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Original Research Article

Determination of Bioaccumulation of Heavy Metals in Leaves, Bark and in Soils by Atomic Absorption Spectrometry

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ABSTRACT

The aim of this paper was to study the metal accumulation in leaves and bark of *Populus nigra L* from atmosphere and in soil. The heavy metals, including Cu, Ni and Pb concentrations were determined by atomic absorption spectrometry (AAS) in leaf, bark and soil samples collected from four polluted areas in Tirupati and rural areas. Atomic Absorption Spectrometry (AAS) was used in this analysis to obtain the concentration of the metals.

Key Words: Bioaccumulation, metal accumulation, heavy metals, *Populus nigra*, Atomic Absorption Spectrometry (AAS).

INTRODUCTION

Metals play a major role in health, for even minute portions of them can significantly affect health. Plants have been used intensively as biomonitors and bio indicators of environmental pollutants in urban, rural and in remote areas (M. Ataabadi. (2010); J.O. Olowoyo.(2010); J. Sardans. (2010); S. Rossini Oliva (2007); B. Markert (2005); M.A. Reis.(2001); B. Wolterbeek (2002) & C. Radulescu (2010). In many studies (M. Ataabadi (2010); M. Miclean, C. Radulescu; (2010); G. State (2010); B. Thomson, (2011); L. Gratani, (2008); E.E. Ukpebor (2010); G. State; (2011); I. Dulama (2012); G. Wagner (1996). the *Populus nigra L.* is considered a good bioindicator for atmospheric pollution and has been recommended as a particularly suitable bioindicator of heavy metals in Europe . Concentrations of major and trace metals in plants depend on root uptake or accumulation of dry and wet deposition on outer plant organs, such as foliage or bark. Several metals, which are essential as nutrients in lower concentration (*i.e.* Zn, Cu, Fe and Mn) can be considered harmful for the plant growing, if the levels of these elements in soil and atmosphere are increased. It is well-known that the most important sources of anthropogenic major and trace element emissions are industrial production, the combustion of fossil fuels in vehicular traffic and energy production, sewage sludge dispersal and fertilizer production. The aim of this study was to investigate the heavy metals uptake from soil in leaves and bark from common popular species *(Populus nigra L.* - fam. Salicaceae). Leaves and bark samples from old trees together with soil samples from two historical polluted sites from Tirupati, Karakambadi and Gajulamandyam were analysed by using Atomic Absorption Spectrometry (AAS). Harmfulness of trace elements first of all related to their ability to bioaccumulation, which involves the increase of these elements within plant tissues Kabata-Pendias, A., Krakowiak, A., Useful Phytoindicator (Dandelion) for Trace Metal Pollution. Transport, Fate and Effects of Silver in the Environment (1997).

Herbaceous plants are rich sources of minerals, vitamins, and also have beneficial antioxidative effects but intake of heavy metal-contaminated herbs may pose a risk to the human health. In the case of herbaceous plants which particular morphological parts are collected for therapeutic destination, the place of trace elements' accumulation is extremely important.

Metals distribution in plant:

Metals distribution in plants is quite heterogenous and is controlled by genetic factors, environment and toxic factors. The metal distribution in plant roots determines the recuperation of a high proportion of metals in roots (80-90 %). Some species of plants can accumulate the highest quantity of absorbed metals in their high parts (tobacco accumulates more than 80 % Cd in its leaves). Linen seeds can also accumulate high concentration of Cd. The edible parts of vegetables like radish, cabbage, tomatoes, carrots, green beans etc. grown on sandy soils added with mud do not indicate an important accumulation of metals (Cd, Cr, Pb), while the parts that are not edible a mass metals in concentrations which would not be accepted in the edible parts. The metals distribution in plant seems to be controlled by some mechanism and this suggests the existence of some boundaries and/or change in the metal chemical state. Different plant parts contain different heavy metals quantities, the highest ones being contained in roots and leaves, and the smallest in flower buds and fruit. The analysis of the roots may indicate the degree of heavy metal accumulation in the polluted soil and offers clues on the soil pollution degree, and the analysis of leaves may even suggest the atmosphere pollution degree. The detection of metal accumulation content in plant is desired, the plant must be washed. The time and the way it should be washed depend on certain standards. Plants take heavy metals from soils through different reactions such as: absorption, ionic exchange, redox reactions, precipitation - dissolution, etc. Mainly the reactions said that the solubility of trace elements depends on minerals in soil (carbonates, oxide, hydroxide etc.), soil organic matter (humic acids, fulvic acids, polysaccharides and organic acids), soil pH, redox potential, soil temperature and humidity. From all elements in soil, only the elements which present availability are transfer. The collection of the samples and sites were showed in figure 1.

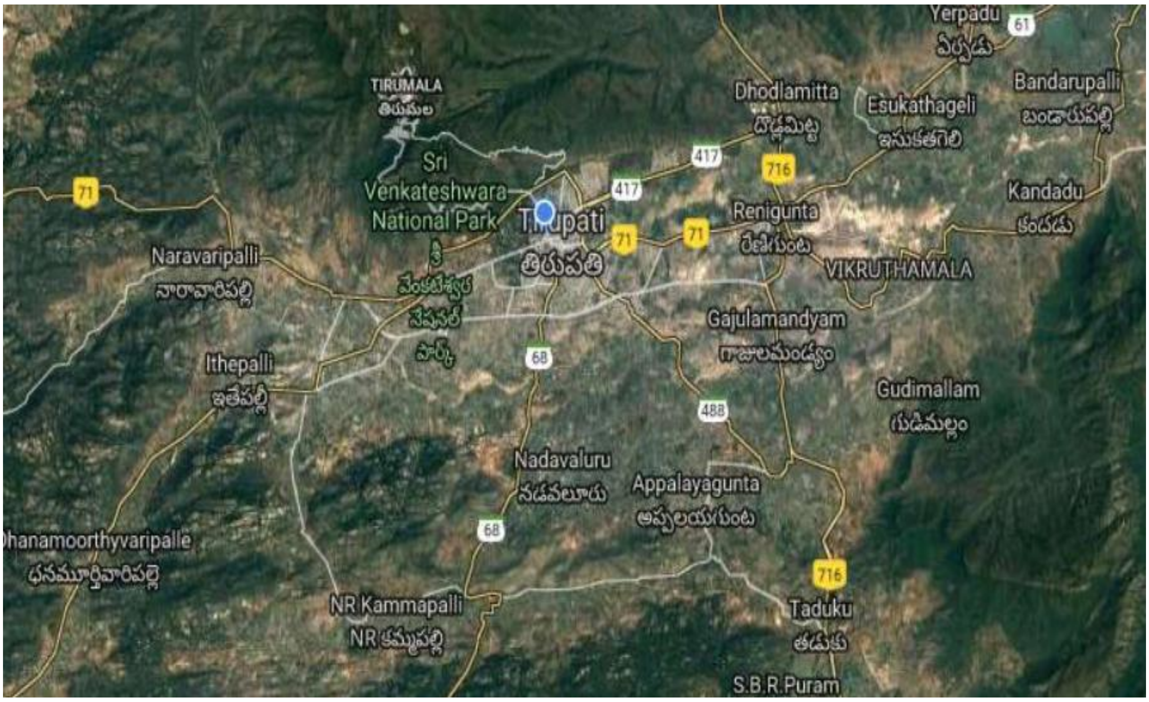

Figure. 1: Layout showing Tirupati industrial belt along the Gajulamandyam, Karakambadi and Mangalam area

RESULTS AND DISCUSSION

The effect of pH on the retention of Cu, Ni and Pb was studied at different pH values (1.0 to 11.0). The data corresponding to each element were shown in Figure 2 .The maximum recoveries were in the pH ranges 5.0 to 6.0 for Cu, Ni and Pb. Hence pH 5.0 was chosen for the simultaneous determination of metal ions in various plant and soil samples.

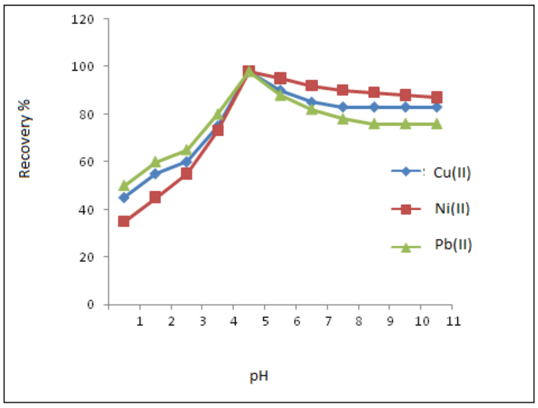

Figure 2. Effect of pH on the metals with recovery (%)

Soil Sample Digestion:

1g of the oven dried sample ground sample was weighed using a top loading balance and placed in a 250 ml beaker which has been previously washed with nitric acid and distilled water. The sample was reacted with sample was reacted with 5ml of HNO_3, 15ml of concentrated H_2SO_4 and 0.3ml of $HClO_4$ using dropping pipette. The mixture was digested in a fume cupboard, heating continued until a dense white fume appeared which was then ingested for 15minutes, set aside to cool and diluted with distilled water. The mixture was filtered through acid washed Whatman No.44 filter paper into a 50 ml volumetric flask and diluted to mark volume 7, 13, 14. The sample solution was then aspirated into the Atomic Absorption Spectroscopic machine at intervals.

Digestion:

The leaf and bark samples were dried in oven at 70^0C for 24 hours. Approximately 0.2 g of the dried leaf and bark samples, respectively, were treated individually with 8 mL HNO3 (65% Merck) and 10 mL H_2O_2 (30% Merck) and then were mineralized using a microwave digestion system. After 40 minutes of digestion the samples were cooled for 30 minutes and the clear solutions were filtered and brought at 50 mL with distilled deionized water. Metals concentrations in the final solutions were analysed by Varian Spectra AA55 Atomic Absorption Spectrometry (AAS). The results were showed in Table 1.

Table 1: Different types metal concentrations in different samples.

Sample	Metal	Heavy metal concentrations (mg/k.g) d.w		
		Leaf	Bark	Soil
Gajulamandyam (Industrial Area)	Cu	12.93± 2.21	8.85±1.12	44.8±2.3
	Ni	1.11±0.1	1.16±0.05	22.07±0.55
	Pb	3.83±0.92	2.28±0.31	47.29±1.75
Karakambadi (Industrial Area)	Cu	12.04±0.78	13.01±1.95	49.06±1.5
	Ni	1.57±0.08	1.91±0.12	28.74±0.12
	Pb	3.96±0.48	2.41±0.37	51.44±0.73
Mangalam	Cu	18.09±0.9	16.08±2.5	14.18±3.0
	Ni	0.65±0.49	1.42±0.53	31.41±0.4
	Pb	3.84±0.93	2.27±0.32	50.41±0.26
Renigunta Industrial area	Cu	14.17±3.0	11.58±1.5	48.24±1.30
	Ni	1.82±0.37	1.63±0.27	1.52±0.60
	Pb	5.3±0.1	9.22±0.16	47.22±0.32

CONCLUSIONS

This study shows that the leaves of *Populus nigra L*. can be used as suitable bio indicators for soil pollution with Cu, Ni, Pb, . Hence it can conclude that the bark of *Populus nigra L* is an excluder for Cu concerning the uptake of these metals from soil. Certainly for Ni, Pb the bark of poplar can be considered a passive monitor of atmospheric pollution with these metals.

Due to the insufficient knowledge about element mobility in poplar bark, a heavy metals transfer from bark to leaves cannot be established.

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