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Assessment of some metals in roadside dust from Damaturu, Yobe State, Nigeria

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Roadside dust samples were collected from commercial and residential areas in Damaturu, Yobe State, Nigeria for the determination of Cr, Pb, Cu, Fe, Ni, Co, Mn, Cd, As and Zn. Sample preparation and digestion were carried out using standard procedures. The samples were determined using flame atomic absorption spectrophotometry after digestion with aqua regia. The levels of Cr, Pb, Cu, Fe, Ni, Co, Mn, Cd, As and Zn were found to be significantly higher in the roadside dust samples from commercial area, while the lowest levels of metal ions were noted in the roadside dust samples from residential area. The results further show that the concentrations of all the metals were significantly higher than the control points. From the results obtained, the concentrations of all the studied metals were generally above the WHO standard values for roadside dust. Hence, the traffic situation in the commercial area might be regarded as the sources of high heavy metals content in the roadside dust when compared with the residential area.

Key words: Heavy metals, traffic, FAAS, WHO.

INTRODUCTION

Vehicular emission and traffic congestions are major source of roadside soil pollution (World Health Organization [WHO], 2006). Motor vehicles have directly and indirectly impacted on the metabolism of roadside plants due to emission of trace elements (Viskari et al., 2000). There has been interest in the levels of trace elements and their source identification associated with urban dusts in past decades (Chatterjee and Banerjee, 1999). Research has established people exposed to trace elements such as lead (Pb), cadmium (Cd), arsenic (As), manganese (Mg) and nickel (Ni) develop alterations in nervous system functions, with neurophysiological consequences constituting a health hazard (Olivero and Solano, 1998).

Many studies throughout the world have identified vehicular traffic, industrial and commercial areas as sources of trace elements in urban dusts (Al-Chalabi and Hawker, 1997) as well as weathering or building facades (Akhter and Madany, 1993). Such toxic elements (e.g. Pb, Cd, As, Mg, and Ni) are deposited on the roadside and might be as a result of combustion, component wear, fluid leakage and corrosion of metals. Most heavy metals are release as a result fuel burning, tyres wearing, oils leakage and battery corrosion. Majority of heavy metals are toxic to living organisms and even those considered essential can be toxic if present in excess (Akhter and Madany, 1993). Trace elements can

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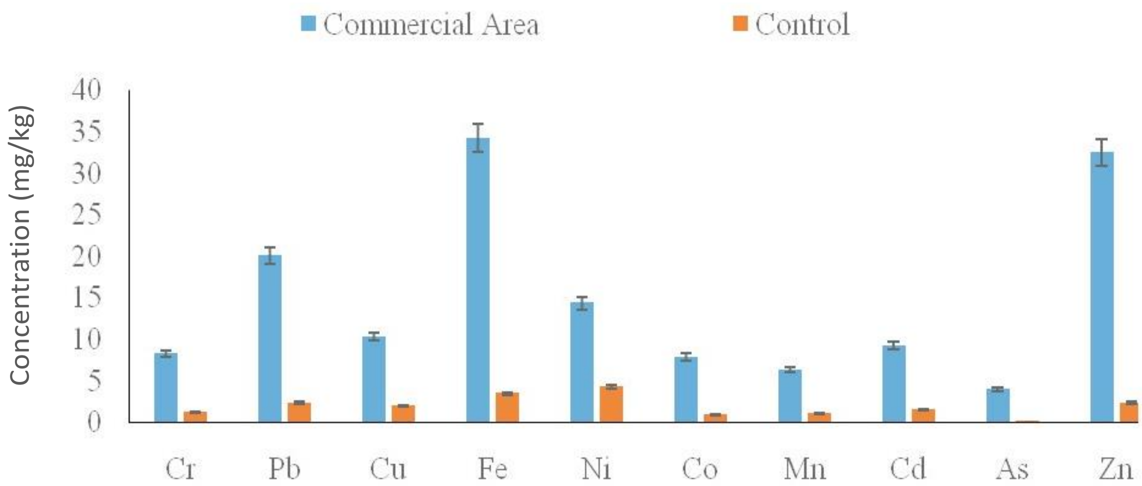

Figure 1. Mean concentrations of some metals in roadside dust from commercial area.

impair important biochemical processes posing a threat to human health, plant growth and animal life (Silva et al., 2005). Research from other studies showed heavy metals can be harmful to roadside plants, animals, and human settlements situated closer to a roads (Akbar et al., 2006).

MATERIALS AND METHODS

Sampling collection

Roadside dust samples were collected from commercial and residential areas. For each of the sampling areas, samples were also collected 200 m away from each sampling point to serve as a control. Roadside dust samples were collected from the two areas and control points by using brush and plastic hand trowel to collect settle dust along the roads.

Samples preparation

Two grams of each air-dried and sieved dust samples was ashed in a muffle furnace at 500°C for 4 h. The ash was digested in 10 ml Aqua regia (1 part conc. HNO_3 to 3 parts HCl) in a digestion tube on a hot plate until the volume reduced to 5 ml as the heating continued. After the digestion, the digestates were centrifuged and 10 ml HNO_3 was added. Samples were cooled and then made up to the volume of 100 ml with distilled water. The concentrations of Cr, Pb, Cu, Fe, Ni, Co, Mn, Cd, As and Zn in the roadsite dust samples were determined using Atomic Absorption Spectrophotometer (AAS, Unicam 969).

RESULTS

The concentrations of heavy metals in roadside dust samples from commercial area and control is as presented in Figure 1. The concentration of Cr ranged from 1.23 to 8.22 mg/kg, 2.34 to 20.12 mg/kg Pb, 1.98 to 10.34 mg/kg Cu, 3.45 to 34.23 mg/kg Fe, 4.34 to 14.34 mg/kg Ni, 0.88 to 7.87 mg/kg Co, 1.09 to 6.34 mg/kg Mn, 1.54 to 9.23 mg/kg Cd, 0.19 to 3.98 mg/kg As, and 2.34 to 32.44 mg/kg. Figure 2 shows the mean concentrations of some heavy metals in roadside dust samples from residential area. The concentrations of heavy metals in roadside dust samples from residential area and control is as as shown in Figure 2. The concentration of Cr ranged from 0.11 to 3.22 mg/kg, 0.21 to 5.23 mg/kg Pb, 0.01 to 2.10 mg/kg Cu, 0.23 to 6.23 mg/kg Fe, 0.11 to 2.12 mg/kg Ni, 0.34 to 2.14 mg/kg Co, 0.02 to 1.02 mg/kg Mn, 0.13 to 1.22 mg/kg Cd, 0.21 to 2.88 mg/kg As, and 0.12 to 6.33 mg/kg.

DISCUSSION

Lead (Pb)

The highest Pb concentration in the roadside dust was 32.44 mg/kg and was detected at the commercial area, while the residential area shows the least value. The control points show the lowest levels of lead as compared to the main roads. The high concentration of Pb at commercial area when compared with other point might be due to the differences in traffic density, metals construction work, iron bending and welding of metals which is a common practice along the street of the commercial area. Results also show that the levels of Pb in dust samples were higher than the control. High values of Pb when compared with control are because all the sample points were in the areas of high traffic density. The traffic situation in this area might be regarded as a source of Pb in the roadside dust. Wear and corrosion of vehicle parts might also be one of the potential sources of heavy metals. Concentrations of Pb in the dust samples from the study areas were lower than that reported by Charlesworth et al. (2003) of 48 ìg/g and was also higher than the range of 1.01 to 2.9 ìg/g reported by Al-Khashman (2006).

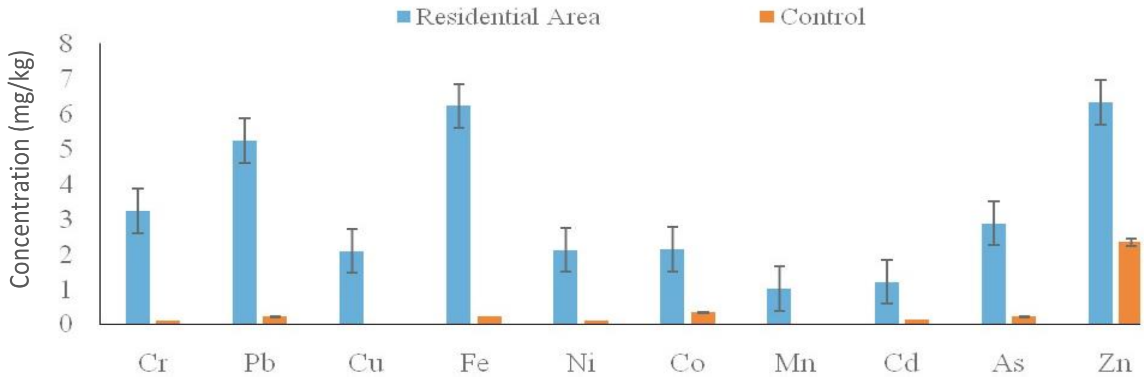

Figure 2. Mean concentrations of some metals in roadside dust from residential area.

Copper (Cu)

Copper may be toxic to both humans and animals when its concentration exceeds safe limits (Bakýrdere and Yaman, 2008). The highest Cu concentration in roadside dust was found at commercial area, while residential shows the lowest value. The high concentration of Cu at commercial area when compared with other point might be due to the differences in traffic density and metals construction work. High values of Cu in the sampling points when compared with the controls might be due to corrosion of metallic car parts (Al-Khashman, 2004; Al-Khashman and Shawabkeh, 2006).

Iron (Fe)

Iron is vital for almost all living organisms, participating in a wide variety of metabolic processes, including oxygen transport, DNA synthesis, and electron transport. It is known that adequate Fe in a diet is very important for decreasing the incidence of anemia (Lynch and Baynes, 1996). High concentration of Fe in dust samples was observed at the commercial area, while residential area shows the least concentration. High concentration of Fe detected at the commercial area may be attributed to differences in traffic density (Adachi and Tainosho, 2004).

Nickel (Ni)

Nickel pollution on a local scale is caused by emissions from vehicle engines that use gasolene which contains Ni and by the abrasion and corrosion of Ni from vehicle parts (Al-Shayeb and Seaward, 2001). The burning of fossil fuels as well as the refining of metals such as Cu introduces considerable amounts of Ni into the atmosphere (Lee et al., 2005). The highest Ni concentration (6.82 µg/g) in the dust samples was found at the commercial area, while residential is the least concentration. Nickel values in the dust samples from the sample points were found to be higher than the control sites and may be the result of high traffic density within the study area.

Manganese (Mn)

The deficiency of manganese in the human body can produce severe skeletal and reproductive abnormalities in mammals. High doses of Mn produce adverse effects primarily on the lungs and brain. The highest Mn concentration in the dust samples was observed at the commercial area, while the least value detected at the residential area.

Cadmium (Cd)

It was reported that cadmium is accumulated mainly in kidneys, spleen, and liver, and its blood serum level increases considerably following mushroom consumption (Kalac and Svoboda, 2001). Cadmium is now the most commonly encountered in cadmium-nickel battery production, although it continues to be used in paints as well as in plastic production where it is an effective stabilizing agent. The highest Cd concentration in dust samples was observed at the commercial area, while residential shows the least concentration. Cadmium values in dust samples from the sample points were found to be higher than the control site; such variation might be attributed to high traffic density. The concentrations of Cd in the roadside samples world-wide has been reported to be 0.5 to 4.0 ìg/g (Fergusson and Kim, 1991). Cadmium levels in dust samples in the commercial area exceed this ranged.

Zinc (Zn)

The highest Zn concentration in dust samples was observed at the commercial area, while residential area shows the lowest value. The traffic situation in the study area is regarded as a source of zinc in the roadside dust. Wear and corrosion of vehicle parts (brakes, tyres, radiators, body, and engine parts) might also be one of the potential sources of Zn in roadside dust. Zn values in the dust samples from the sample points were found to be higher than the control sites.

Conclusion

In all the sampling points, Fe, Zn and Pb show the highest concentrations in roadside dust. The high concentration of these metals in the roadside dust samples may be attributed to metals construction work, iron bending and welding of metals. At the same time, the traffic situation at the commercial area of the study might be regarded as a source of heavy metal content in the roadside dust. The concentrations of all the metals in the sampling points were higher than the control.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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