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Tamaridus Indica and Balanites Eagyptiacabarks: The Bio – Indicator of Environmental Pollution

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ABSTRACT
Tamaridusindica and Balaniteseagyptiaca tree barks fromYobe State, north east, Nigeria, and the soils around them were analysed for their Zinc concentrations using atomic absorption spectrophotometry. The results of the analysis indicate various concentration levels obtained from soil solution through mineral uptake by plants. The mean values of Zn range between 0.52 - 8.13 µgg^{-1} in the bark and 0.06 - 10.01µgg^{-1} in the soil. All the values obtained correlate well with the anthropogenic activities in the study area and are below the recommended safe limits for heavy metals by WHO, FAO, EU, and NESREA guidelines. The statistical comparison of the values between the bark and soil shows correlation at $P < 0.01$ and significant difference at $P < 0.05$. The study further demonstrates the suitability of some of the trees as a good bio indicator.

KEYWORDS:*Tamaridusindica, Balaniteseagyptiaca, Zinc, Tree bark.*

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I. INTRODUCTION

Zinc is an essential trace element in all living organisms (Ohnesorge and Dusseldorf, 1988). The toxicity of zinc and zinc-containing compounds is low and, with exception of minor importance compared with the significance of zinc deficiency. Zinc occurs in minerals in the earth's crust with a medium concentration of about 70mg/kg. The principal ores are the sulphides, sphalerite, wurzite (ZnS), smithsonite ($ZnCO_3$) and hemimorphite ($2ZnO_xSiO_2.XH_2O$) (Saager, 1984).Zinc is sourced in the air from the emission of industries like iron smelters, mining activities and from traffic emission (tyre abrasions and combustion) (Ondov*et al.*, 1974). The particle size of zinc dust in ambient air are on the whole small; 52-70% have diameters lower than 5µm (VDI, 1984). Zinc level in ambient air of city areas varies between 0.1 and 1.7 µg/m^3, with a mean annual level lower than 1µg/m^3 (Lee and Vonlehmaden, 1973).Zinc is essential to plants and animals growth. Deficiency symptoms in plants and animals (Kirchgessner and Roth, 1982) have been reported. Some of these deficiency diseases include decreased growth, testicular atrophy, alopecia and decimal lesions (Underwood, 1979).Severe irritation in the upper and lower respiratory tract and pneumonitis can be induced by inhalation of zinc chloride smoke (Marrs*et al.*, 1984). Inhalation of zinc oxide fumes is associated with fever, an illness characterized by sore throat, cough, hoarseness, chills, myalgians, malaise and fever accompanied by sweating nausea vomiting (Marrs*et al.*, 1984).Therefore this research investigates the uptake from the soil of Zinc in an arid environment on the basis of concentration in tree barks in the study area, and to compare the suitability of different tree barks as bioindicators of Zinc and determine a good choice of tree for planting if contamination with this metal is observed.The research also focuses on the determination of concentration of Zn in the soil around the plant samples of interest in the study area.

II. MATERIALS AND METHODS

In the preparation of reagents, chemicals of analytical grade purity and deionized water were used. All glass wares were socked in (1:4) HNO_3 solution and were rinsed with tap and deionized water before drying in the oven at 105^{0}C. All weighings were on Toledo AB54 analytical balance. Pipette filler was used in pipetting all solutions.

Study Site: Yobe State Nigeria is in the Sahel eco-climatic zone and was chosen as the study site. It is within the latitude 13.3^{0}N and longitude of 12.3^{0}E (Fig. 1). It is predominantly an agricultural state (YBSG, 2009). The climate of the region is the Sahel savannah type with low humidity and temperature variation.

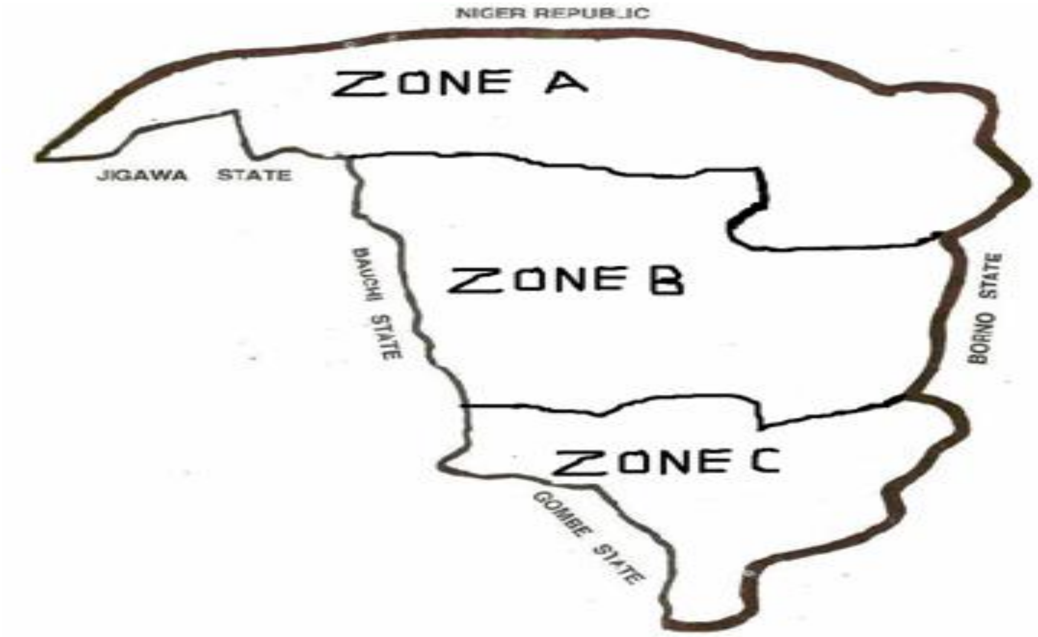

Fig. 1 Yobe State showing sampling sites

Fig. 3.3: Yobe state showing sampling zones

Fig. 2: Yobe State showing sampling sites

Sampling: Samples were collected from seven hundred and fifty (750) sampling sites between October and May 2008 – 2010 during the dry seasons. Representative of these matured samples of*Ficusthoningi*,and*Adansoniadigitata*, were collected from the wild in the State. Several samples of each plant were collected from these locations. All samples were authenticated by the Department of Biological Sciences, and by comparison with Herbarium samples of Bayero University Botanical garden in Kano. Similarly, surface soil samples were taken from the top to 10cm, at the base of trees used for bark collection with the help of stainless steel trowel to avoid contamination and were transferred to the laboratory in paper bags (Yilmaz*et al.,* 2006).

Sample Treatment :A clean stainless cutlass was used to remove the bark after it was etched with hard brush to remove lichens, mosses and dust (Grodzinska, 1982). The chips of the barks of the samples were collected from different sites during dry season. The number of sites from the sampling area was ten samples with twenty-five of each. The locations were carefully chosen to reflect the entire State. The trees used for sampling were matured and healthy plants. The barks were carefully removed using a cutlass to a depth of approximately 1cm (Tye*et al.,* 2006) at an average height of about1.5m above the ground level along the prevailing direction of the wind (Ayodele*et al.,* 2000). Samples were taken from the rough bark of trees not infected by insects. The knife was further washed after each sampling with 10% HNO_3 to avoid cross contamination. The samples were kept in paper envelopes and then placed in polyethylene bags before taken to the laboratory. The samples were then air dried in the laboratory. The dried samples were then pulverised with a laboratory mill (mortar and pestle). The mill was thoroughly cleaned with 10% HNO_3, distilled water and dried after each grinding to avoid cross contamination.

Sample Preparation :Soil Sample.: The soil sample was ground and sieved to uniform size through a 2mm mesh and stored in a labelled plastic container. 20cm^3 of concentrated Nitric acid was carefully added to 1g of soil sample in a 250cm^3 beaker. The mixture was allowed to cool for 1 hour. 15cm^3 of concentrated perchloric acid was added. The mixture was digested on a sandbath till the appearance of white fumes.The digest was dissolved in 0.1M Hydrochloric acid, filtered into a 100cm^3 volumetric flask and made to mark (Arnold *et al.,* 2005).

Bark Sample : The bark sample was air dried in the laboratory at room temperature. The dried samples were pulverised to uniform size with a laboratory mill (mortar and pestle), sieved through a 2mm aperture and stored in a labelled plastic container (Mansor and Afif, 2011).
2g of the bark sample was taken into porcelain crucible and ashed at 500^0C in a muffle furnace to constant weight. Upon cooling overnight, the samples were then digested using 10% HNO_3 (Odukoya*et al.,* 2000), filtered in to50ml volumetric flask and diluted to volume.

Elemental Analysis : The Zn was determined using an atomic absorption spectrophotometer model VGB 210 SYSTEM, Buck Scientific. The result of each sample was the average of three sequential readings. Deionized water used as blank was treated using the same procedure.

Statistical treatment : All statistical computations were carried out with the aid of Microsoft Excel 2007 version obtained from Microsoft Corporation, USA; and Statistical Package for Social Sciences. One way analysis of variance (ANOVA) in randomized complete block design was performed to check the variability of data and validity of the results with SAS software system (SAS, 2002).

III. RESULTS AND DISCUSSION

The concentrations of Zn in the bark and soil vary among the trees investigated in the state thus a number of samples from a population were analysed and the results treated statistically for a meaningful correlation. Yobe was divided into three sampling zones, which were chosen in such a way that samples collected at these sites gave an overview of the state, based on the abundance of these plant species and activities taking place in these zones. All the samples collected from the three zones were combined and analyzed for Zinc concentrations.The frequency distribution pattern for Zn in the bark of *Tamaridusindica* is as shown in (Fig. 2). The distribution is multimodal and is skewed towards low concentrations of high frequencies with a mean and standard deviation of 6.36 ± 0.49μgg^{-1}. Chunilall*et al.* (2005) observed that accumulation of selected metals varied greatly among plants species and uptake of an element by a plant is primarily dependent on the plant species, its inherent controls and the soil quality. The distribution pattern for Zn in the soil around *Tamaridusindica* is as shown in (Fig. 2). The distribution is bimodal and is skewed towards low concentrations of high frequencies with a mean and standard deviation of 5.93 ± 0.82 μgg^{-1}. Excess zinc can lead to respiratory incapacitation, as indicated by increased respiratory activity, that is, breathing rate, volume and frequency of ventilation, coughing and decrease in oxygen uptake deficiency. Zinc damage enhances lactic acid production/accumulation as temperature and exposure time are increased. Zinc can also kill aquatic life by causing direct damage to the gill membranes (Hem, 1985). Comparing the Zn concentrations in the bark and soil, a significant correlation is indicated ($P < 0.05$) to exist between them (Table 1). Similarly, a significant difference was observed ($P< 0.05$) in both soil and bark when the Zn concentrations in *T. indica* was compared with its concentration in other trees from the state.

The frequency distribution pattern for Zn in the bark of *Balaniteseagyptiaca* is as shown in (Fig. 3). The distribution is unimodal and is skewed towards low concentrations of low frequencies with a mean and standard deviation of 5.49 ± 0.70 μgg^{-1}. Zn is an essential micronutrient needed not only by human beings, but also by crops, almost half of the world's cereal crops are deficient in Zn, leading to poor crop yield (Castillo-Duran *et al.*, 1988). The frequency distribution pattern for Zn in the soil around *Balaniteseagyptiaca* is as shown in (Fig. 3). The distribution is unimodal and is skewed towards low concentrations of low frequencies with a mean and standard deviation of 4.96 ± 0.27μgg^{-1}. The activity of Zn^{2+} represents Zn availability to plants and can be used to predict possible solid phases that control Zn solubility in the soil. Depending on the soil and soil properties, different Zn precipitates may form in soils and control Zn solubility at different levels. The solubility of Zn and the mechanisms that control Zn solubility may vary with soil properties, such as pH, organic matter content and clay (Lindsay and Catlett, 1998). Comparing the Zn concentrations in the bark and soil, a significant correlation is indicated ($P<0.01$) to exist between them (Table 2). Similarly, a significant difference was observed ($P<0.05$) in both soil and bark when the Zn concentrations in *B. eagyptiaca* was compared with its concentration in other trees from the zone.

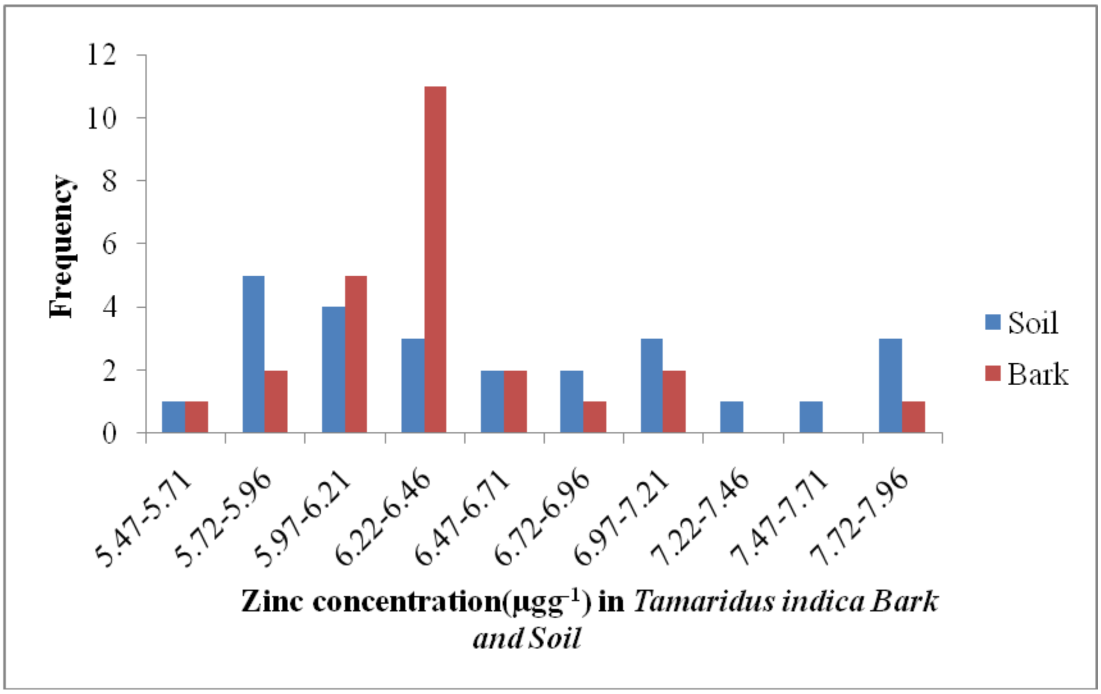

Fig 2: Frequency Distribution pattern for Zinc in *Tamaridusindica*

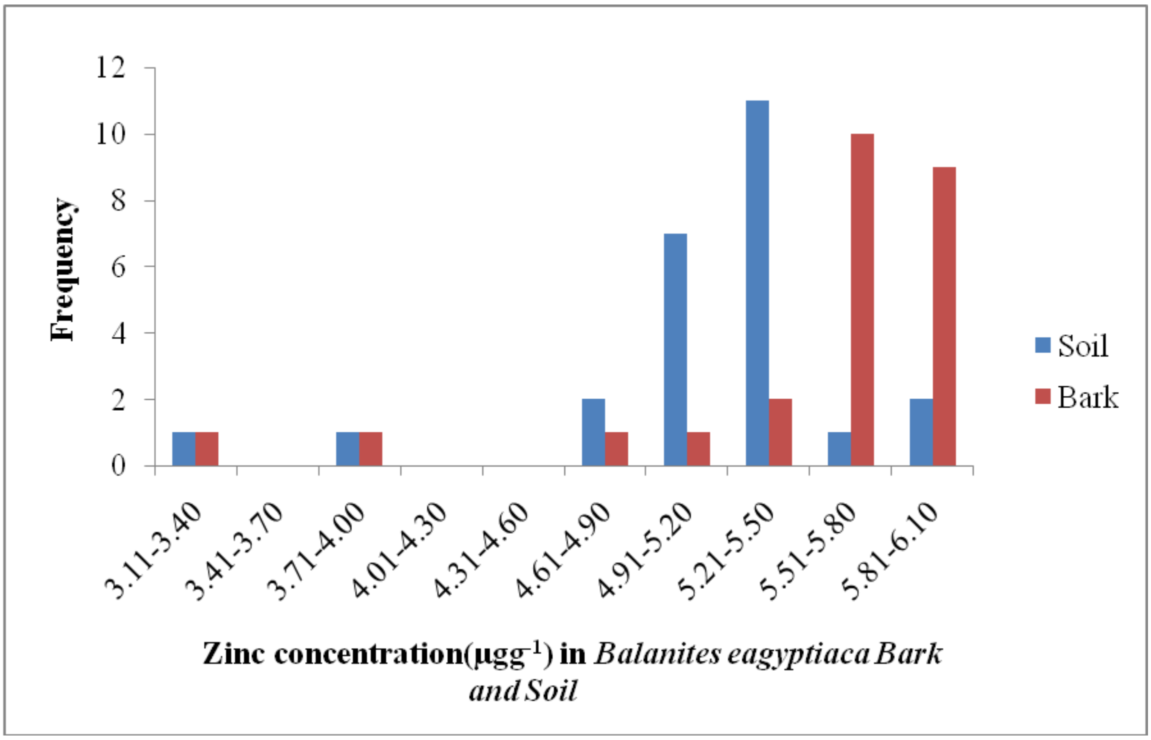

Fig 3: Frequency Distribution pattern for Zinc in *Balaniteeagyptiaca*

CORRELATION TABLES FOR ZINC

Table 1: Correlation of Zn levels between Bark and Soil for *TamaridusIndica*

Correlations			
		Znbark	**Znsoil**
Znbark	**Pearson Correlation**	1	.918(**)
	Sig. (2-tailed)		.000
	N	25	25
Znsoil	**Pearson Correlation**	.918(**)	1
	Sig. (2-tailed)	.000	
	N	25	25
** Correlation is significant at the 0.01 level (2-tailed).			

Table 2: Correlation of Zn levels between Bark and Soil for *Balaniteeagyptiaca*

Correlations			
		Znbark	**Znsoil**
Znbark	**Pearson Correlation**	1	.974(**)
	Sig. (2-tailed)		.000
	N	25	25
Znsoil	**Pearson Correlation**	.974(**)	1
	Sig. (2-tailed)	.000	
	N	25	25
** Correlation is significant at the 0.01 level (2-tailed).			

IV. CONCLUSION

The low value of Zinc found in this investigation was probably due to the almost zero level industrialization in the study area which is an indication that industries contribute greatly to soil, water, sediment and atmospheric pollution. In general the results indicated that none of the plant species were identified as hyper accumulator because both species accumulated Zn at less than $1000 \mu g g^{-1}$ (Baker and Brooks, 1989). However, based on translocation factor and normal concentration values plant species were identified which may have potential for phytoremediation. Contaminated soils can potentially lead to the uptake and accumulation of this metal in the edible plant parts causing risk to human and animal health (Jagrati*et al.*, 2012). This also indicates that heavy metals present in the soil phases can assimilate and accumulate into plant and their accumulation seems to be obvious. Plants are sensitive to environmental conditions and their elemental composition actively responds to changes in the condition of the environment. Plants are endlessly exposed to showers of potentially useful and toxic heavy metals and also absorb them from soil via root systems (Ge*et al.*, 2005). The concentrations of Zinc in the bark can be expected to be an indicator of trace metal loading at the time of sampling.

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