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Full Length Research Paper

Analysis of street dust for heavy metal pollutants in Mubi, Adamawa State, Nigeria

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This study is aimed at determining the elemental concentrations of heavy metal pollutants that may be present in street dust samples in Mubi, Adamawa state, Nigeria. Dust samples were collected in mechanical workshops (MWK), motor parks (MPK), market areas (MKA), roundabouts/highways (RHW) and residential areas (RDA). The dust samples were digested using aqua regia digestion method and Flame Atomic Absorption Spectrophotometer was used for the elemental analyses. The variation in concentration of most of the heavy metals determined from different sites decreases in an order represented as MWK >MPK >MKA >RHW > RDA. The heavy metals showed a variation that indicated that Fe >>> Zn >> Pb >> Cu >> Cd, Iron (Fe) had the highest concentration in all the sampling areas with range of 5330.50 ± 499. 80 – 24100.00 ± 968.20 µg/g. A lower value was observed for Cd with respective range of 0.59 ± 0.19 – 1.33 ± 0.36 µg/g. Cobalt and Selenium were not detected in all the samples. Statistical analysis by ANOVA and t-test showed a significant difference (P<0.05) between the elements determined. This suggested that, the heavy metal pollutants in street dust samples of Mubi did not originate from common anthropogenic sources because some heavy metals are soil derived. Probably automobile emission, welding of metal and exhaust from generators may be the major sources of the elements.

Key words: Metal pollution, dust, sampling sites, automobile emission, atomic absorption spectrophotometer, toxic substances, concentration.

INTRODUCTION

Heavy metal pollutant in urban street dust has become a growing concern in recent years. In Nigeria, Street dust is one major way through which heavy metals may find their way into soils and subsequently living tissues of plants and human beings. 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 and accumulation in the ecosystem.

A range of metals and chemical compounds found in the street dust environment are harmful. Pollutants can attack specific sites or organs of the body and disease can develop as a consequence to such exposure (Archer and Barratt, 1976; Ayodele and Gaya, 1998). Although there have been considerable number of studies on the concentration of heavy metals in street dust, the vast majority have been carried out in developed countries with long histories of industrialization (Jaradat and Momani, 1999). Very few studies have been carried out in developing countries like Nigeria. Little interest has been focused on the contamination of street dust by other heavy metals in Nigeria. Such data on pollutant metal concentration of street dust in such areas are extremely scarce.

This paper therefore reports the concentration of heavy metals in Mubi street dust at different sites. From places of high activities to places of low activities that is mechanical workshops, motor parks, market areas roundabout and high-ways and residential areas.

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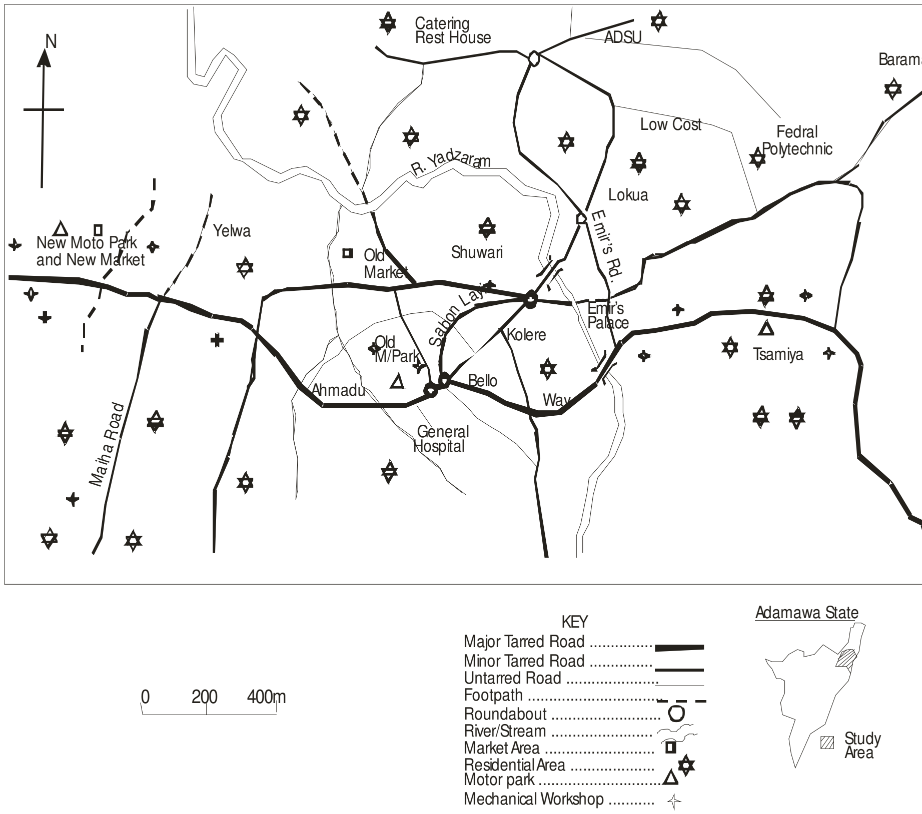

Figure 1. Showing major streets in Mubi municipal.

MATERIALS AND METHODS

Sampling map

Five sites were selected for the study along the major roads in Mubi metropolis. Ten replicate samples were collected from the sampling sites as shown in Figure 1. It shows the major roads and sampling sites. Street dust samples were taken from mechanical workshops, motor parks, market areas round about and high ways and residential areas.

Sampling

Street dust samples were sampled using brush and plastic scoop to collect the settled dust along the streets. Samples were collected between October, 2005 to May, 2006 to avoid rain-washing out the heavy metals. During this period the largest difference of heavy metal concentration in street dust may occur

Sample preparation

Dust samples were collected and transferred to clean polyethylene bags. All the samples were dried at 100 - 110^{o}C to drive out moisture. On cooling each sample was sieved through a nylon sieve of 250 µm diameter.

Procedure

All experiments were performed with analytical reagent grade chemicals. The digestion of the dust samples were done using aqua regia that is 3:1 ratio of hydrochloric acid to trioxonitrate (v) acid (Ward et al., 1977).A portion of 0.5 g of each of oven dried dust samples were weighed and transferred into 250 ml beaker. The samples were heated to boil for 30 min and were acid washed to pass through (whatman 540) and then filtered into 100 ml volumetric flask and were made up to the mark with distilled water. Calibration standards were prepared from the stock solution by dilution and were matrix matched with the acid concentration of the digested samples (Whitehead, 1975). The digested samples were then analysed for heavy metal using Unicam SP 969 Atomic Absorption Spectrophotometer.

RESULT AND DISCUSSION

Table1 presents the concentrations of some heavy metal pollutants determined in the street dust samples in Mubi between October 2005 to May 2006.

Fe had the highest concentration followed by Zn, Pb, Cu, Ni, Cr and Cd in the five different sampling areas. The high concentration of iron in the street dust samples may be attributed to metal construction works, iron bending and welding of metals, which is a common practice along the streets in Mubi. Virtually in every mechanical workshop there are various sections that deal with either filling of metals, welding of these metals and paveling of vehicle bodies. Iron fillings from this metal works, exhaust emissions from vehicles, oil spillage of gasoline, diesel, engine oil and lubricating oils, coupled with rusting of non

Table 1. Elemental concentrations (μg/g) of street dust samples between October, 2005 to May, 2006 in Mubi.

Sample	Cu	Cd	Zn	Pb	Cr	Fe	As	Co	Se	Ni
RDA	11.63 ± 1.99^{a}	ND	102.22 ± 3.07^{a}	20.37 ± 1.97^{a}	5.40 ± 1.97^{a}	9110.25 ± 49.90^{a}	ND	ND	ND	8.62 ± 1.0
MKA	46.04 ± 5.57^{b}	1.33 ± 0.36^{a}	143.12 ± 7.95^{b}	216.34 ± 15.90^{b}	3.66 ± 1.49	5330.50 ± 499.80^{a}	ND	ND	ND	ND
MPK	$52.35 \pm 1.8^{b,c}$	1.04 ± 0.25^{a}	683.68 ± 28.7^{c}	$241.34 \pm 10.40^{c,b}$	1.22 ± 0.14^{c}	20500.75 ± 1005^{b}	ND	ND	ND	ND
MWK	$50.09 \pm 4.03^{b,d}$	0.59 ± 0.19^{b}	$705.80 \pm 15.00^{d,c}$	$235.37 \pm 13.40^{d,c}$	ND	24100.00 ± 969^{c}	ND	ND	ND	ND
RHW	25.06 ± 1.08^{e}	0.67 ± 0.22^{a}	206.64 ± 8.64^{e}	121.53 ± 11.40^{a}	ND	8660.25 ± 953.60^{a}	ND	ND	ND	ND

All values represent Mean ± SD (Standard Deviation). Comparison was done within the column and values with different Superscripts are statistically different ($p < 0.05$). **ND**: Not Detected RDA = Residential Areas. MKA = Market Areas, MPK = Motor park MWK = Mechanical workshops. RHW = Roundabouts and High Ways.

- coated metals have all collectively contributed to the high concentration of the elements Fe, Zn, Pb, Cu, Cr, and Ni. Studies have shown that, stainless steel and alloy steel contain Fe, Cr, Co, Al and/ or Cu and that exhaust emission from both gasoline and diesel fueled vehicles contain variable quantities of these elements (Chong, 1986).

The sources of cadmium in the urban areas are much less well defined than those of lead, but metal plating and tire enforced with metals were considered the likely common anthropogenic sources of cadmium in street dust through burning of tires and bad roads. Other sources of cadmium and zinc are found in lubricating oils as part of many additives. It was reported that the cadmium level in car tires is in the range of 20 to 90 (μg/g) as associated Cd contaminations in the process of vulcanization (Yu et al., 2003). The uses of cadmium-plated and galvanized equipment in food processing, cadmium-containing enamel and pottery glazes, and cadmium base pigments or stabilizer in plastics may also be significance sources of food contaminations. As, Se, and Co were not detected in all the samples. Lead, the significant element of most concern in environ-mental heavy metal pollution, exhibit high level of contamination in all the samples collected. There is a decrease in elemental concentration from place of high activities for example, mechanical workshops, motor parks and round about and highways to places of lower activities like residential areas. Decreased elemental concentrations with distance from the high ways, mechanical workshop, and motor parks would indicate surface dust/ soil contamination by extraneous sources. Statistically lead shows no significant difference in market areas, motor parks and mechanical workshops ($p<0.05$). This indicates that the level of lead in Mubi originnates from common source. The most probable source of such contamination is the lead particulate matter emitted from gasoline vehicles, which settles along the roadsides as dust. Other sources of lead contamination could be from paints, pesticides, gasoline additives, lead pipes and other materials (Young, 1971).

Statistical analysis showed significant differences ($P < 0.05$) between the elements as indicated in Table 1. This suggests that, the indicated heavy metal pollutants in street dust of Mubi did not originated from common anthropogenic sources with probably automobile and the welding of metals as the major sources.

The health implication of this ugly trend is quite obvious. This dust with its high heavy metal contents has a high vulnerability of causing cough in both children and adults during inhalation. Inhalation of siliceous dust causes siliceous disease of the lungs (Leke, 1999). It has been observed that inhalation of some mineral particles can produce diseases in persons working in quarry sites, mines and welders. These mainly affect the lungs and the major pathogenic effect is the formation of fibrotic tissues in the lungs. The degree of incapacitation or loss of operational capacity of the lungs is dependent on the amount and type of mineral dust inhaled. This response of lungs to mineral dust with the attendant formation of fibrotic tissue is commonly referred to as pneumo-nomosis (Nsi and Shallsuku, 2002). Chromium and its compounds are known to cause cancer of the lungs, nasal cavity and para nasal sinus and suspected to cause cancer of the stomach and larynx (ATSDR, 2000).

Apart from these direct effects of the dust on man, its effects are also felt indirectly. It settles on dried foodstuff such as rice, groundnut, maize, yam flour and dried cassava when the moisture contents of these foods are still high, the dust dissolves in this moisture and become absorbed and thereby contaminate the foodstuff. Dust also settles on building, walls, roofs, windowpanes and doors causing mechanical abrasion and aesthetic blight.

Conclusion

This study has shown that the street dust in Mubi is relatively contaminated with heavy metals. The heavy metal contaminations in street dust show a considerable decrease from place of high activities to a place of low activities (mechanical workshops to residential areas). This decrease might indicate aerial deposition of metal particulates in the street dust environment from extraneous sources and not only a function of soil type. Automobile and metal construction works could be responsible for the build up of the heavy metals in the street dust along the high ways and mechanical workshops through the emission of particulates. The street dust environment had a significantly high content of heavy metals, especially Fe, Zn, Pb and Cu and generally their levels increased with increasing traffic volume and welding of metals in urban areas. Finally, results obtained from this research work would now provide significant reference value for future studies of these areas and other regions in Adamawa state.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR, 2000). Toxicological Profile for Chromium. Atlanta, G.A: U.S. Department of Health and Human Service public Health service.

Archer A, Barratt RS (1976). Lead in the Environment: Monitoring for Lead. Sci.Total Environ 96:173-176

Ayodele JT, Gaya UM (1998). Chromium, Zinc and Manganese in Kano Municipality Street Dust. J. Chem. Soc. Nig 23:24-31

Chong C (1986). Determination of silver, Bismuth, Cadmium, Copper, iron, Nickel and Zinc in Lead and Tin base Solder and White Metal Bearing Alloys by Atomic Absorption Spectrophotometer, Talanta, 33:91-94.

Jaradat QM, Momani AK (1999). Contamination of Road Side Soil, Plants, and Air with Heavy Metals in Jordan: A Comparative Study. Turk J. Chem. 23.209-220.

Leke JT (1999). Environmental Health. Adeka Press and Publishing Co. Ltd Markudi, p.18

Nsi EW, Shallsuku P (2002). Industrial Pollution: A Case Study of Dust Pollution from a Cement Industry. J. Chem. Soc. Niger. Vol. 27 (1): 85-87.

Ward IN, Brooks RR, Roberts E, Boswell C (1977). Heavy Metal Pollution from Automotive Emission and its Effect on Roadside Soils and Pastures in New Zealand. Environ. Sci. Technol. 1:917-20

Whitehead PJ (1975). Pye Unicom Atomic absorption Data Book 1st Ed., Pye Unicom Ltd. Cambridge, Engl.

Young SR (1971). Chemical Analysis in Extractive metallurgy; charley and pickers gill Ltd. Leeds p.188

Yu KN, Yeung ZL, Kwok RCW (2003). Determination of Multi-element Profiles of Soils using Energy Depressive X-Ray Fluorescence (EDXRF). Appl. Radiat, Isot. 58: 339-346.