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Heavy Metal Levels in Pine (Pinus caribeae Morelet) Tree Barks as Indicators of Atmospheric Pollution Calabar Municipality, South Eastern Nigeria

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Abstract
Biomonitoring of the air quality in Calabar was carried out by analyzing barks from pine tree (*Pinus caribeae* Morelet). Barks were collected from trees along highways with heavy traffic; residential areas with low traffic and the control, and analysed using atomic absorption spectrophotometer for lead (Pb) and Manganese (Mn). The result showed the highest Pb level in the heavy traffic site U. J. Stadium by Calabar Road, 0.66± 02 mg/kg and lowest 0.01mg/kg in the control. Manganese was highest in the heavy traffic site, Stadium by Calabar Road 0.57± 0.02 mg/kg and lowest at the control 0.05± 0.01. The relatively low level of lead might be due to the unleaded petrol imported into the country
Keywords: Bio-monitoring, Emission, Toxicity, Contamination, Pine bark

Introduction

There is a growing awareness of the dangers posed by heavy metals in the ecosystem. Scientific literature is full of reports of heavy metals and their effects on the environment. Though natural components of the environment, heavy metals are of late, posing great concern because they are being added in increasing amounts to the soil, water and air through human activities. Most heavy metals are essential and needed in small amounts in living organisms, but their excessive amounts are harmful to plants and animals (WHO, 1972). For this reason, heavy metal pollution is becoming a threat to our life support system. Vehicular emissions are a great source of heavy metal accumulation in the surrounding space and plant species (Ward *et al*; 1974, Momani *et al*; 2006 and Scerbo *et al*; 2002).

Biological monitors such as plants have been used to measure the atmospheric concentration of trace elements (Onianwa, *et al;* 1986, Onsanaya *et al*; 1993, Celik *et al*; 2005). Plants are used as the cheapest indicator for monitoring the heavy metal concentration in the atmosphere. There are several ways of monitoring air pollution: measure concentration of pollutants in the air (Bellis *et al*; 2001) or rainwater (Jiries *et al*; 2001) and soil (Turer *et al*; 2001) but of all the methods, the use of biological indicators has the advantage of being the cheapest. Biological indicators including plants have been used to measure the atmospheric concentration of trace elements (Onianwa *et al*; 1986, Celik *et al;* 2005).

Different bioindicators such as mosses, lichens and woody vascular plants are used in monitoring air pollution. The barks of broad-leaved and coniferous trees are used in air pollution studies (Lippo *et al;* 1995, Adeniyi, 1996). Unlike mosses and lichens, tree barks have not been shown to sensitively collect heavy metals and other pollutants (Kord and Kord 2011) therefore, they are suitable indicators in urban and industrial areas where other bioindicators are infrequent (Lostchert and Kohm, 1978, Santamaria and Martin, 1997). Pine trees have been studied to assess whether pine species can be used as a biomonitor or for the determination of heavy metal pollution. Results of such studies have shown that pine trees are good absorbents of air borne pollutants including anthropogenic heavy metals. Among the studied pine tree barks are Turkish red pine (*Pinus brutia* Ten), (Dogan *et al*; 2007), Italian red stone (*Pinus pinea* L) (Oliva and Migorance 2006 and Masson Pine (*Pinus massonia* Lamb), (Kuang *et al*; 2007). The aim of this study was to investigate and assess heavy metal pollution in the atmosphere of Calabar Municipality, using pine (*Pinus caribeae* Morelet) barks as bioindicator.

Materials and Methods

Description of Study area: Calabar metropolis is located on $4^0$57′N and $8^0$19′E in the South Eastern coast of Nigeria. The temperature ranges between 22^0C and 32^0C. Rainfall ranges between 26mm and 613mm monthly.

Sampling and Analysis:

Tree bark samples were collected from trees of about 20 years old situated along the highways (high traffic areas) and streets in low traffic areas in 2012. Three trees were sampled at each location; heavy traffic, light traffic and control (Residential area of Gross River University of Technology, Calabar Campus) between October and November, 2012. The barks obtained from each site were mixed and put in polytene bags and taken to the laboratory for analysis.

The tree barks were dried to a constant weight. The dried samples were pounded using wooden mortar

and pestle into fine powder. 1g of dried powdered and sieved sample was weighed and put into a conical flask after which 5ml of 60% perchloric acid was added. This was then poured into a crucible and ignited to ash in a muffle furnace at 300^0C for 2 hours. It was allowed to cool and then 10ml of 60% perchloric acid was added and heated to digest the charred sample into a solution. This procedure was replicated thrice. For each sample, the digest was diluted to 100ml with deionized water. It was then used for analysis using Buck Scientific Atomic Absorption Spectrophotometer Model Buck 210 VG at Chemistry Laboratory, University of Calabar, Nigeria.

Results and Discussion

Heavy metal concentrations in the sampled barks are presented in Tables 1 and 2. Pine barks in both the heavy and light traffic sites accumulated the heavy metals lead and manganese in varying amount as shown in Tables 1 and 2. U. J. Esuene Stadium by Calabar Road had 0.66±0.02 mg/kg, followed by Calabar Urban Development Authority (CUDA) by New Ikang Road 0.06 ±0.01 mg/kg. Barracks road by the Cenotaph had 0.05±0.01 mg/kg. The control had the least 0.01 mg/kg. Manganese was highest at U. J. Esuene Stadium by Calabar Road 0.57±0.02 mg/kg followed by CUDA by New Ikang Road 0.52±0.02 mg/kg. Barracks Road by the Cenotaph had 0.16±0.04 mg/kg. The control had the least, 0.05± 0.0mg/kg).

In the light traffic sites the levels of Pb and Mn were considerably lower than the heavy traffic sites. The concentration of lead was same in Etta Agbo Layout and Satellite Town 0.05±0.01 mg/kg, while Unical Hotel had the highest 0.07±0.01 mg/kg with the control being 0.01 mg/kg. Manganese was considerably lower in the light traffic sites than the heavy traffic sites. Etta Agbo Layout and Satellite Town had almost the same concentration of 0.16±0.01 mg/kg and 0.16 ±0.02 mg/kg respectively. Unical Hotel was not much different at 0.15 ±0.01 mg/kg. The control was least at 0.05 mg/kg.

The lead levels were lowest at the control and highest at U. J. Esuene Stadium by Calabar Road a heavy traffic site. The values here were relatively low because, lead pollution on a local level is caused by emission from motor vehicles using imported fuel in the study area. Also the heavy metal concentration in plants in urban and highway roadsides, are due to higher vehicular emissions. Manganese was higher than lead in only the low traffic sites. This might be due to its inclusion in petrol for its antiknock properties.

Table 1: Mean concentration (mg/kg) of Pb and Mn in Heavy traffic sites.

Sites	Pb	Mn
Calabar Road by Stadium	0.66±0.02	0.57± 0.02
CUDA by New Ikang Road	0.06± 0.1	0.52±0.02
Barracks Road by Cenotaph	0.05±0.01	0.16±0.04
Control	0.01	0.05±0.01

Means of Triplicates ± standard deviation

Table 2: Mean concentration (mg/kg) of Pb and Mn in light traffic sites.

Sites	Pb	Mn
Etta Agbo Layout	0.05±0.01	0.16±0.02
Satellite Town	0.05± .01	0.16± 0.01
Uncial Hotel	0.07±.01	0.15±0.01
Control	0.01	0.05±.01

Means of Triplicates ± standard deviation

The result of this study show that pine tree (*Pinus caribeae* Morelet) bark is a good bioindicator of air pollution, as a result agrees with other studies on pine tree barks (Oliva and Mingorance 2006; Oliva *et al* 2007). The mean values of the heavy metal concentrations were lower at the control sites.

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