International Journal of Chemistry and Applications.
ISSN 0974-3111 Volume 4, Number 3 (2012), pp. 157-162

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Heavy Metals Uptake by *Lactuca taraxacifolia* (Wild Lettuce) in the Semi-arid Region of Bagwai Kano-Nigeria

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Abstract

Levels of heavy metal concentrations, from some parts of Bagwai Local Government Area, Kano state of Nigeria, in *Lactuca taraxacifolia* was assessed using atomic absorption spectrophotometry. The concentrations of lead, manganese and zinc in *Lactuca taraxacifolia* and iron, manganese, zinc and Cu in were bioaccumulated. They are hence endemic indicator plant species with potential for use in bioaccumulation, phytoremediation / phytoextraction as interrelationships between these metal concentrations in the soil and their tissues were significant ($p<0.05$).

Keywords: Heavy metals, *Lactuca taraxacifolia*, wild lettuce, bioaccumulation, phytoremediation. Bagwai.

Introduction

As a result of increasing anthropogenic activities, the heavy metal pollution of soil, water, and atmosphere represents a growing environmental problem affecting food quality and human health. Heavy metals may enter the food chain as a result of their uptake by edible plants, thus, the determination of heavy metals in environmental samples is very important [1, 2].

The introduction of harmful substances into the environment has been shown to have many adverse effects on human health, agricultural productivity and natural ecosystems[3]. Heavy metals is a general collective term which applies to the group of metals and metalloids with atomic density greater than 4 g/cm3 or 5 times or more, greater than water [4, 5]. Their pollution of the environment, even at low levels and the resulting long – term cumulative health effects are among the leading health concerns all over the world [6, 7]. The heavy metals are introduced into the environment through

so many sources which include, decomposition of fossil fuels, smelting, glazing, electroplating [8, 9]. Pb has been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic [10, 11]. *L. taraxacifolia* also taxonomically recognized as *Launaea taraxacifolia* is a plant specie that is cultivated mainly in the Western part of Nigeria. It has a basal rosette of leaves with erect stems up to 1.3m high from a woody rhizome [12, 13].

Soil is one of the repositories for anthropogenic wastes. Heavy metal contamination in the soils is a major concern because of their toxicity and threat to human life and the environment. To a small extent trace metals enter the body system through food, air and water and bioaccumulate over a period of time [14, 15].

The interaction between metals and solid phases of soil, soil water, and air within and above soil depends of a variety of chemical factors and determine the heavy metal transport and fate. Absorption of metals from soil water to soil particles is the most important chemical determinant that limits mobility in soils [16]. Heavy metals from soil enter plants primarily through the root system. In general, plant roots are the most important site for uptake chemicals from soil [17]. Heavy metals may have significantly toxic and hazardous effects on human health, especially lead, as a non-essential element [18].

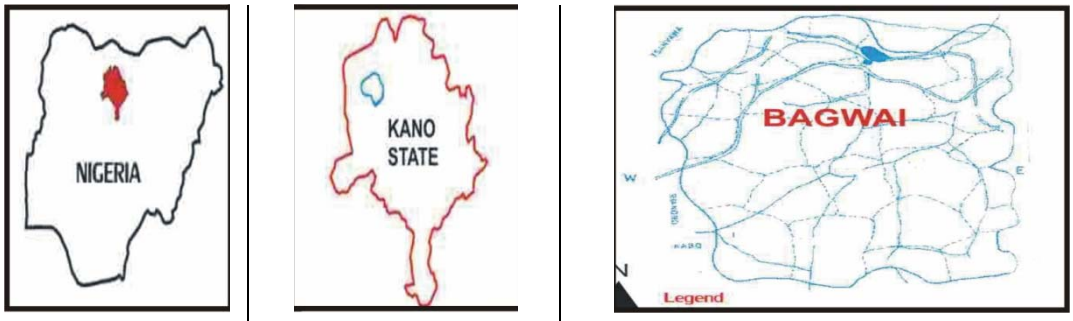
The intense and inadequate use of fertilizers and pesticides in the soil, coupled with the increase in industrial activity and mining are the main reasons for the contamination of soil, waterways and the water table by heavy metals [19].

Materials and Methods

All experiments were performed with analytical reagent grade chemicals. Glass distilled water was used throughout. Heavy metal concentrations were determined by Atomic Absorption Spectrophotometer (Alpha 4). The results of each metal were the average of ten sequential readings [20]. Blank solutions were prepared each time new preparations were made.

Study Site

Bagwai-Kano, Nigeria is in the Sudan eco-climatic zone was chosen as the study site. It is within the latitude 12.2^0N and longitude of 8.3^0E (Figure.1) and predominantly an agricultural land with heavy application of fertilizers, pesticides and herbicides during rainy and dry seasons farming [21].The climate of the region is the Sudan savannah type with moderate relative humidity and temperature variation.



(A) **(B)** **(C)**

Figure 1: (A): Map of Nigeria. (B): Map of Kano State. (C): Bagwai Local Government Area map

Sample preparation

Lactuca taraxacifolia was harvested from different parts of the Bagwai Local Government area. The fruits, the stem and roots were sampled and dried in the laboratory. They were then pulverized using pestle and mortar and then dried in the oven for 3hours at 80^0C. The dry samples were beaten to fine powder in a steel bladed electric mill (National Food Grinder Model MK 308 Japan) and were sieved through 250-µm sieve [22, 23]. The samples were oven dried to constant weight at 105° C and were packed in double stacked waterproof polythene bag and stored in screw-capped bottles.

Elemental Analysis

Sample solutions were prepared by ashing 1.0g of each in a furnace at 450^0C and the residue of the sample was dissolved in 0.1M HNO_3, and was diluted to 100cm^3 0.1M HNO_3. Concentrations of the metals were determined using an atomic absorption spectrophotometer (Alpha 4). The result of each sample was the average of ten sequential readings. Background light absorption and scattering were compensated for either by deuterium hollow cathode lamp or by tungsten/halogen lamp. Distilled water was used as blank was digested using the above procedure.

Results and Discussion

Table 1 represents heavy metals concentration in soil and *Lactuca taraxacifolia* in which with the exception of Cr where the concentration of the metal in the plant is less than in the soil, and Co totally absent, levels of other metals are higher in the plant than in the soil. The concentration factor (CF) was found to be higher in Zn (CF ≈ 3). This implies that the plant could be used to clean up a site contaminated with zinc metal. The high concentration of the metal may be related to its physiological role in the plant [24]. Pb and Mn having the concentration factor (CF ≈ 2) indicates that the plant has bioaccumulated these metals. Concentrations of Ni, Fe, Cu and Cr were

found to be similar in the plant and the soil samples having a concentration factor (CF ≈ 1).

Table 1: Heavy metal Concentration in *Lactuca taraxacifolia,* soil and concentration factor

Element	Concentration (µg/g)		Concentration Factor (CF)
	Plant	Soil	
Pb	3.41	2.09	1.63
Ni	1.60	1.33	1.20
Zn	10.13	3.38	3.00
Fe	7.87	7.45	1.06
Co	ND	ND	ND
Cu	2.53	2.04	1.24
Cr	2.31	3.63	0.64
Mn	4.30	2.24	1.92

ND = Not determined

For the purpose of phytoremediation, plants are grown for a certain period of time and are then harvested and subjected to composting, compaction, incineration, ashing, pyrolysis, direct disposal or liquid extraction. In principle, the best plants for the purpose are those that can tolerate the polluted soil condition, can absorb high amounts of the contaminants, and have economic value (e.g. flowering plants) so that they can be a source of income.

Conclusion

Determination of concentrations of trace metals in *Calocynthis bulgaris* for its bioaccumulation in the plant has revealed cobalt the most bioaccumulated. This is followed by Manganese, Copper and Nickel. This shows that the plant could be used to clean Co-polluted site to a greater extent and then Cu, Fe and Zn-polluted sites to their lower respective extents. It may also be difficult to account for this pattern of distribution but suggestions that cobalt may be co-precipitated with these metals has been made [25]. Fe and Cr were least accumulated by the plant.

The ability of a plant specie to clean up a metal-contaminated site depends upon the amount of metals that can be accumulated by the candidate plant, the growth rate of the plant and the planting density. The plant should have sufficient tolerance to the site conditions to grow well and should be able to accumulate multiple metal contaminants. The plant species should be fast growing and easy to harvest [26]. Plant properties for phytoremediation are to be fast growing, have high biomass, and are tolerant to pollution. Plants are grown for a certain period of time, harvested and subjected to composting, compaction, incineration, ashing, pyrolysis, direct disposal or liquid extraction.

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