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Eucalyptus camaldulensis a bioindicator of sulphur, zinc and lead in Jos, Nigeria

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ABSTRACT

The leaves of *Eucalyptus camaldulensis* from Jos and environs, Plateau state, Nigeria, were analysed for Zinc (Zn) and lead (Pb) while the bark were analysed for sulphur (S), Zn and Pb. Soil samples from the same location were also analysed. The aim was to estimate the S, Zn and Pb load of the environment and thus the suitability of the plant as a bio-indicator of these elements. The S content of the bark samples ranged from 0.77 to 1.54mg/g with a mean value of 1.03mg/g, indicating pollution of the environment. The concentration of Zn in the leaf ranged from 5.92 to 69.28 μg/g while the range in the bark was 13.10 – 47.77 μg/g The concentration of Zn is the soil ranged from 10.41 – 58.46 μg/g The corresponding range of Pb in the leaf was 4.09 – 8.27 μg/g while in the bark the range was 3.98 – 54 μg/g The level of Pb in the soil was 4.32 – 8.70 μg/g Zn was more concentrated in the leaves than the bark while Pb was more concentrated in the bark than the leaves. Zn is an essential element required for metallo-enzyme formation in the leaf, the photosynthetic organ of the plant while Pb is a toxic element and its accumulation in the bark could be a way of getting rid of its toxicity from the plant system.

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INTRODUCTION

Our environment is becoming relatively unsafe as a result of environmental pollution. Toxic gases such as SO_2, CO and NOx as well as heavy metals pollute the environment [1]. Direct determination of the concentration of the pollutants is the usual method for estimating their levels. However, the use of plants as bio-indicators in estimating the level of pollutants is becoming wide spread for some reasons among which is the fact that plants are sedentary and samples can always be taken without much variation.

As a consequence of its being in direct contact with the environment a plant is able to record the changes that take place. It is necessary for plants that can be used as bioindicators to meet the criteria such as having large number of species that can be easily identified and readily adaptable [2].

It has become more rewarding to use bioindicators than the direct analysis because it is cheaper and the bio-indicator records the actual concentration at the time of sampling [3]. A possible plant that can be used for biomonitoring is *Eucalyptus camaldulensis* (Ec) Hausa– Jemaiza, an exotic plant species adaptable to a range of Nigerian site [4]. It is an evergreen tree or shrub with about 700 species and was first introduced to Nigeria in 1916 in the mining area of Jos Plateau as cover crop [5].

In this study the leaves of *Eucalyptus camaldulensis* were analysed to indicate Zn and Pb while the bark samples were analysed for S, Zn and Pb load of the environment in Plateau state.

EXPERIMENTAL

Materials

Leaf and bark samples of *Eucaluptus camaldulensis* were obtained from different locations in Jos–Bukuru metropolis covering areas of intense industrial and vehicular activities as well as those of low activities. Solutions were prepared from analytical grade reagents obtained from May/Baker and British Drug House.

Sampling

At a depth of 0–30cm, 1kg of soil sample was obtained using a core sampler, 50g of this was ground to fine powder and dried at 105°C after which it was stored in plastic bottles until needed. 250g of leaves was collected at a height of 2.5 metres above the ground in the direction of the prevailing wind at the time of sampling [2]. The leaves were placed in clean plastic bags and then transported to the laboratory, after which they were rinsed with distilled water to remove surface impurities and air-dried as recommended [6].

They were ground using mortar and was stored in plastic bottles until needed.

Tree bark samples were excised using a new sharp stainless steel knife at the height of 1.5 metres above the ground [6] in the direction of the prevailing wind [2]. Each excised material 3-5 mm thick was transported in plastic bags and air – dried after which it was ground to fine powder using mortar and then stored in clean plastic bottles until needed.

Preparation of sample solutions and determination

One gram powdered sample was weighed and digested using the acid mixture HNO_3, $HClO_4$ and H_2SO_4 [7]. The resultant solution was filtered and diluted to mark in a 50 cm^3 volumetric flask and preserved for the determination of Zn and Pb. Another 1g portion of the powdered sample was weighed into a digestion tube and 5cm^3 HNO_3 – $HClO_4$ (ratio 2:1) was added after which the mixture was heated in the fume cupboard. 1cm^3 1:1HCl solution was added to dispel traces of oxides of nitrogen. The solution was cooled and then diluted with 10cm^3 distilled water and filtered into a 50cm^3 volumetric flask and diluted to mark. This was set aside for S determination. Standard sulphate sulphur solutions were prepared using anhydrous K_2SO_4 as described [8].

The digest (10cm^3) of was transferred into a 50cm^3 volumetric flask and water was added to bring the volume to about 40cm^3. Gelatin–$BaCl_2$ (2cm^3) solution was added and the volume was made up to the mark with water[9]. It was allowed to stand for 30 minutes, after which the percentage transmittance was determined at 420nm using CECIL 3000 spectrophotometer as describ- ed [9]. Zinc and lead were determined using Atomic Absorption Spectrophotometer (Buck Scientific). Blank solutions were prepared [8].

RESULTS AND DISCUSSION

Table 1 shows the S content in the bark samples. The concentration of S ranged from 0.77 to 1.54mg/g. The distribution patterns for S is unimodal and skewed towards higher frequencies of low concentration of S with a mean of 1.03mg/g and coefficient of variation of 19.42% (Fig 1). The S concentration observed are higher than the range 0.829-0.853mg/g reported for *Fgus Silvalica* bark [11] but lower than the range 1.60 –2.15mg/g reported for Scots pine needles in Kano municipality [12], possible sources of S in the environment include industrial operations utilizing process heaters, catalytic cracking, H_2S flares, de – coking operations and decomposing organic wastes as well as sewage and traffic emissions [12]. Sulphur on oxidation produces SO_2 to form acid rains. SO_2 has been reported to have caused forest decline [13] making its presence a nuisance [11,12, 13].

The direct release of vehicle exhausts and industrial fumes which contain SO_2 and other toxins endangers health. The effect of SO_2 causes damage to building materials, cause deterioration of properties and a lot of other adverse effects.

Table 1: Sulphur distribution in Eucalyptus camaldulensis bark in Jos and environs (mg/g)

Mean	1.03
SD	0.20
Maximum	1.54
Minmum	0.77
Range	0.77

Table 2 shows the Zn content in the soil, *Eucalyptus camaldulensis* leaves and bark. The frequency distribution patterns for Zn in soil, *Eucalyptus camaldulensis* leaves and bark in Plateau State is shown in Fig 2. The distribution patterns for Zn in the leaf is multi-modal and is skewed towards high frequencies of low concentration with a mean of 31.26 μg/g (Table 2) and coefficient of variation of 10.24%. The distribution pattern for Zn in the bark is also multi-modal and skewed towards high frequencies of low concentration with a mean of 23.03 μg/g (Table 2) and coefficient of variation of 32.70%. The distribution pattern for Zn in the soil is with a mean of 30.42 and coefficient of variation of 38.03%. The level of Zn in the soil was higher than that in the bark but lower than that in the leaves. The leaf contained higher concentration of Zn than the bark. This could be because the element is required in the photosynthetic process in the leaf [14]. It is essential to plants as it forms metallo enzyme complexes. Zn forms stable bonds with nitrogen and sulphur ligands and assists in the utilization of phosphorus and nitrogen in plants. The element is essential for the leaf expansion, elongation of inter-nodes, the flowering and fruiting of plants as well as auxin metabolism for example, tryptophan synthetase and typtamine metabolism [15].

The frequency distribution pattern for Pb in the soil, *Eucalyptus camaldulensis* leaves and bark in Plateau State is given Figure 3. The distribution is multi-modal and skewed towards high frequencies of low concentration with a mean Pb concentration of 5.60 μg/g (Table 3) and coefficient of variation of 30.0% for the leaf while for the bark a mean value of 5.80 μg/g was obtained with coefficient of variation of 22.76%.

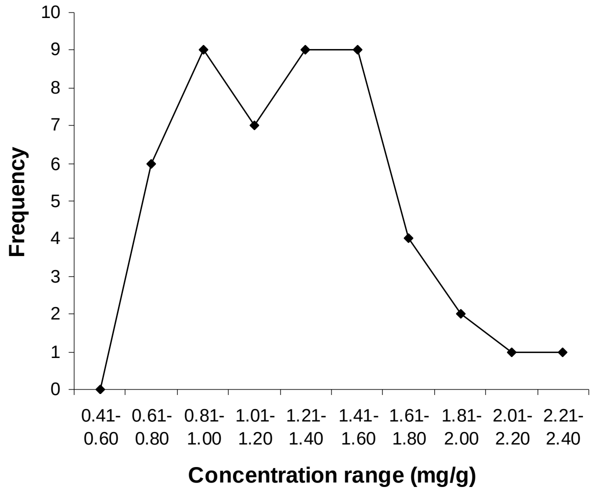

Figure 1: Frequency distribution pattern for sulphur in Eucalyptus camaldulensis

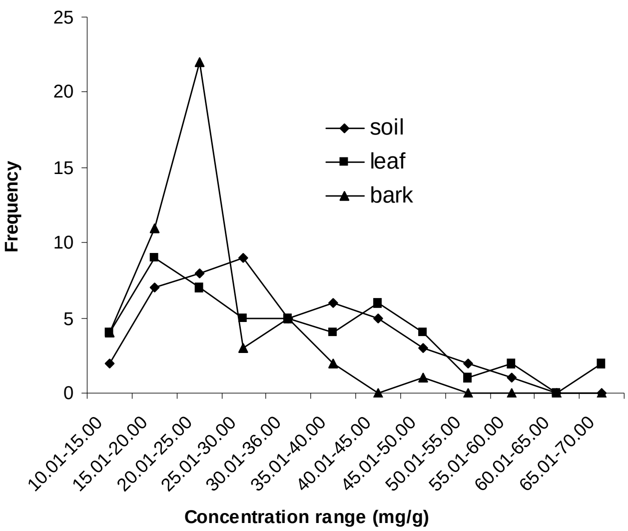

Figure 2: Frequency distribution pattern for Zn in soil, *E. camaldulensis* **leaves and bark**

The distribution pattern for Pb in the soil is multi-modal with a mean of 6.03 µg/g and coefficient of variation of 22.39%. The Pb concentration in the bark was higher than that in the leaf because the element is toxic and not needed in plant metabolism in the leaf [12].

Pb concentrates in the bark as a way of removing the element from active circulation in the plant. When the bark is excised along with the accumulated Pb, the plant system in relieved of the possible toxic effects of Pb [13]. Major sources of Pb into the environment includes the burning of petrol, which accounts for about

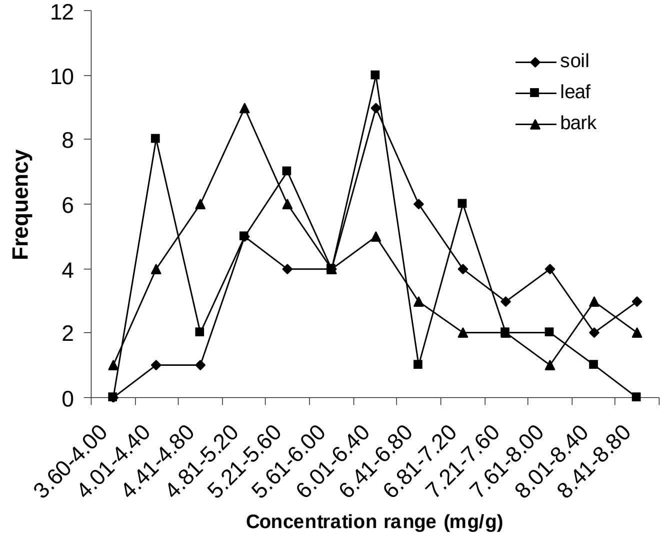

Figure 3: Frequency distribution pattern for Pb in soil, *E. camaldulensis* **leaves soil and bark**

80% of Pb in the atmosphere and industrial activities releasing Pb in the from of air-borne Pb [14, 15].

Eucalyptus camaldulensis is readily adaptable and has many species. The plant accumulated high levels of S, Zn and Pb with the values for Zn in the leaf being higher than that in the soil. The concentration of S (1.03mg/g), Zn (31.26µg/g) and Pb (5.60 µg/g) in the plant are higher than the values 0.5mg/g, 20µg/g and 0.1 µg/g in normal unpolluted plants [20]. This suggests that the plant is suitable for monitoring S, Zn and Pb levels in the environment. The results obtained from this study

shows that the environment under study is polluted with respect to the elements determined.

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