. Using X – rays fluorescence spectroscopy, cationic concentrations of total suspended particles (Tsp) along some major high ways in Sokoto metropolis were analyzed. The results revealed a mean concentration of 365µgK/m3, 1446.6µgCa/m3, 440µgTi/m3, 52µgFe/m3, 44.3µgCu/m3, 440µgTi/m3, 430µgZn/m3, 74.0µgGa/m3, 16.3µgAs/m3, 18.0µgPb/m3, 79.0µgRb/m3, 5.75µgSr/m3, 64.0µTh/m3, 90.0µgY/m3, 42.6µgU/m3 and 10.5µgZr/m3.

KEYWORDS: Chemical Indicators, Environmental pollution, Suspended Particles, X-ray Fluorescent Spectroscopy

1. INTRODUCTION

Suspended particles in the atmosphere are comprised of either solid particles or fine liquid droplets, and included in this group are aerosols, smoke, fumes, dust, fly ash and pollen [1]. The bulk of this suspended particle emissions from human activity which have diameters of less than 100 – micros (millionths of a metre) are known as total suspended particles (TSP). In order to visualize how small macrons are, one micron is approximately the size of bacteria [**2**]. Particles that are less than 10microns and 2.5 microns are defined as inhalable particles (PM 10) and respirable particles (PM 2.5) respectively. The tinier the particles size, the further particles will penetrate into the lungs [3]. Generally, the exact make up varies with both place and season. These particles come from both natural and manmade sources, some of the natural sources comprises of windblown soil and mineral particles, volcanic ash, seas salt spray, and biological materials such as pollen, spores, bacteria and smoke from forest fires. The man made sources result in both coarse and fine particle.

Coarse form comes from windblown dust from agricultural soil, roads and construction sites, smaller forms are created by the combustion of fossil fuel, residential heating and other sources as well[4]. They can be released directly from a given source or form in the atmosphere through the transformation of gaseous emission. However, the concentration of TSP varies with place, season, meteorology and daily weather [5]. The TSP has a greatest effect on health, which comes from particles 10 microns, or less in diameter (PM 10). TSP in this range can irritate bronchitis, cause asthma and other respiratory diseases [6]. In some cases small particles have been connected to greater hospital admissions and premature death [7]. It causes asthma, cardiovascular or lung disease, in children and the elderly. This TSP also causes corrosion, soiling, damage to vegetation and visibility reduction [8]. This greatest effect

on health shows that TSP comprises of hazardous elements [9]. That is why chemist and doctors have revived their interest to analytically determine the elemental composition of the particles [10].

2. LITERATURE REVIEW

According to a research of suspended particulate matter in China conducted by Gerhard Lammel et al, 2006, Elemental concentrations in suspended particulate matter were determined simultaneously by filter-sampling and inductively coupled plasma mass spectrometry (ICP-MS) and ICP optical emission (ICP-OES) at a coastal, urban background site (Qingdao, Shandong, Eastern China) and an island site (Gosan, Jeju Island, Korea), in June 2003. At the coastal site, the concentrations of Cr, Co, Ni and As were in the range of 1-10 ng m-3, those of V, Cu, Zn and Pb in the range of ten to several hundreds of ng m-3. The level of Pb seems to have doubled, and those of Cu and Zn are increased by more than a factor of 3, since the mid 1990s. At the island site, the levels were 5-25 times lower than at the coastal site [11]. And also Karue J. et al,2003 in a paper, titled Measured components in total suspended particulate matter in a Kenyan urban area in which an analysis was conducted using gravimetric and energy dispersive X-ray fluorescence (EDXRF) of the suspended particulate matter in the air at the city centre, an industrial area and one residential. The total suspended particulate matter (TSP) mean levels ranged from 69.983 to 397.903 µg m−3 [12].

3. EXPERIMENT

3.1 MATERIALS

The samples used in this research work were collected from six different sites, the sites character and the sampling period was listed in Table 1.

3.2 CHEMICALS/REAGENTS

All the chemicals and reagents used in this study were of analytical grades, the glass wares used were cleansed, rinsed with distilled water and air dried.

Table1: Sample collection

Site	S/C	S/P
A-University Hostel	Sensitive site	6 Hrs
B-Illela Garage	Commercial site	6 Hrs
C-CBN Roundabout	Commercial Site	6 Hrs
D- Kalambaina Road	Residential Site	6 Hrs
E-Dandima Roundabout	Heavy traffic site	6 Hrs
F-FGC Roundabout	Sensitive site	6 Hrs

Key: S/C: Site Character, S/P: Sampling Period

3.3 SAMPLING PROCEDURE

Sampling was done with an Edward EB 3A vacuum pump/compressor. It was operated at an average flow rate of 7 L/min with 6 hr continuous samples obtained from each site. The samples were collected on 15.0, Whatman filter paper. All particles greater than two microns are retained by the filter paper. The filter paper is neatly folded into four (4) and sealed in polyethene bag which has been labeled.

4. RESULTS AND DISCUSSION

4.1 RESULT

The elements and concentration of the metals analyzed in micro gram/meter cubic (µg/m^3) was presented in Table **2.**

Table 2: Concentration of metals analyzed

Element	Concentration(µg/m^3)
K	365
Ca	14.6
Ti	440
Fe	520
Cu	44.0
Zn	430
Ga	74.0
Pb	18.0
Rb	79.0
Sr	5.75
Th	64.0
Y	90.0
U	42.6
Zr	10.5

4.2 Discussion

Using X-ray fluorescent spectroscopy, the Tsp along some motor ways in Sokoto town was found to contain about eighteen metals with potential environmental hazards which were listed in Table 3.

Table 3: Metals found in TSP Analyzed

Potassium	K	Iron	Fe
Calcium	Ca	Nickel	Ni
Titanium	Ti	Cupper	Cu
Vanadium	V	Zinc	Zn
Thorium	Th	Gallium	Ga
Yttrium	Y	Lead	Pb
Uranium	U	Rubidium	Rb
Zirconium	Zr	Strontium	Sr

In sample A (Jibril Aminu Hostel, UDUS) only Rb and Zr were detected with a little concentration of 32.0µg/m^3, 01.0µg/m^3, and 0.03µg/m^3 respectively. This low concentration shows that the environment can be regarded as un-polluted area.

Potassium is found in sample B, D, E, and F with a concentration of 920, 100, 300, and 140(ug/m^3) respectively. Indicating that sample B has the highest concentration and sample D has the lowest concentrations compared to the other samples. The higher concentration in sample B may be as a result of windblown dust from farms treated with potassium fertilizers.

Titanium is only found to be present in sample B (Illela Garage) with a concentration of 440µg/m^3, which is greatly higher when compared with the result found by Tabour and Warren in several American cities. The concentrations are 0.01µg/m^3 in 754 samples, 0.01-0.1µg/m^3 in 71.4% samples and 0.01-0.3µg/m^3 in 53% samples [13].

However, Vanadium was found with concentrations of 380μg/m³ in sample D and 10μg/m³ in sample E. The higher concentration in sample D may be due to higher traffic in the sample site and also due to cement industry. But the low concentration in sample E may be as a result of rainfall on the sampling day.

Iron was detected in only two sample sites i.e. sample C (CBN roundabout) with concentration of 98.0μg/m³ and in sample D (Kalambaina road) with concentrations of 6.0μg/m³. Higher concentrations in sample C may be from the automobile due to the high traffic in the site.

Nickel however, was found only in two samples i.e. sample C and E with a concentration of 18.0μg/m³ and 20.0μg/m³ respectively. These concentrations are nearly the same with the only difference of 2μg/m³. The higher concentration in samples may be from fuel combustion of the automobiles.

Concentrations of 68.0μg/m³, 7.0μg/m³, and 58.0μg/m³ of Cupper in sample B, D, and E were respectively detected, which shows that, sample B has highest concentration and sample D has the lowest. This implies that sample B site has higher wind blow dust more than sample D and F.

Zinc is found in sample C, D, and F with concentrations of 55.0μg/m³, 30.0μg/m³, and 44.0μg/m³ respectively. The concentration in sample C may be from both fuel combustion and waste incineration, while that of sample F may be from fuel and coal combustion only.

Lead is found in only three samples i.e. sample B, D, and F with concentrations of 39.0μg/m³, 11.0μg/m³, and 4.0μg/m³ respectively. The highest concentrations in sample B may be due to the presence of motor park and the fact that, the sample was taken during the rush hours of vehicles in the evening. The moderate concentration of 11μg/m³ in sample D may be due to low traffic of automobiles during the sample hours. However, lower concentrations in sample F of 4.0μg/m³ may be due to a little rainfall on the sampling day. Moreover, other metals like Rb, Sr, Th, Y, U and Zr, are found to be detected in different samples with different concentrations. Rb is found to be present in three samples i.e. sample A, B, and D with concentrations of 32.0μg/m³, 176μg/m³, and 31.0μg/m³ respectively.

Sr however, was found in four different samples with concentration of 0.3μg/m³, 8.0μg/m³, 8.0μg/m3, and 4.0μg/m³ in sample B, D, E, and F respectively. Again Th is found in only sample B and D with a concentration of 29.0μg/m³ and 99.0μg/m³ respectively. Sample D shows a greater difference from B. Y also has concentrations of 87.0μg/m³, 23.0μg/m³ and 18.0μg/m³ in sample B, C, and D respectively. The concentrations of 87.0μg/m³ from sample B which is higher than the concentration found in sample C and sample D may be from automobiles. Zr was detected in sample A and D with concentration of 1.0μg/m³ and 20.0μg/m³ respectively.

5. CONCLUSION

This work showed that the six samples analyzed in this research work contains trace amount of K, Ca, Ti, V, Fe, Ni, Cu, Zn, Ga, Pb, Rb, Sr, Th, Y, U, and Zr. The presence or absence of some elements in suspended particles along some motor ways in sokoto may be link to the industrial process and the transportation activities. Hence the concentrations of the elements analyzed in the samples understudy may reveal information on the environmental friendliness and quality of the air around the environment, and probably give an idea of the sources of these metals in the environment. It was obvious from this study that, the total suspended particles along motor ways in sokoto metropolitan analyzed have low metal contents especially in University's Hostel (Jibril Aminu Hostel). However, despite the low concentrations, they could still lead to serious health hazard considering their cumulative effects in the environment.

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