

MANGIFERA INDICA AS A BIOINDICATOR OF LEAD, COPPER AND IRON IN THE VICINITY OF A METAL SMELTING PLANT, BUKURU JOS, NIGERIA.

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ABSTRACT

The levels of lead, Pb copper Cu and iron Fe in *Mangifera indica* leaf and bark and the native soil samples in the vicinity of Makeri smelting plant, Bukuru, Plateau state, were determined using Atomic Absorption Spectrophotometer (AAS). The aim was to assess the extent of pollution of the environment under study. Results show that the soil pH ranged from 9.40 to 10.17 indicating that the soil samples were generally alkaline with the possible effect of trapping metal ions as hydroxides. The leaf, bark and soil samples gave mean Pb values of 33.40 ± 0.01 , 19.25 ± 0.03 and $12.30 \pm 0.12 \mu\text{g/g}$ respectively at a distance of 10 metres from the factory. The corresponding values obtained at a distance of 200 metres were 9.65 ± 0.01 , 5.20 ± 0.10 and $11.65 \pm 0.0 \mu\text{g/g}$ for leaf, bark and soil samples respectively. However, at a distance of 400 metres away from the factory, the leaf, bark and soil samples gave 6.03 ± 0.02 , 3.10 ± 0.12 and $10.40 \pm 0.05 \mu\text{g/g}$. The value of Cu was 27.00 ± 0.11 , 14.00 ± 0.17 and $43.50 \pm 0.15 \mu\text{g/g}$ in the leaf, bark and soil samples respectively at 10 metres away from the factory, decreasing to 20.00 ± 0.03 , 10.85 ± 0.02 and $39.30 \pm 0.20 \mu\text{g/g}$ while at a distance of 400 metres the corresponding values were 19.30 ± 0.22 , 8.00 ± 0.13 and $3.00 \pm 0.17 \mu\text{g/g}$ for the leaf, bark and soil samples respectively. The value of Fe was $479.55 \pm 0.1 \mu\text{g/g}$ in the leaf, $116.8 \pm 0.15 \mu\text{g/g}$ in the bark and $817.11 \pm 0.10 \mu\text{g/g}$ in the soil sample at a distance of 10 metres which decreased to 220.00 ± 0.22 , 80.30 ± 0.10 and $749.60 \pm 0.13 \mu\text{g/g}$ respectively at 200 metres. The values further decreased to 62.15 ± 0.13 , 32.70 ± 0.11 and $655.20 \pm 0.21 \mu\text{g/g}$ in the leaf, bark and soil samples respectively at a distance of 400 metres suggesting that the metal smelting activity of the factory has contributed to high metal load in the environment.

KEY WORDS: *Mangifera indica*, bioindicator, metals

INTRODUCTION

Interest has grown over the years concerning the fate of our environment in view of the daily accumulation of toxic substances in it (Rao, 1991). Heavy metals contribute to the pollution of the environment. They occur mostly in the dissolved form, ionic chellated, colloidal or as suspended matter. Some are found to be metallo-proteins in which oxygen carriers like the haemoglobin, haemo-cyanin combine with the heavy metals tightly (Bryan, 1976). Heavy metals such as mercury, copper, cadmium, and lead are known to be very toxic and they inhibit enzyme activities by forming mercaptide with the sulphhydryl group (Katz, 1994).

Smelting activities may be expected to increase the metal load of the environment as wastes are often disposed within the environment. Biomonitoring using plants is now more commonly used than the direct chemical analysis. This is because the plant resides within the environment and thus records all changes therein. Also they can tolerate large volumes of heavy metals due their physiology.

Various plant species have been used as bioindicators for example mosses (Grodzinska, 1978), lichens (Pakarinen *et al*, 1978), broad leafed trees (Linzon *et al*, 1976), Coniferous trees (Grodzinka, 1984; Huttunen *et al.*, 1985) and agricultural crops (Salami *et al*, 2001).

In this study the use of *Mangifera indica* as a bioindicator of Pb Cu and Fe in the environment of a metal smelting plant is reported.

EXPERIMENTAL

Area of Study

Plateau state lies between longitude $8^{\circ} 15^1 - 11^{\circ} 15^1 \text{E}$ and latitude $8^{\circ} 10^1 - 11^{\circ} 15^1 \text{N}$.

Materials

The leaves and bark samples of *Mangifera indica* as well as soil samples were obtained in the vicinity of Makeri smelting Factory Bukuru Jos South Local Government Area Plateau State (Salami, 2004). They were then transported to the laboratory in clean polyethylene bags.

Sampling

Sampling was done at an interval of 2 months for a period of 7 months during the dry seaeon (September 2007/March 2008) and at varying distances of 10, 200 and 400 metres away from the factory.

500g of leaf sample was collected at a height of 2.5 metres above the ground level in the direction of the prevailing wind at the time of sampling (Salami, 2004). The leaves were rinsed with distilled water to remove surface impurities and the water allowed to drain off in a

dust free environment followed by drying. The dry sample was powdered using a mortar and stored in dry plastic containers until needed.

Bark samples were excised using a new sharp stainless steel knife at the height of 1.5 metres from the ground in the direction of the wind at the time of sampling (Salami, 2004). Each excised material 3-5mm thick was air-dried in a dust free room after which it was ground to fine powder using a mortar and then stored in plastic bottles until needed.

Standardization and Sample Analysis

1000ppm lead solution was prepared by dissolving 1.600g of $Pb(NO_3)_2$ in $20cm^3$ of 1% HNO_3 and the volume was made to $1000cm^3$. A 100ppm stock solution of copper was prepared by dissolving 3.8031g $Cu(NO_3)_2 \cdot 3H_2O$ in distilled water and volume was made to the mark in a $1000cm^3$ volumetric flask using distilled water. 7.0215g of $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$ was weighed and dissolved in distilled water and the volume was made to the mark in a $1000cm^3$ volumetric flask to give 1000ppm Fe (Salami *et al.*, 2007). 1g of the powdered oven dried sample (at $105^\circ C$) was weighed and digested with $7cm^3$ acid mixture of HNO_3 : H_2SO_4 : $HClO_4$ in the ratio 5:1:1 as reported (Salami, 2004). The resulting digest was diluted and filtered into a $50cm^3$ volumetric flask and set aside until needed. The blank, sample solutions as well as standards were aspirated into the Atomic Absorption spectrophotometer at 324.8nm, 277nm and 248.5nm for Cu Pb and Fe respectively. Calibration curves were prepared from the reading of the standards while sample solution concentrations were calculated from the standard curves using the expression.

$$\text{Metal (\%)} = \frac{\text{C ppm} \times \text{solution volume (cm}^3\text{)}}{10^4 \times \text{sample weight (g)}}$$

where C = Concentration (ppm)

RESULTS AND DISCUSSION

The results of the analysis are represented in Figures 1 to 3. Figure 1 shows that the concentration of lead (Pb) in the leaf of *Mangifera indica* samples ranged from 6.03 to 33.40 $\mu g/g$ and the bark samples gave 3.10 to 19.25 $\mu g/g$ while the soil sample ranged from 10.40 to 12.30 $\mu g/g$. This shows that the bark samples gave the highest concentration of Pb while the least was obtained in the leaf sample. Pb is a toxic element and is not useful to the plant. Its concentration in the bark could be a way of getting the metal out of the plant system when the bark is excised (Reeves and Brooks, 1983).

The range of Pb obtained in the leaf samples is higher than the value 6.39 $\mu g/g$ obtained by Salami *et al* (2001). This could be due to the metal smelting activities which has the effect of releasing metal residues into the environment (Day *et al*, 1975). The values obtained in the present study are higher than the range 2.4-4.1 $\mu g/g$

reported for *Lylophylum connatum* (Laaksovitva and Alakujjala, 1978) but lower than the value 106 $\mu g/g$ reported for *Lolium perene* (Kovacs *et al*, 1992). The leaf and bark samples have higher concentration of Pb than the soil suggesting that the plant is a good bioindicator of Pb. The value of Pb obtained for soil samples is lower than the range 30-156 $\mu g/g$ reported for soil samples (Milto *et al*, 1992).

Fig. 2 shows that the concentration of (Cu) in the leaf, bark and soil samples ranged from 19.30 to 27.00 $\mu g/g$, 8.00-14.00 $\mu g/g$ and 3.00-43.50 $\mu g/g$ respectively. The element is useful to plants as a component of several enzymes for example ascorbic acid oxidase (Van, 1976). The soil sample contained higher concentration of Cu than the leaf or bark samples suggesting that the plant is not a good accumulator of the element. Corrosion, wear and tear of machine parts release the metal components of the machine into the environment which can be picked up by plants (Kovacs, 1992). The concentration of Cu in the plant is higher than the normal level of 2 $\mu g/g$ (Yagodin, 1984). This is due to the mineral processing activities in the area under study. The range Cu recorded for the leaf samples is higher than the range 3.76-7.60 $\mu g/g$ reported for *Azadirachta indica* leaf in Gombe state while the value of the element obtained for the bark sample is higher than the range reported for *Azadirachta indica* bark (Salami *et al*, 2006), an indication that the area under study is more polluted than Gombe.

In Fig. 3 the concentration of iron (Fe) in the leaf ranged from 62.15 $\mu g/g$ to 479.55 $\mu g/g$, the range in the bark was 32.70 to 116.80 $\mu g/g$ while the corresponding value of the element in soil was 655.2 to 817.11 $\mu g/g$. The sample closest to the smelting plant had the highest concentration of Fe. This may be due to the smelting wastes which are often deposited on the soil within the premises. The soil samples gave higher value of the element than the amount found in either leaf or bark. This is in agreement with the report made by Kelly *et al* (1978). The values 655.2 to 817.11 $\mu g/g$ obtained in the present study for the soil samples are lower than the value 2,700 $\mu g/g$ reported for soil samples from Nagytetyeny, Hungary (Kovacs, 1992). The values of the metal recorded for the leaf samples are higher than the mean value of 60.39 $\mu g/g$ reported for *Azadirachta indica* leaf in Bauchi state (Salami, 2004). The three elements had their highest concentrations 10 metres from the factory site and decreased as the distance increased from 10 to 200 and 400 metres. The lowest concentration was obtained at a distance of 400 metres from the metal smelting plant suggesting that the effect of the metal smelting activity was most pronounced at the base of the factory.

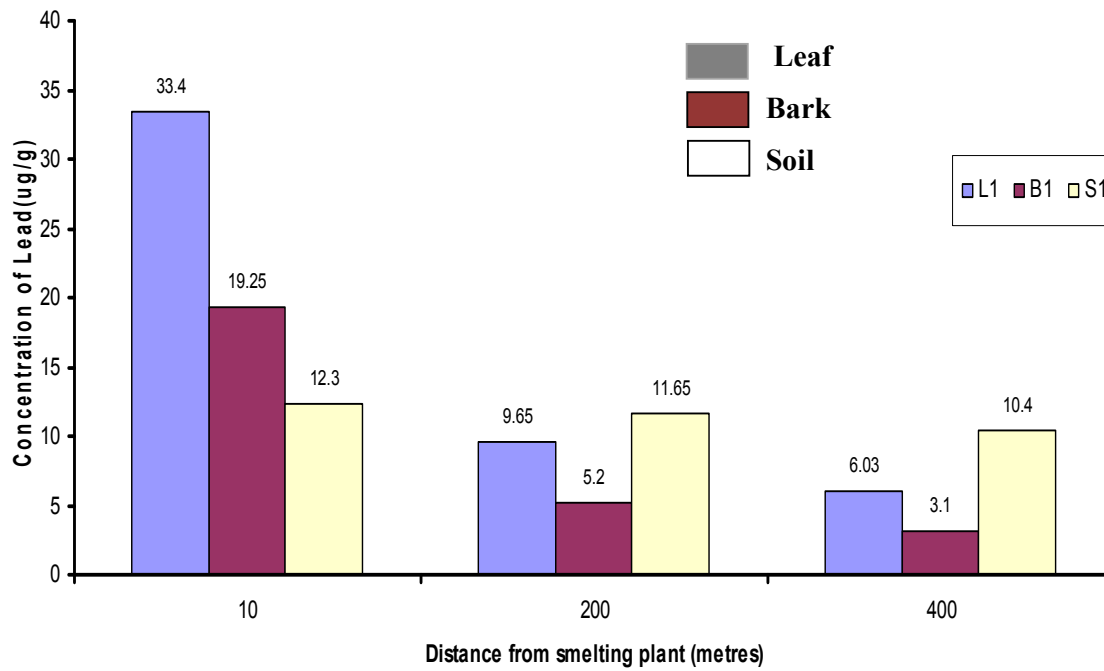


Fig 1: Variation of lead content of leaf, bark and soil samples with distance from a metal smelting plant.

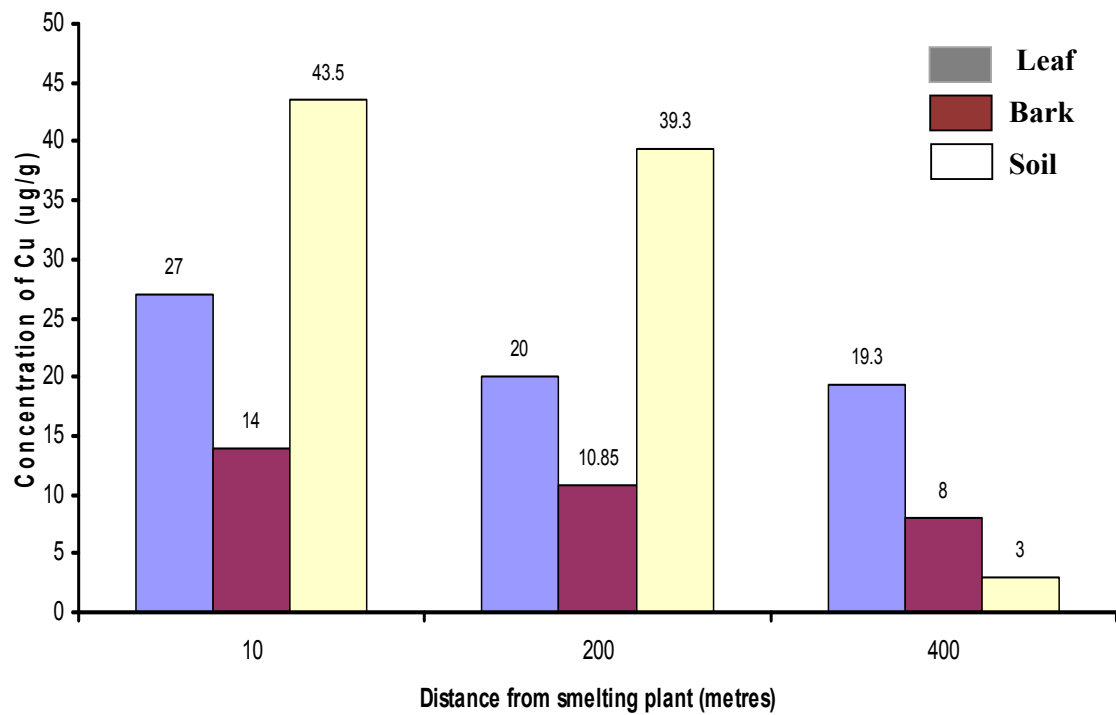


Fig 2: Variation of Cu content of leaf, bark and soil samples with distance from a metal smelting plant.

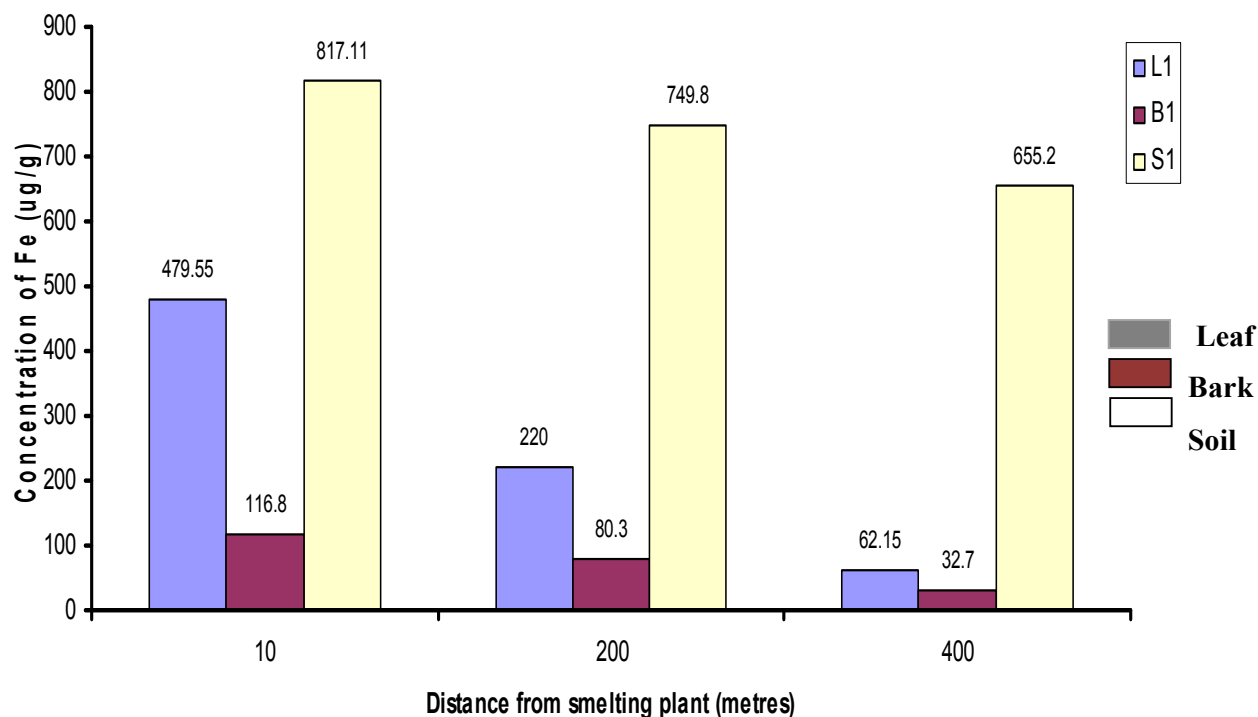


Fig 3: Variation of Fe content of leaf, bark and soil samples with distance from a metal smelting plant.

CONCLUSION

The concentrations of Pb, Cu and Fe were highest at the factory site but decreased at a distance of 10 metres from the factory. These further decreased at 200 and further still at 400 metres. The smelting activity has polluted the land and plant materials in the immediate vicinity of the factory. Crops grown very close to the factory are very likely to be contaminated with these metals making the crops unfit for human consumption. Also wells dug within the premises of the factory are very likely to have high concentration of the metals making the water in them unfit for domestic uses. *Mangifera indica* accumulated higher concentration of Cu and Pb than the prevailing concentration in the soil as illustrated in Figures 1 and 2. This show that the plant is a good bioindicator of Cu and Pb.

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