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LEVEL OF HEAVY METALS IN SOILS AND LEMON GRASS IN JOS, BUKURU AND ENVIRONS, NIGERIA.

S. J. SALAMI, E. A. AKANDE, AND D.M. ZACHARIAH

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ABSTRACT

The need to have a reliable, cheap and reproducible means of assessing the level of pollutants in the environment is of great importance to Scientists. This is very obvious from the fact that the environment is becoming increasingly polluted through the activities of man. This study was aimed at assessing the pollution level of the environment using a plant species (biological indicator)

The leaves of Lemon grass (*Cymbopogon giganteus*) were analysed using Atomic Absorption Spectrometry for the level of Zinc, (Zn), Copper, (Cu), Lead (Pb) and Cadmium (Cd). Samples of the native soil of the plant were also analysed for the same determinants. The concentration of Zn in the Lemon grass samples ranged between 3.53 and 5.20 mg/100g leaf sample while the value in the native soil ranged between 9.32 and 11.80 mg /100g soil sample. The Cu content of the leaf samples ranged between 2.02 and 5.04 mg /100g sample while the values in the soil samples ranged between 2.11 and 3.86 mg /100g sample. Pb accounted for about 8.06 -16.80 mg /100 g in the soil and 7.15 - 19.05 mg /100 g leaf samples. The leaf samples gave 1.40 - 2.16 /100 mg Cd /100g sample while the soil samples gave 1.21 - 2.70 mg Cd /100g soil sample.

The results indicated that Lemon grass showed some preference for accumulating Cu ,Pb and Cd than for Zn, the ratio of the concentration of determinant in the plant to that in the soil was greater than unity in respect of Cu, Pb and Cd indicating that Lemon grass has a tendency of accumulating the said metallic elements to the extent that their concentration exceeds that in the native soil.

KEYWORD: Heavy metals, lemon grass, soil.

INTRODUCTION

Heavy metal pollution of the environment is of great concern to all Scientists as a result of its detrimental effects on the human environment. A soil rich in heavy metals is a potential source of the metals to plants. Atmospheric deposition is another source of heavy metals to plants in the form of particulate matter (Rao,1991). A common method of determining the levels of heavy metals is the direct determination which could be costlier than the indirect measurement referred to as biomonitoring (Kovacs, 1992). With direct determination, there is the possibility of the variation in concentration of determinants at different times when the pollutant is discharged, while at other times it is evenly dispersed. With bioindicators, the level of pollutants increases as more are introduced into the environment.

Biomonitoring using plants as bioindicators is gaining popularity as opposed to the use of animals. This is because plants are sedentary and record all the changes taking place in their environment. Also , samples can always be taken from plants. Animals are not good bioindicators because their physiology does not support the accumulation of toxic substances without consequences such as death but plants are able to tolerate pollutants better. A plant that can be used as a bioindicator should be easily identified and readily adaptable (Kovacs, 1992). Various plant species have been used as bioindicators of heavy metals (Grodzinska, 1984). Lichens have been used to monitor pollution levels in cities (Grodzinska, 1978) while *Parmelia physodes* was used for estimating lead level in the environment of a highway (Schutte, 1977). *Lolium perene* leaf has been reported to contain higher level of Cd (2.5µg/g) than the soil (1.90µg / g) showing that the plant species accumulated Cd to levels above that in the soil (Kovacs, 1992). Beckett et al (1982) reported the suitability of *Cladonia rangiferina* as an indicator of Fe, Pb and Ti. The leaves of forest species such as *Vaccinicum myrtillus* and V. vitis – idaea have been used to monitor the metal loads of Cd, Fe, Mn and Pb at the site of a Zn processing factory

(Czuchajowska et al, 1980). Not much information is available on the use of lemon grass as bioindicator of heavy metals in the environment. The present study is therefore aimed at the use of Lemon grass species to estimate the levels of Zn, Cu, Pb and Cd in the environment

STUDY METHODOLOGY

Fieldwork

The area under study (Jos – Bukuru) has been described ealier (Salami et al, 2001). Lemon grass (*Cymbopogon giganteus*) is a perennial grass often used as a low hedge around houses. It is very common in both cities and villages. 500g of soil sample was obtained using a core sampler from a depth of 20 cm from seven different locations and treated separately. This was broken into small particles and stored in clean polyethylene bags until needed. 100g of Lemon grass was obtained from the same sites and rinsed with distilled deionised water for about 30 seconds after which the wash water was allowed to drain off completely in a dust-free room. The sample was then chopped into small pieces and stored in clean polyethylene bags for analysis. The leaf and soil samples so obtained were designated as L1-L7 and S1-S7 where L and S represent leaf and soil samples respectively.

Samples	Location
L1,S1	University of Jos Senior Staff Quarters, Bauchi Road
L2,S2	Naraguta Village
L3,S3	Angwan Rukuba
L4,S4	Rock Havens, Zaria Road
L5,S5	National Library, Dadin Kowa
L6,S6	Bukuru Low cost housing estate
L7,S7	Bukuru Township

S. J. Salami, Department of Chemistry, University of Jos, Jos, Nigeria.
E. A. Akande, Department of Chemistry, University of Jos, Jos, Nigeria.
D. M. Zachariah, Department of Chemistry, University of Jos, Jos, Nigeria.

Reagents

All reagents used were of Analytical grade supplied by British Drug House {BDH} and May and Baker except otherwise stated. Solutions were prepared using distilled deionized water where water was the solvent.

Laboratory analysis

Moisture content and dry matter

2 g of freshly cut leaves was placed in a pre-weighed clean dry porcelain dish and weighed again after which the dish with content was placed in an air oven at 105 ^{o}C for 24hrs. The sample was re-weighed at intervals until constant weight was obtained. The procedure was repeated using a 2 g sample of the native soil. The loss in weight was noted and the percentage moisture content and dry matter were evaluated as earlier reported (Salami and Non, 2002).

$$\text{Moisture content (\%)} = \frac{\text{Weight loss (g)} \times 100}{\text{Sample weight (g)}}$$

Dry matter (%) = 100 - % Moisture content

Determination of Heavy metals by Atomic Absorption Spectrophotometry (AAS)

Sample preparation

Stewart (1974) has described a wet digestion method of sample preparation. The wet digestion method involving the use of concentrated percholoric acid, concentrated nitric acid and sulphuric acid was used to bring the sample into solution. 20g of each of the samples was weighed and cut into small pieces, dried at 105 ^{o}C and powdered using a mortar and pestle after which it was stored in dry plastic bottles. 1 g oven dried powdered soil sample was weighed into a 100 cm^3 Kjeldhal digestion flask, 5 cm^3 of concentrated nitric acid (HNO_3) was added followed by 1 cm^3 each of concentrated sulphuric acid (H_2SO_4) and 60 - 62% perchloric acid ($HClO_4$). The flask was placed in a slanting position on an electric heating mantle in a fume cupboard and heat was supplied gradually until the evolution of white dense fumes of H_2SO_4. The volume of the digest was reduced by heating but not to dryness. The flask was set aside to cool after which the content was diluted with distilled deionised water and then filtered into a 50cm^3 volumetric flask. The content was diluted to the mark with distilled water and used for the determination of Zn, Cu, Pb and Cd. 1g of oven dried powdered lemon grass sample was treated in the same way as the soil.

Standard solutions

1000 ppm stock solution of Zn, Cu, Pb and Cd were prepared and serial dilutions were also carried out to obtain the appropriate working range as earlier described (Salami and Non, 2002). The sample solutions as well as standards were aspirated into the Atomic Absorption Spectrophotomer at 213.8 nm, 324.8 nm, 277 nm and 215.8nm for Zn, Cu, Pb, and Cd respectively. Calibration curves were prepared from the readings of the standards while sample readings were extrapolated from the standard curves.

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

Where C (ppm) is the reading of sample. Dilution factors were applied where necessary.

RESULTS AND DISCUSSION.

The results of the analysis are as shown in Tables 1, 2 and 3 for the Lemon grass and soil samples

Table 1: The moisture and Dry Matter content of the Lemon grass (L) and Soil (S) samples (%).

	Moisture	Dry Matter
L1	23.20 ± 0.20	76.80 ± 1.15
L2	24.93 ± 0.10	75.07 ± 1.86
L3	19.21 ± 1.09	80.79 ± 2.19
L4	21.54 ± 0.40	78.46 ± 2.01
L5	24. 0.3 ± 0.22	75.97 ± 1.74
L6	27.60 ± 0.40	72.40 ± 2.38
L7	27.80 ± 0.30	72.20 ± 2.11
S1	5.15 ± 0.07	94.85 ± 3. 45
S2	4.14 ± 0.06	95.86 ± 2.63
S3	2.94 ± 0.05	97.06 ± 3.03
S4	3.43 ± 0.09	96. 57 ± 1.51
S5	4.56 ± 0.65	95.44 ± 2.75
S6	6.23 ± 0.26	93.77 ± 1.81
S7	6.56 ± 0.92	93.44 ± 2.12

Mean ± Standard deviation of 4 determinations

From Table 1, it can be seen that the moisture content of the soil samples ranged from 2.94 to 6.56% while the corresponding range for Lemon grass samples was 19.21 – 27. 80%. The moisture contents of the samples were low because the samples were obtained between October and December, a period which coincides with the dry season. The moisture content of the Lemon grass was higher than that of the soil possibly because Lemon grass has succulent root system that tend to store water for the plant. The dry matter content of the grass samples ranged from 72.20 to 80.79% while the range for the soil was 93.44 to 97.06%.

Table 2: Zn ,Cu,Pb and Cd Content of Lemon grass samples (mg/100 g dry sample).

Samples	Z	Cu	Pb	Cd
L1	4.90 ± 0.20	2.00 ± 0.21	19.00 ± 0.20	1.50 ±0.10
L2	5.00 ± 0.10	4.01 ± 0.30	15.06 ± 0.13	1.40 ± 0.02
L3	4.50 ± 0.20	5.04 ±0.30	11.12 ± 0.40	2.16 ± 0.03
L4	4.20 ± 0.12	4.00 ± 0.20	7.15 ± 0.21	1.42 ± 0.11
L5	5.22 ± 0.14	2.02 ±0.40	12.00 ± 0.20	2.23 ± 0.02
L6	3.53 ± 0.21	2.06 ± 0.04	14.01 ± 0.40	2.03 ± 0.01
L7	4.70 ± 0.10	2.05 ± 0.05	19.05 ± 0.42	1.61 ± 0.21

Mean ± Standard deviation of 4 determinations

Table 2 shows the heavy metal content of the lemon grass samples. L6 gave the lowest value of Zn (3.53 ± 0.21 mg/100 g sample) while the highest value (5.22 ± 0.14 mg/100 g sample) was obtained in L5. The values of Zn obtained for Lemon grass in this study are within the range 2.32-12.6 mg/100g sample reported for Linden tree leaves (Milto et al.1992). The value of Zn in this present study (3.53 - 5.22 mg /100g sample) are lower than the 251 mg Zn/100g sample obtained for Lemon grass growing in a heavily polluted area near the discharge point of waste from automobile factory (Somasheka et al ,1982). Among the soil samples ,S3 gave the highest value of Zn (19.90 ± 0.79 mg/100g sample) while the least was obtained in S5 (9.32 ± 0.27 mg/100g sample). The high level of Zn could due to the release of soil dusts rich in Zn from the quarry activities, metal works and welding of various articles.

The Cu content of the leaf samples L1-L7 are within the range 2.00-5.04 mg/100g sample. The highest concentration of Cu recorded for sample L3 (5.04 ± 0.30 mg/100g sample) is lower than the value 11.00g Cu/100g sample reported for Lemon grass from a heavily polluted area near an automobile factory (Somasheka et al ,1982). The high concentration of Cu could be due to the leachates from disposed mine wastes. The Cu content of the soil samples ranged between 2.22 - 3.86 mg/100g samples. Some of these values are generally lower than those recorded for the Lemon grass leaf samples indicating that Lemon grass is a good accumulator of Cu. The ratio of Cu in Lemon grass to Cu in soil were 0.74, 1.9, 1.31, 1.05, 0.71, 0.78 and 0.92, an indication of substantial level of accumulation of the element in Lemon grass, making the plant a good accumulator of Cu. The values of Cu obtained in the present study for the soil samples are within the range 0.96- 5.00 mg/100g soil sample reported by Milto et al (1992).

The Pb content of the Lemon grass samples ranged between 7.15- 19.05 mg/100g sample. The highest value (19.05 ± 0.42 mg /100g sample) was obtained in L7, a sample obtained from the busy township. The levels of Pb recorded in the present study were lower than the values 17, 32 and 310mg / 100g sample reported for *Lemanea*, *Amblysteigium* and *Fontinalis* species respectively (Whinton, 1979). The values are also lower than the value 1732 mg / 100g reported for *Hylocomium splendens* (Maschke, 1981). The environments of Jos and Bukuru are less polluted with respect to Pb compared to the environments described by Whinton (1979) and Maschke (1981). A major source of Pb is the use of petrol by automobiles which accounts for about 80% of Pb in the atmosphere, with about 50% of this falling to the ground within a distance of 100 metres from the road while the remainder is distributed widely in the biosphere (Lagerwerff, 1972). Another source is the indiscriminate dumping of mine wastes as this contributes to the Pb load in plants (Day et al, 1975). The value recorded for L7 is higher than the range 1.2- 12.6 mg/100g sample reported for Linden leaves (Milto et al 1992).

Table 3: Zn ,Cu,Pb and Cd Content of Soil samples (mg /100 g dry sample)

Samples	Zn	Cu	Pb	Cd
S1	11.80 ± 0.06	2.71 ± 0.28	11.76 ± 0.95	1.70 ± 0.13
S2	10.91 ± 0.12	2.11 ± 0.15	10.41 ± 0.67	1.21 ± 0.25
S3	19.90 ± 0.79	3.86 ± 0.97	13.35 ± 1.05	1.70 ± 0.08
S4	14.55 ± 1.15	3.82 ± 0.18	8.06 ± 0.25	1.30 ± 0.11
S5	9.32 ± 0.27	2.86 ± 0.14	13.17 ± 1.05	2.69 ± 0.33
S6	9.60 ± 0.88	2.63 ± 0.36	16.80 ± 1.21	2.70 ± 0.17
S7	10.50 ± 0.90	2.22 ± 0.02	12.72 ± 0.9	1.80 ± 0.09

Mean ± Standard deviation of 4 determinations

Table 3 shows the heavy metal content of the soil samples. Samples S1-S7 gave Pb concentrations in the range 8.06-16.80mg/100g samples, which are generally lower than those, obtained for the Lemon grass samples, again indicating some significant extent of accumulation of Pb in the leaf. The range of Pb concentrations in the soil in the present study (8.06-16.80 mg/100g) is close to the range (3.00-15.60 mg Pb /100g soil sample) ealier reported (Milto et al ,1992).The value of Pb obtained in samples L1-L7 (7.15-19.05 mg/100g sample) are quite lower than the 2900 mg Pb /100g sample recorded for Linden leaf in a heavily polluted soil (Somasheka et al, 1982). This shows that the environment under study is less polluted.

Sample L5 gave the highest concentration of Cd, (2.23 ± 0.02 mg /100g sample) while the least (1.40 ± 0.02 mg /100g sample) was obtained in sample L2. The location of sample L5 (its proximity to metal scrap waste dump site and a busy road) could have contributed to the high value of Cd in L5 as compared to L2 obtained from a village community relatively less polluted. The concentrations of Cd in the present study are generally higher than those reported for the respective soil samples S1-S7 (1.21-2.70 mg/100g soil sample indicating that Cd is accumulated by Lemon grass. Jinxiong and Nianxion (1994) reported similar accumulation of Cd in rice with 90 percent of the Cd concentrated in the root. The concentrations of Cd in the present study for S1-S7 (1.21-2.70 mg/100g sample) are within the range 0.10-14.30 mg/100g soil sample recorded for the soil fairly polluted by a small power station (Dudka et al, 1995).

CONCLUSION

The present study has shown that Lemon grass tends to selectively accumulate Cu ,Pb and Cd . Lemon grass is thus a good bioindicator of Cu, Pb and Cd as evidenced by the high ratio of the element concentration in Lemon grass to that in the soil. This is a case of preferential accumulation of Cu, Pb and Cd, similar to that of Cd in *Lolitum perene* (Kovacs, 1992).

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