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Lead Characterization of Street Dust in Some Cities of South Eastern Nigeria

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Abstract: Concentrations of lead in street dust in selected cities of Aba, Abakaliki, Enugu and Onitsha were determined. The results showed the overall mean lead concentrations for five streets in each of the four Cities selected for the study; Aba (345.994±27.12 mg kg^{-1}), Abakaliki (162.154±16.24 mg kg^{-1}), Enugu (322.508±24.43 mg kg^{-1}) and Onitsha (291.978±34.34 mg kg^{-1}). The lead concentrations for each of these four Cities studies correlated positively with commercial, industrial and vehicle traffic emission in these cities.

Key words: Lead, street dust, cities, Southeastern Nigeria

INTRODUCTION

Lead is one of the heavy metals known to man since 2500 BC[1]. It is a natural constituent of the earth's crust minerals with average concentration of about 16 ppm. Pb^{2+} is the stable ionic species in most of the natural environment[2]. Lead enters the environment from natural sources of minerals particularly galena, anthropogenic sources are hundred folds greater[2]. These anthropogenic sources are mining, milling and smelting of lead and metals associated with lead such as zinc, copper, silver, arsenic and antimony. Other anthropogenic sources include; combustion of fossil fuels, municipal sewage, commercial products such as lead- acid storage batteries, paints, ceramics, dynes, glassware, gasoline additives of organic lead of tetraethyl lead and tetraethyl lead[2]. Metallic lead and the common minerals such as galena (PbS), Lanarkite (PbO), cerrusite ($PbCO_3$), anglesite ($PbSO_4$) have very low solubility. The lead concentrations in natural water is between 1-0.01 mg kg^{-1}[2,3]. In spite of complete elimination of organic lead additives in gasoline in 1996, the gasoline in use in Nigeria contains 0.66 g of lead per liter in form of tetraethyllead[2,4]. It has been estimated that Nigeria consumes annually four hundred million liters of gasoline. This means two thousand seven hundred and seventy metric tonnes of leaded gas emission annually[4].

Lead is readily bound by organic matters, which are rich in the surface of 2-5cm soils called dust[2,5]. These organic matter bound lead are easily available to plant and it is also bio-accumulated by both terrestrial and aquatic organisms[2,5].

Lead is not very mobile under normal environmental conditions. It is retained in the upper 2-5 cm soil (dust) especially soils with at least five percent organic matter or pH_5 or above. Leaching of lead is not important under normal conditions[2,5]. The accumulated lead in the soil may be retained for several hundred thousand years. This is because the half-life of lead ranges between 740-5900 years[6]. Lead poisoning effects are well documented in[1]. Short term exposure to lead at relatively low concentrations can cause interference with red- blood- chemistry, delays in normal physical and mental development in babies and young children, slight deficits in attention span, hearing and learning disabilities in children and slight increases in the blood pressure of some adults[2,7-11,18-20]. It appears that some of these effects particularly changes in the levels of certain blood enzymes and in aspects of children's neuro- behavioural development may occur at lead level so low as to be essential without reaching a threshold[2]. Long-term exposure (bio accumulative effect) to lead has been linked to cerebrovascular and kidney diseases in human. Lead has the potential to cause cancer from a life time exposure at above the action level of 0.015 mg kg^{-1}[2,10].

The four cities selected in the southeastern Nigeria include Aba, Abakaliki, Enugu and Onitsha. They represent two commercial centers in the southeastern Nigeria and two administrative capital cities. Cities all over the world suffer from environmental pollution due to undesirable levels of heavy metals like lead, air pollution and noise pollution[12,21]. Therefore to monitor city pollution, there is need to indicate material occurrence. Street dust (top soils 2-5 cm) contains heavy metals such as lead at level that makes for reliable analysis[13].

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Study samples can be obtained without disturbing the ecosystem. This makes large scale and repeated sampling possible[14]. This study therefore reports lead concentrations in five different street dust in each of the four selected cities in the southeastern Nigeria of Aba, Abakaliki, Enugu and Onitsha.

MATERIALS AND METHODS

Sample collection: Street dust samples were collected from five different streets at random in each of the four cities of Aba, Abakaliki, Enugu and Onitsha, respectively. A composite sample of each street dust random collected at four different points was stored in a labeled plastic bag until required for analysis[1,5].

Sample preparation: Each of the composite street dust samples was oven dried at 100-105°C until a constant weight was achieved. Each of the dried street dust samples was pass through 2 mm Nylon screen to obtain a fine dust powder. The fine dust powder of each street was stored in a labeled polyethene bag until required for analysis.

Sample analysis: One thousand milligram of each sieved street dust sample was digested in 250 mL flask in a fume chamber, using the following extractants: -25 mL of concentrated Nitric acid was added, followed by the addition of 4 mL of perchloric acid and then 2 mL of concentrated sulphuric acid. The solution mixture was heated until there was appearance of dense white fume. De-ionised water, 40 mL was added and heating continued for for 1 h[14]. The digested sample was allowed to cool, then flittered through an acid-washed whatman No. 40 filter paper into a labeled 100 mL flask. Each filtrate was then made up to 100 mL mark with de-ionized water. The concentration of lead in each digest was measured using atomic absorption spectro photometer[15,16]. A standard solution of lead was prepared using Nitric acid[11]. Standard solution of lead was matrix matched to each sample digest. Single lead hollow cathode lamp was used as line source in the AAS analysis. A dust sample was collected from untarred walkway and used as primary reference materials[5]. This primary reference material was prepared and digested in the same manner described for each of the street dust composite samples.

RESULTS AND DISCUSSION

The lead concentrations in each of the five street sample digest in the four cities of Aba, Abakaliki, Enugu and Onitsha are presented in Table 1-4, respectively with standard deviation values.

Table 1: Lead concentrations in street dust in aba in mg kg^{-1}

Street name	Mean (x) mg kg^{-1}
Ngwa road	414.29±5.83
Okigwe road	307.14±5.83
Faulks road	375.00±9.22
Aba- owerri road	265.50±7.46
Azikwe road	368.04±9.34
Over all mean	345.994±27.13

Values are means±standard deviation of four determinations

Table 2: Lead concentrations in street dust in abakaliki in mg kg^{-1}

Street name	Mean in mg kg^{-1},
Enugu-abakaliki road	175.00±4.13
Kpiri-Kpiri road	139.29±4.12
Ezza road	185.73±5.83
Presco road	112.50±3.57
G.R.A road	198.25±3.59
Over all mean (Y)	162.54±16.24

Values are means±standard deviation of four determinations.

Table 3: Lead concentrations in street dust in enugu in mg kg^{-1}

Street name	Mean in mg kg^{-1}
Achara layout	239.90±4.16
Old park road	321.43±5.84
Obiagu road	342.88±5.84
Zinks avenue road	385.73±5.84
Uwani road	323.20±3.60
Over all mean Y	322.508±24.43

Values are mean±standard deviation of four determinations.

Table 4: lead concentrations in street dust in onitsha in mg kg^{-1}

Street name	Mean in mg kg^{-1}
Mbanugo street	269.09±1.86
Anikwe street	217.40±0.79
Ziks avenue road	372.24±1.78
Ajasa street	231.44±0.05
Modebe street	370.81±1.81
Over all mean (Y)	291.978±34.34

Values are means±standard deviation of four determinations

The values of mean lead concentration of primary reference material±standard deviation of four determination is 57.138±0.11 mg kg^{-1}.

Table 1 shows that Ngwa road street dust sample analyzed contains the highest mean value of lead 414.29±5.83 mg kg^{-1}. This was followed by samples obtained from faulks road 375±9.22 mg kg^{-1}. The street dust samples from Aba- Owerri road gave the lowest lead concentrations 265.5±7.46 mg kg^{-1}. The trend in mean lead concentrations in the dust samples collected and analysed in five streets in Aba commercial city were Ngwa road > faulks road> Azukwe road > Okigwe road > Aba-Owerri road.

The over all mean value of lead concentrations in the five street dust samples in Aba is 345.994±27.13 mg kg^{-1}. This value is higher than lead concentrations in the primary reference material 57.138±0.01 mg kg^{-1}. Again this over all mean value in the five street dust samples in Aba is more than three fold higher than lead concentrations in the natural environment (16 mg kg^{-1}). This high values may be attributed to anthropogenic sources such as

vehicle traffic emission, industrial activities, foundry activities, municipal sewage such as lead-acid storage battery leakage among other sources.

From Table 2, the street dust sample collected and analysed from the G.R.A in Abakaliki gave the highest lead concentrations 198.25±3.59 mg kg^{-1}.

On the other hand, the street dust samples collected along presco road yielded the lowest concentrations of head 112.50±3.57 mg kg^{-1}. The trend in the concentrations of the lead in the five street dust samples collected and analyzed in Abakaliki were G.R.A road > Ezza road > Enugu-Abakaliki road > Kpiri-kpiri road > presco road.

The over all mean value lead concentration in the five street dust samples collected and analyzed is 162.54±16.24 mg kg^{-1}. These relatively lower mean values of lead concentrations when compared to those obtained at Aba may be due to the semi-rurual nature of Abakaliki city.

Table 3 shows that the street dust sample collected and assayed along Ziks avenue in Enugu gave the highest lead concentrations of 385.73±5.84 mg kg^{-1}. Whereas the street dust samples collected along Achara layout in Enugu yielded the least concentrations of lead 239.90±4.16 mg kg^{-1}. The trend in the lead concentrations in the five street dust samples in Enugu were ziks avenue > Obiagu road > Uwani road > old parkroad > Achara layout.

The over all mean value 322.508±24.43 mg kg^{-1} in the five strret dust samples in Enugu were lower than those obtained at Aba. This difference in over all mean value of lead concentrations between dust samples in Aba and Enugu may be attributed to less industrial activities and vehicle traffic emissions in Enugu than Aba.

Table 4 showed the lead concentrations in five strret dust samples collected and analyzed in commercial city Onitsha from Table 4, it was observed that street dust samples collected along ziks avenue gave highest mean value of lead 372.24±0.74 mg kg^{-1}. Whereas the street dust samples collected along Anikwe street gave the lowest mean value of lead 217.24±0.79 mg kg^{-1}. The trend in the concentrations of lead in the five strret dust samples in Onitsha commercial city were ziks avenue > Modebe street > Mbanugo street > Ajasa street >Anikwe street. The high concentrations of lead in the five street samples in Onitsha may be attributed to copious volumes of vehicle traffic emissions, industrial activities, foundry activities, municipal sewage leakages among other anthropogenic sources. The general high lead load in street dust samples in each of the five streets in the four selected cities for investigation may be due largely to vehicle traffic emission associated with 0.66 g Pb per litre of petroleum motor spirits (gasoline) in Nigeria[5]. This situations present health and environmental risks to the residence of these cities. This is because lead is not very mobile under environmental conditions. Again leaching of lead is not important controlling mechanism under normal environmental conditions since lead solubility is very low (< I,ug kg^{-1} at pH 8.5-11)[2]. The short terms and long term (bio- accumulative) effects of high concentrations of lead in these street dust samples may include; mental retardation, in babies and young children, diarrhea, stunted growth, muscle weakness, abdominal colic, interference with red blood chemistry, hearing and learning disabilities, in children, slight increase in the blood pressure of some adults, cerebrovascular and kidney diseases[2,7-11]. Lead exposure for a life time has the potential to cause cancer at level above the action level of 0.015 mg kg^{-1} in blood stream of human through ingestion of dusts or through drinking water[2]. The trend in the over all mean values of lead concentrations in the four cities investigated were Aba (345.994±27.13 mg kg^{-1}) > Enugu (322.508±24.43 mg kg^{-1}) > Onitsha (291.978±34.34 mg kg^{-1}) > Abakaliki (162.54±16.24 mg kg^{-1}).

This study has revealed high level of lead concentrations in the street dust samples collected and analyzed in the four selected cities in southeastern Nigerian of Aba, Abakaliki, Enugu and Onitsha respectively. Therefore the analysis of street dust samples can be used in the monitoring and evaluation of lead pollution levels in other cities of southeastern Nigeria and else where in the country.

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