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AN ASSESSMENT OF HEAVY METAL CONTENT OF ROADSIDE VEGETATION ALONG TWO MAJOR HIGHWAYS IN THE SOUTHWESTERN NIGERIA

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ABSTRACT

Emission of pollutants from motor vehicles is a problem associated with road transportation. Plants and plant materials on roadsides are directly impacted by such emissions. The level of impact needs to be established and related to vehicular traffic density. Vehicular counting and collection of samples from both roadside plants and plant materials being sun-dried were carried out on two roads selected for this study; Ife/Ibadan road in Osun/Oyo Sates and Ogbomosho - Igbeti road in Oyo State. The samples were collected at various distances along the roads, and analyzed for lead, zinc and cadmium in the laboratory using Atomic Absorption Spectrophotometer (AAS). A combination of t-test, Pearson correlation and descriptive statistics (bar chart) were used in presenting the results at (p< 0.005) . The result shows that there are more vehicles plying Ife-Ibadan road (7,732 vehicles per day) than Ogbomosho-Igbeti road (2941 vehicles per day). The results confirmed the presence of lead, zinc and cadmium in varying amounts in the plant materials and cassava flour sampled along the two roads. The order of the metal concentrations on both roads is the same i.e. Pb > Cd> Zn. It also revealed that vehicle type is of great importance in emission from automobile exhaust. When the heavy metal contents of the plant materials were compared with FAO/WHO guidelines for edible materials for man (plants and animals, it was established that roadsides vegetation were contaminated by heavy metals such as lead. The implication of this is that roadside farming and drying of plant materials by the roadside should be discouraged.

Keywords: Heavy metals, traffic density, cassava flour, vehicular counting, Ife-Ibadan and Ogbomoso-Igbeti roads.

INTRODUCTION

Hydrocarbons, oxides of Sulphur (SO_x), oxides of Nitrogen (NO_x), Carbon monoxide (CO), Lead (Pb) and particulate matter are some of the harzadous emissions from motor vehicles. The Blacksmith Institute (2007) lists locations in world's worst polluted places, the top ten nominees are located in Azerbaijan, China, India, Peru, Russia, Ukraine and Zambia in Africa as the world' most polluted sites. The presence of lead in automobile exhaust emission has been linked to the addition of tetraethyl lead $\{(C_2H_5)_4$ Pb$\}$ to petrol (Ademoroti, 1986).

Aribike (1996) observes that automobile exhaust emission and combustions of fossil fuels are the sources of metals in the atmosphere. Motor vehicle exhaust emissions are known to produce elevated concentrations of Pb in roadside vegetation (Ndiokwere, 1984; Bada, 2000; Gadgil *et al.*, 2006). W

exhaust emissions from vehicles constitute the "source" of atmospheric pollutants, man, animal, vegetation and soil are "sinks" hence, the use of human blood, skeletal tissues, bark of trees, soil and plants has been employed as a means of monitoring levels of metals in the atmosphere (Osibanjo and Ajayi, 1980; Ndiokwere, 1984; Ademoroti, 1992; Amusan *et al.*, 2003; Gadgil *et al*., 2006). Studies have revealed the damaging effects to man and animals exposed to toxic metal such as lead, mercury, zinc, cadmium, oxides of sulphur and nitrogen, carbon (ll) oxide (CO) to include: various diseases such as rheumatoid, arthritis, diseases of kidney, nervous and circulatory systems, inflammation of the liver, cancer of skin, liver and lung, gastrointestinal and respiratory tract irritations (Kimani, 2007; Casarett and Doull, 1996).There are quite a number of ways by which heavy metals get the atmosphere, the plant and ultimately

man and animal through the consumption of food substances contaminated by these metals. It is a known fact that some of these pollutants will ultimately find their way into the food chain when man consumes milk or meat or both sourced from the animals that have grazed on such a contaminated vegetation, and food substances that have been exposed (Ferner,2001; Ma *et al*., 2006).

Plants have- been used successfully as bio-monitors of pollution levels in the environment and certain plant species and varieties are reported to be so sensitive that they can be conveniently employed as monitors of specific pollutants (Gadgil *et al*, 2006). Roadside contamination from vehicle exhaust emissions has not been fully investigated in Nigeria and this in part, formed the basis of this effort. With the preponderance of pollutants traceable to vehicle exhaust emissions in the atmosphere, there is the need to know how traffic densities affect depositions on vegetation along major highways in Southwestern Nigeria. The objectives of the study are to:

Determine the number of vehicles i.e traffic densities on the two roads selected

Determine the levels of heavy metals in herbaceous plants and cassava and

Relate the concentrations of these heavy metals in both plant and cassava flour to traffic density.

The Study Sites

The study areas were two major roads in the South Western Nigeria: Ile-Ife – Ibadan Express way (A122) in Osun/Oyo states and Ogbomoso – Igbeti road in Oyo state. The Ife – Ibadan Road is 75km while the Ogbomoso – Igbeti Road is 92km. Ife-Ibadan is a dual carriage way while Ogbomoso-Igbeti is a single carriage way.

Vehicular Counting (V.C.)

The number of vehicles plying the two roads selected for this research was counted from 7a.m to 7p.m for a whole week i.e. from Monday to Sunday. The vehicle count was divided into four categories; motor cycles, cars, buses and trucks.

Vegetation or Plant Sampling

From Obafemi Awolowo University, Ile-Ife Campus gate, to Ikire along the road, a total of twelve (12) plant samples were collected from vegetation on the edges of left shoulder of the road where cassava flour were being sun dried at Kilometers; 2.5-32.10 latitudes N 07^0 23' and N $07^0$29' and longitudes E $004^0$11' and E $004^0$26' and also from Ogbomoso-Igbeti road a total of fifteen (15) plant samples were collected at Kilometers 1.2-43.2 and located within latitudes N$08^0$10'and N $08^0$90' and E $004^0$10' and E $004^0$15' All the plant samples (herbaceous) were collected with the aid of a stainless steel penknife at the ground level surface from the various points where cassava flour samples were also collected and put into labeled polythene bags.

Chemical Analysis

The plant samples were taken to the laboratory where they were identified. Immediately after this, the samples were placed under a running tap to wash of dirt and soil particles. The samples were dried in an oven maintained at 80^O C for 48 hours. They were later ground to fine powder using a Laboratory Stainless Steel Hammer Mill (Model Christy 8000 RPM8) and properly labeled. Thereafter, two g each of the powdered samples was ashed at 550^O C for three hours in a GallenKamp furnace, allowed to cool to room temperature in a dessicator. The ash was dissolved in 5ml of concentrated HCl and then made up to volume in a 100-ml volumetric flask (Alloway, 1995). The solution was then filtered using Whatman No 4 filter paper. Analysis of the digest for lead, cadmium and zinc content was carried out using Atomic Absorption Spectrophotometer (AAS)..

RESULTS AND DISCUSSION

Traffic Count

The average daily traffic density was found to be 7,732 (field survey, 2008) on Ife-Ibadan road while the average daily traffic density on Ogbomoso-Igbeti road was 2941(field survey, 2008) and this was less than the value for Ife-Ibadan road. The daily traffic flow or density on both roads is presented in Fig.1. It also revealed that the traffic density on both roads varied from Monday to Sunday. The contribution of vehicle type to the average daily traffic density is presented in Figs. 2 and 3. On Ife-Ibadan Road the highest vehicular type was cars and this was followed by buses while the trucks were the lowest i.e. cars > buses > trucks > bikes The daily ranges are; 127-204 for bikes, 3446-5891 for cars, 2284-3733 for buses and 299-693 for trucks. On the other hand, on Ogbomosho–Igbeti road, the highest contribution was from the trucks followed by the buses and this was followed by the bikes while the rest contribution was from cars i.e. trucks > buses > bikes > cars. The daily ranges are; 165-563 for bikes, 105-177 for cars, 932-1160 for buses and 1111-

1400 for trucks. The average daily traffic density that was found to be 7,732 on Ife-Ibadan road (dual carriage way) was higher than 5364 reported by the Federal Ministry of Works(1999) while 241 that was found on Ogbomoso-Igbeti (single carriage way) was lower. The increase in the number of vehicles can be attributed to the increase in the salaries of workers which was reflected in their abilities to acquire more vehicles. The high numbers of trucks on Ogbomoso-Igbeti road could be attributed to the fact that the road leads to Oke Ogun area of Oyo State which is reputed for being the major food crops producing area of Southwestern Nigeria. And for the bikes it could be from the fact that there are large numbers of villages where inhabitants are mostly farmers that relied on motorbikes as a means of transportation.

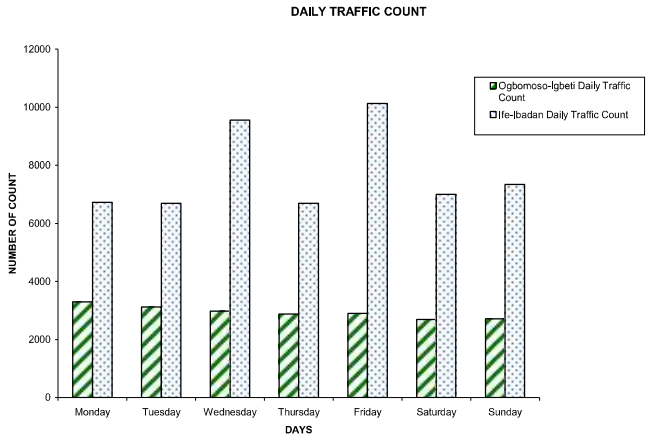

Fig .1: Daily Traffic Density on Ife – Ibadan and Ogbomoso – Igbeti

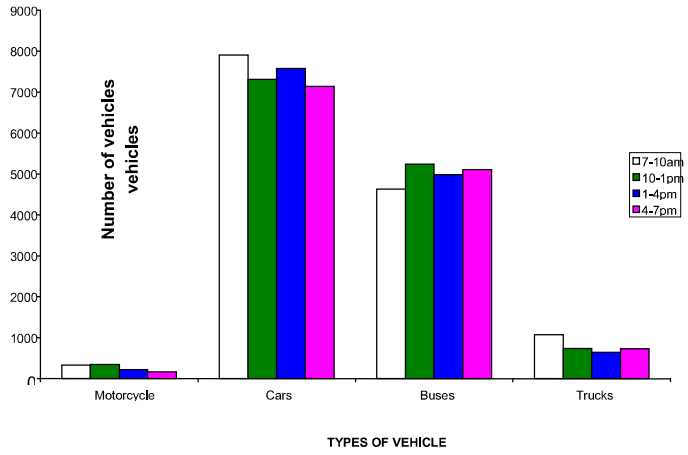

Fig .2: 12 Hours Traffic Count of Vehicle on Ife – Ibadan Road

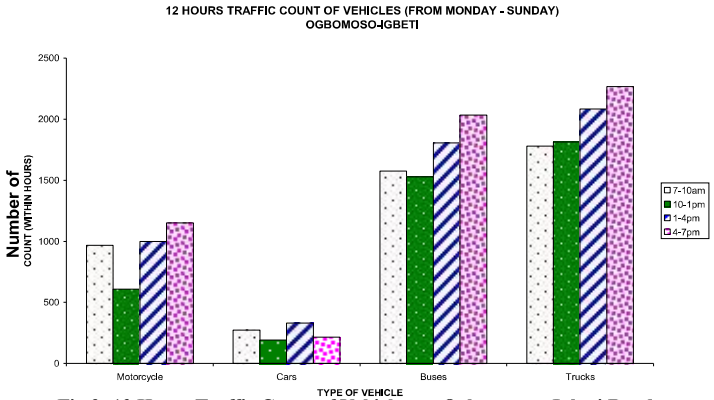

Fig 3: 12 Hours Traffic Count of Vehicles on Ogbomoso – Igbeti Road

Heavy metal content of plant

The results of chemical analysis carried out to determine heavy metals presence in plant samples are presented in Figs. 4 and 5. Mean concentration of lead in plant samples from Ogbomosho-Igbeti road was slightly higher than the mean concentration of lead in plant samples from Ife –Ibadan road i.e 7.77 > 7.65 mg/kg (Figures 4 and 5). The mean concentration of cadmium was higher in plant samples from Ife – Ibadan road than the mean concentration of cadmium for Ogbomoso – Igbeti plant samples i.e. 1.00 > 0.62 mg/kg. The mean concentration of zinc was higher in plant samples from Ife – Ibadan road than the mean concentration of zinc in Ogbomoso – Igbeti plant samples i.e 0.50 > 0.04 ppm. Statistical t- test analyses revealed that there was significant differences in the concentrations of both lead and cadmium from the two roads. However, there was no significant difference in the concentrations of zinc. A number of previous works had established the that from 1– 50m from road edges are contaminated with heavy metals such as lead (Pb) (Ndiokwere, 1981; Fatoki and Ayodele, 1991; Amusan *et al.*, 2003; Atayese *et al.*, 2009). The observed high concentrations of these metals in the plants could also be attributed to the enhanced metal concentrations in the soil as reported by (Garcia *et al.*, 1979; Davies, 1983; Xiong, 1998; Cobb *et al.*, 2000; LeCoultre, 2001; Amusan *et al.*, 2003). Also, heavy metals contamination brought about changes in the nitrogen and phosphorus concentration in plant samples depending on the extent of automobile exhaust released along road side (Bhargava *et al.*, 2003), reduction in growth and yield of plants (Balba *et al.*, 1991), changes in chloroplasts number and volume (Turcsanyi, 1992) and may affect germination, young or old trees, stem growth, leaf formation, root growth, flowering/fruiting, plant growth rate and biomass, photosynthesis, mineral nutrition, transpiration and secondary metabolism (Breckle and kahle, 1992; Csintalan and Tuba, 1992).

When these results from the samples were compared with the FAO/WHO (2001) safety guidelines that recommended the threshold levels of lead in plants to be 0.3ppm, cadmium to be 0.5ppm and zinc 40.00ppm it can therefore be confirmed that the plants were contaminated with respect to lead and cadmium. However, the zinc concentration was below the recommended limit.

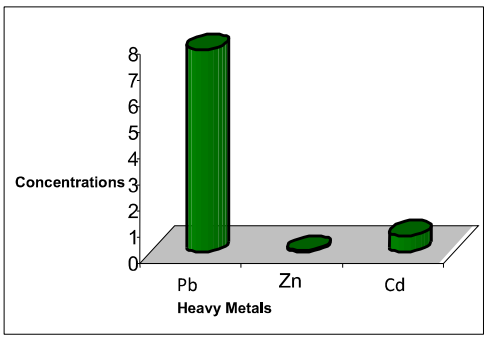

Fig 4: The concentrations of lead, zinc and cadmium in plant samples along Ogbomoso – Igbeti Road

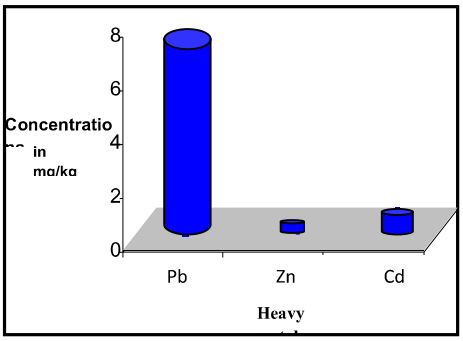

Fig 5: The concentrations of lead, zinc and cadmium in plant samples along Ife – Ibadan Road

The observed higher concentration of heavy metals in samples from Ogbomoso-Igbeti road was unexpected as a result of low traffic density. Similarly samples from Ife- Ibadan road were expected to have higher concentration because of traffic density but this was not so. This finding has therefore negated the reported results of higher concentrations of metals in high traffic density as opposed to low traffic density (Ademoroti, 1996; Amusan *et al*., 2003; *Gadgil et al*., 2006). The unexpected higher concentration of metals in the samples collected from Ogbomoso- Igbeti road could be attributed to the fact that there are more trucks plying the road than Ife-Ibadan road. These heavy trucks use diesel that may contain more lead than petrol or gasoline being used by most cars, buses and motorbikes. Some vehicles use gasoline that may be unleaded. Also, the width and type of carriage way may be another source of the difference despite higher traffic density on Ife-Ibadan road than Ogbomoso-Igbeti. The wide alley may encourage high wind drift that will carry the fine particles farther away from the point of emission at the road side.

The relationship that exists between traffic density and concentration of metals shows that motor vehicles could be a major source of metal pollution in the road side since no industrial activity could be linked to the presence of these metals.

Conclusion

There are more vehicles plying Ife-Ibadan road than Ogbomoso-Igbeti road and also, road side vegetation and cassava flour being sun -dried by the road sides are contaminated by heavy metals such as lead which are traceable to the automobile exhaust. It was again observed in this study that vehicle type is of great importance in emission from automobile exhaust because there was significantl higher metal contents from Igbeti-Ogbomoso road than from Ife-Ibadan road which was attributed to the type of vehicles rather than density of vehicles plying the roads.

Recommendation

As a result of the roadsides being contaminated, certain steps should be taken to ensure that metals associated with automobile exhaust do not get into food chain and also to reduce the effect of these metals on the ecosystem. Some of the measures are; government should carry out sensitization campaign to educate people on the danger of heavy metals on man and animals, roadside farming activities should be discouraged along major roads or urban areas with heavy vehicular traffic. The use of lead - free gasoline i.e. unleaded petrol should be encouraged and promoted and there should be an enforcement of the edict banning the sun–drying of foodstuff such as Cassava Flour along roadside.

REFERENCES

Ademoroti, C.M.A. (1986): Levels of Heavy Metals on Bark and Fruit of Trees in Benin City, Nigeria. International Journal of Environmental Pollution, 11 pages; 241-253.

Ademoroti, C.M.A. (1992): "Blood Lead Levels in People Living in Traffic Areas of Lagos". Teaching Monograph, Chemistry Department, University of Benin, Benin City. Nigeria.

Ademoroti,C. M. A. (1996): Environmental Chemistry and Toxicology. Foludex Press Limited, Ibadan. 171 – 195..

Alloway, B.J. (Ed.) (1995): Heavy Metals in Soils. Blackie and Sons Limited, Glasgow. 1- 52.

Alloway, B. J. and Davie us, B. E. (1971): Heavy Metal Content of Plants Growing on Soil Contaminated by Lead Mining. Journal of Agricultural Science Cambr, 76:321 – 323.

Amusan, A. A., Bada, S. B. and Salami, A. T. (2003): Effect of Traffic Density on Heavy Metal Content of Soil and Vegetation Along Roadsides in Osun State Nigeria. West African Journal of Applied Ecology, 4: 107 114.

Aribike, D. S. (1996): Environmental Impacts of Industrialization in Nigeria: A Treatise Paper Presented at the Conference of Nigerian Society of Chemical Engineers, November 14-16, 1996.

Atayese, M.O, Eigbadon, A, I., Oluwa, K. A. and Adesodun, J. K. (2009): Heavy Metal Contamination of *Amaranthus* Grown Along Major Highways in Lagos, Nigeria. Africa Crops Science Journal, 16 (4): 225-235..

Bada, S.A (2000): Heavy Metal Concentration of Soil and Vegetation Associated with Highways of Two Different Traffic Densities in Osun State. An Unpublished Master of Science Thesis Submitted to the Institute of Ecology and Environmental Studies, Obafemi Awolowo University, Ile-Ife, Nigeria.

Balba, A.O. Shibiny, G. and El-Khatib, E. (1991): Effect of Lead Increment on the

Yield and Lead Content of Tomato Plant. Water Air Soil Pollution, 21: 82-86.

Bhargava, A.K., Gupta, R; Bhargava, S. (2003): Effect of automobile exhausts on Total N, P and Total Heavy Metal of Road Side Sugar Cane at District Saharanpur, U.P. Adv. Plant Science, 16(2) : 557-560.

Blacksmith Institute World's Most Polluted Places (2007): Obtained at http:// www.blacksmithinstitute.Org / ten. Retrieved on 19 - 5 - 2010.

Breckle, S.W. and Kahle, H. (1992): Effects of toxic heavy metals cadmium and lead on growth and mineral nutrition of beech *Fagus sylvatica* L. Vegetatio, 101 (1) : 43-53.

Cassaret and Doull (1996): Heavy Metals and Health. World Resources Institute, Washington.

Csintalan, Z. and Tuba, Z. (1992): The Effect of Pollution on the Physiological Processes in Plants. In: Biological Indicators in Environmental Protection, Kovacs, M.(ed),Ellis Horwood , New York.

Davies, B. E. (1983): A Graphical Estimation of the Normal Lead Content of Some British Soils. Geoderma, 29: 67-75.

FAO / WHO (2001): Food additives and contaminants. Joint FAO/WHO Food Standards Programme, ALINORM 01/12A: 1-289.

Fatoki,0. S. and Ayodele, E. T. (1991): Zinc and Copper in Tree Barks as Indicators of Environmental Pollution. Environment International,17: 455- 460.

Federal Ministry of Works and Housing (FMW&H) (1999): Microcounts Form of Ife-Ibadan road. FMW&H (Traffic Unit) Ibadan, Nigeria.

Gadgil, J.M, Gaikwad, U .S., Ranade, C.D. (2006): Plants as Bio- Indicators of Automobile Exhaust Pollution: A Case study of Sangli City. Journal of Environment – EN, 86:29 – 33.

Garcia, W. J., Blessin, C. W., Sandford, H. W. and Inglett, G. E. (1979). Translocation and Accumulation of Seven Heavy Metals in Tissues of Corn Plant Grown on Sludge-Treated Strip-Mined Soil. Journal of Agricultural Food Chemistry, 27:1088-1094..

Kimani, N.G (2007). Environmental Pollution and Impact to Public Health, A Pilot Study Report in Cooperation with the United Nations Environment Programme (UNEP), Nairobi, Kenya.

LeCoultre, D. (2001). A Metal-Analysis and Risk Assessment of Heavy Metal Uptake in Common Garden Vegetables. East Tennessee State University, United State of America.

Ma, H.W.,Hung, M.L. and Chen, P.C. (2006): Asystemic health risk assessment for the chromium cycle in Taiwan. Environment International. 10:1016..

Ndiokwere, C.L (1984): A Study of Heavy Metal Pollution from Motor Vehicle Emissions and its Effect on Roadside Soil, Vegetation and Crops in Nigeria. Journal of Environmental Pollution, Series B, and 7 pages: 35-42.

Osibanjo, O. and Ajayi, S.O. (1980): Trace Metal Levels in Tree Barks as Indicators of Atmospheric Pollution. Environment International, 4: 239-244.World Health Organization (1977): Environmental Health Criteria 3. Lead .WHO, Geneva.

Turcsanyi, G. (1992): Plant cells and tissues as indicators of environmental pollution. In: Biological indicators in environmental protection, Kovacs, M. (Ed.) Ellis Horwood, New York.

Xiong, Z. T. (1998). Lead Uptake and Effect on Seed Germination and Plant Growth in a Lead Hyper Accumulator *Brassica pekinensis* Rupr. Bull. Environmental Contamination Toxicology, 60: 287-291.