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# Analysis of heavy metals concentration deposited in roadside soil

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## ABSTRACT

*Atomic absorption spectrometry (AAS) flame atomization technique was used to analyzed the concentration of Pb, Cr, Mn, Zn, Cd and Ni on the soil samples collected from a segment of the Samaru highway (Sokoto Road) from Main gate to North gate (and from North gate to Main gate) of Ahmadu Bello University, Zaria. A total of ten (10) samples from both sides of the road were collected systematically and analyzed at the National Research Institute for Chemical Technology (NARICT), Zaria. The result of the analysis showed that Lead (Pb) has the highest concentration level followed by Manganese (Mn), Chromium (Cr) and Cadmium (Cd) with mean values of 1.4439ppm and1.7850 ppm, 0.3192ppm and 0.3254ppm, 0.0154ppm and 0.0131ppm, and 0.1726ppm and 0.1449ppm respectively. The concentration level of the heavy metals obtained from the analysis is lower than the Maximum Permissible Limits of 20ppm, 0.2ppm, 60ppm, and 0.25ppm for Lead, Manganese, Chromium and Cadmium respectively.*

**Keywords:** Heavy metals, AAS, Roadside soil, Pollution

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## INTRODUCTION

Heavy metals are typical car exhaust pollutants and their deposition pattern is well documented in soil and vegetation. Street dust is generally composed of car exhaust, gas originated particles and wind transported particles. Heavy metals which are found in street dust such as Pb, Cr, Mn, Zn, Cd and Ni play a significant role in environmental pollution. Thus, high concentration of metals for example Pb, Cd, Zn etc., needs to be investigated for their ecological and health implications. These metals posses bioaccumulation property and the possibility of the amount of these metals to reach critical stage and threatening human health increase the importance of this type of research.

According to the kind of vehicle in traffic; the quality of heavy metals varies in street dust. The use of leaded gasoline gives a boost to the importance of lead level especially in street dust even at the start of 21$^{st}$ century. Air pollution has long been recognized as lethal form of pollution, much of the problems of societal concern today are the heavy metals associated with air pollution. Although the main source of heavy metals are from exhaust from traffic (motor vehicles), other sources such as roadside deposition of motor engine oil, battery wastes, car tires, use of metal containing pesticides in destroying/killing of roadside grasses, trees, and flowers, and indiscriminate dumping of waste on the roadside could also contribute significantly. Pollution of the natural environment by heavy metals is a universal problem because these metals are indestructible and most of them have toxic effects on living organisms, when they exceed the permissible concentration levels (Fergusson, J.E., 1990).

## MATERIALS AND METHODS

### 2. EXPERIMENTAL

### 2.1 Sampling

Soil samples were collected from a segment of the Samaru highway (along Sokoto road) from Main gate to North gate of Ahmadu Bello University Samaru, Zaria on the 2nd of June 2012. They were collected using a stainless steel material at different distance of about 120m of intervals within the sampled area. A total of 10 samples were collected (5 from each side of the road) in a clean labeled polythene bag for onward analysis in the laboratory.

### 2.2 Sample Digestion

The samples were oven dried at $105^0$C to constant weight for 6 hours (Walinga *et al*, as quoted by Galadima et al., 2010). The oven dried material was crushed and sieved through 2.00 mm mesh to obtain sample that were used in digestion. 1.0g of the sieved sample was then reacted with 15ml of concentrated HCl, 5ml of $HNO_3$ and 0.3 $H_2SO_4$. Stock solutions were prepared based on standard analytical methods. The sample solution was then aspirated into the Atomic Absorption Spectrometer (AAS) at intervals and then analyzed for the presence of Pb, Mn, Cr and Cd.

## RESULTS AND DISCUSSION

The results of the analysis are presented in tables 1and 2.

**Table 1: concentration of the metals in ppm (from Main gate to North gate)**

| S/NO | SP | LEAD (Pb) | CADMIUM (Cd) | CHROMIUM (Cr) | MANGANESE (Mn) |
|---|---|---|---|---|---|
| **1** | $A_1$ | 2.5581 | 0.0145 | 0.1031 | 0.2772 |
| **2** | $B_1$ | 1.1938 | 0.0248 | 0.1862 | 0.4278 |
| **3** | $C_1$ | 0.9096 | 0.0158 | 0.2189 | 0.2515 |
| **4** | $D_1$ | 1.3075 | 0.0131 | 0.2012 | 0.3233 |
| **5** | $E_1$ | 1.2506 | 0.0090 | 0.1534 | 0.3163 |
| **TOTAL** | | 7.2196 | 0.0772 | 0.8628 | 1.5961 |
| **Mean** | | 1.4439 | 0.01544 | 0.17256 | 0.31922 |
| **Standard deviation** | | 0.641373 | 0.005822 | 0.045677 | 0.067392 |

*Sp=sampling point*

**Table 2: concentration of metals in ppm (from north gate to main gate)**

| S/NO | SP | LEAD (Pb) | CADMIUM (Cd) | CHROMIUM (Cr) | MANGANESE (Mn) |
|---|---|---|---|---|---|
| **1** | $A_2$ | 1.5917 | 0.0151 | 0.0679 | 0.3193 |
| **2** | $B_2$ | 0.8527 | 0.0041 | 0.1585 | 0.4202 |
| **3** | $C_2$ | 2.8424 | 0.0090 | 0.1132 | 0.3434 |
| **4** | $D_2$ | 1.5349 | 0.0179 | 0.1585 | 0.3023 |
| **5** | $E_2$ | 2.1034 | 0.0193 | 0.2264 | 0.2420 |
| **TOTAL** | | 8.9251 | 0.0654 | 0.7245 | 1.6272 |
| **Mean** | | 1.78502 | 0.01308 | 0.1449 | 0.32544 |
| **Standard deviation** | | 0.739691 | 0.006389 | 0.059047 | 0.06488 |

*Sp=sampling point*

It could be observed that Lead (Pb) has the highest concentration level in all the samples analyzed followed by manganese (Mn), then chromium (Cr) and cadmium (Cd) with values ranges from 0.9096ppm to 2.5581ppm, 0.2515ppm to 0.4278ppm, 0.1031ppm to 0.2189ppm and 0.0090ppm to 0.0248ppm (fig 1) respectively and 0.8527ppm to 2.8424ppm, 0.2420ppm to 0.4202ppm, 0.0679ppm to 0.2264ppm and 0.0041ppm to 0.0193ppm (fig 2) respectively. Therefore the concentration of the metals in increasing order is given as Pb>Mn>Cr>Cd.

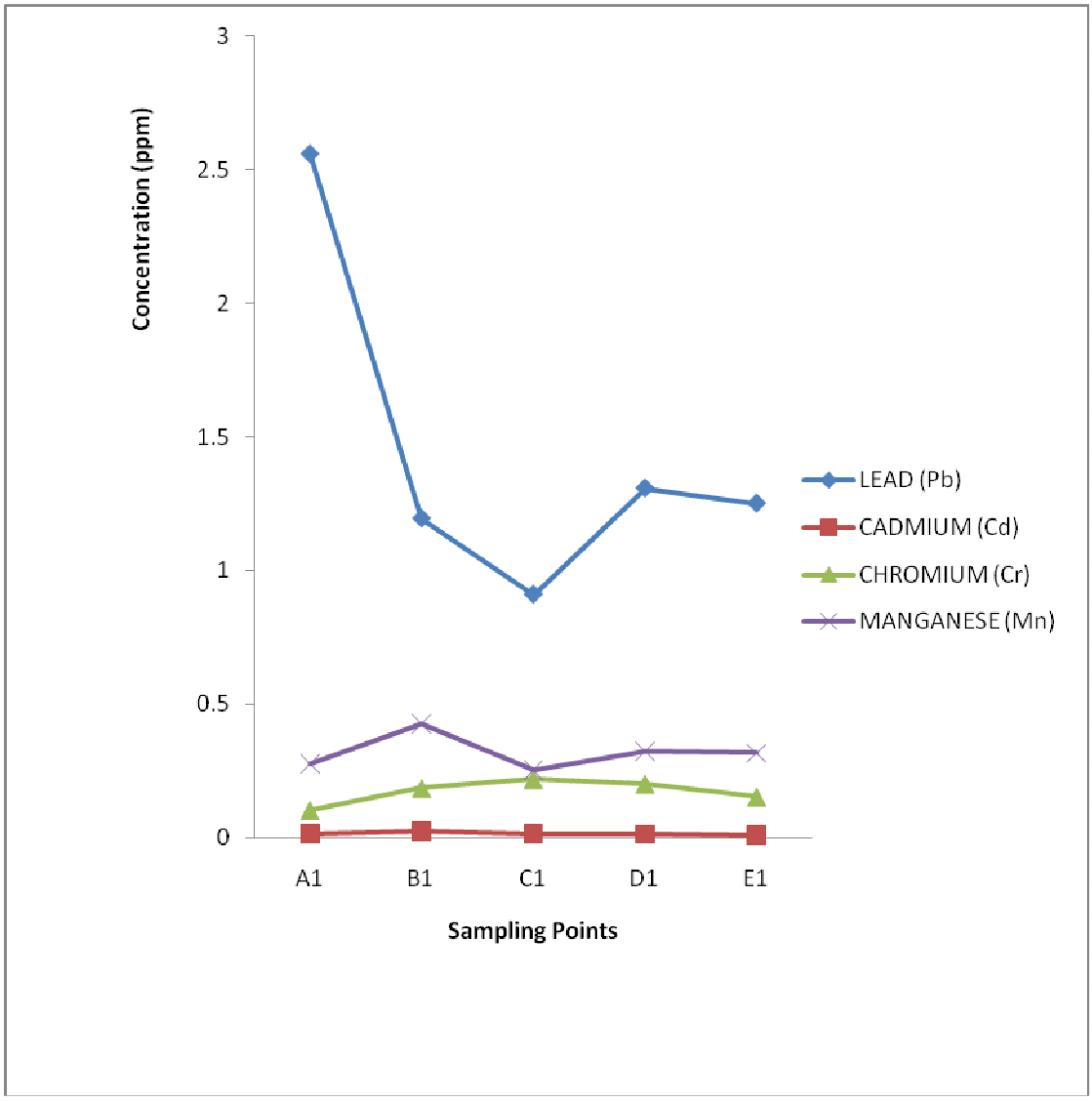


**Figure 1: concentration of the heavy metals in ppm (from Main gate to North gate)**

The high Lead (Pb) concentration in all the samples could be due to the deposition from automobile exhaust, garbage disposal, discarded batteries, filling stations, motor parks and other lead bearing materials. According to Fifield and Haines (2000), natural heavy metal concentration of surface soils in ppm (mg/kg or µg/g) are Pb=20, Cd = 0.25 and Cr = 60. From the chart above it can be seen that Pb has the highest level of concentration ranging from 0.9096±0.8ppm to 2.5581ppm (fig 1) and 0.8527ppm to 2.8424ppm (fig 2) with a mean value of 1.4439 ppm (table 1) and 1.7850 ppm (table 2), when compared with the value for Pb determined by Fifield and Haines (2000), it can be observed that the concentration level of Lead is lower than 20ppm reported by Fifield and Haines (2000). Studies have indicated that the effect of Lead can now be detected at levels below those previously considered to be without hazard 0.2-0.4ppm (Waldbott, 1978).

Cadmium has the lowest concentration level with a range of 0.8527 to 2.8424ppm (fig 1) and 0.0041ppm to 0.0193ppm, with a mean value of 0.0154ppm (table1) and 0.0131ppm (table 2). The level of Cd in this research is very low when compared to 0.25ppm as reported by Fifield and Haines (2000). Alloway (1995) mentioned that 0-1 µg/g of cadmium in soil indicates non contamination, 1-3 µg/g indicates slight contamination of soil and 3-10 µg/g indicates contaminated soil. So when the values obtained for Cd from this research are compared to these values, it can be stated that the soil is not contaminated with cadmium that is the level of Cd in the soil did not exceed the tolerance or permissible level. Also Aksoy (1996) found that the mean cadmium concentrations of urban roadside

soils and rural roadside soils near Bradford city as 2.44µg/g and 1.04µg/g respectively. These values are also higher than the values obtained in this research.

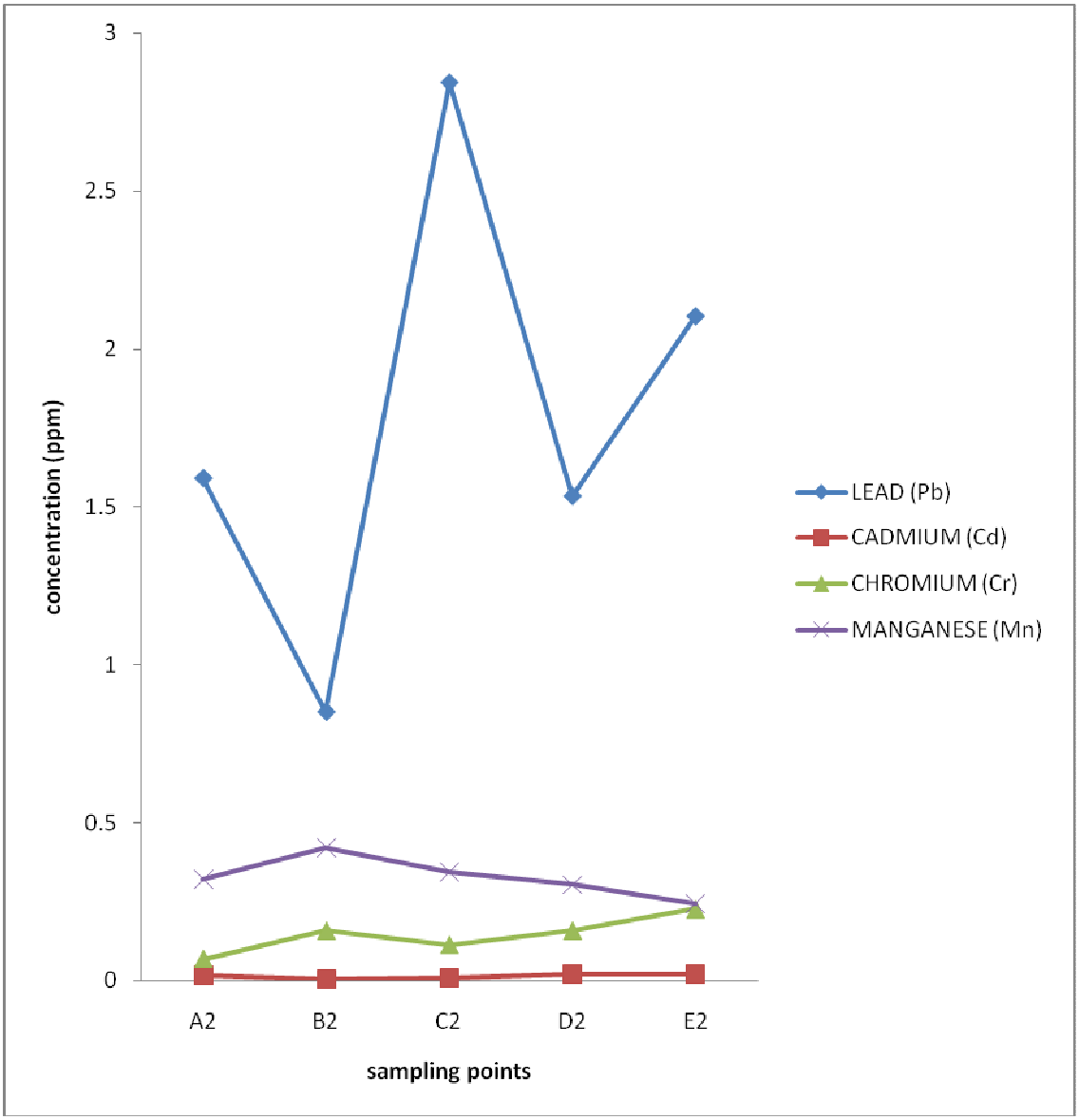


**Figure 2: concentration of the heavy metals in ppm (from North gate to Main gate)**

The values obtained for the concentration of chromium in this research work are in the range of 0.1031ppm to 0.2189ppm (fig 1) and 0.0679ppm to 0.2264(fig 2) with mean values of 0.1726ppm (table 1) and 0.1449ppm (table 2). When these values are compared with 60µg/g stated above, it appears that the values from this research are far less than the natural heavy metal concentration of the soil as reported by Fifield and Haines (2000).

Manganese on the other hand has concentration level ranges from 0.2515ppm to 0.4278ppm (fig 1) and 0.2420ppm to 0.4202ppm (fig 2) the mean concentration of Mn for are 0.3192ppm (table 1) and 0.3254ppm (table 2). It could be observed that the concentration level from this research is higher than that of the Interim National water quality standards for Malaysia which is 0.2ppm (Jatau, 2012).This indicates that the soil of the study area is contaminated with Manganese which is a clear indication of pollution potential. When in low concentration Mn is believed to be important for the function of enzymes system involved in the protein, fat, energy metabolism and oral supplementation is believed to lower blood glucose levels (Jatau, 2012).

## CONCLUSION

The result of this work show that the pollution levels along the study area as a result of vehicular emissions has not risen to a dangerous level at the moment. There is also the danger of build-up of small doses either through inhalation or absorption through skin or bioaccumulation. These can lead to unpleasant genetic and somatic consequences, most of which are due to exposure to relatively low level of concentration over a long period of time (Botkin et al 1998). Therefore we need to tackle the problems before they reach a critical level so as to prevent the well being of the living organism and the environment as a whole

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