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Utilization of *Talinum Triangulare* (Water-Leaf) in Accessing the Level of some Heavy Metals in Selected Farm Sites Around Veritas University, Abuja, Nigeria

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ABSTRACT

Utilization of Talinum triangulare (water-leaf) in accessing the level of some heavy metals in selected farm sites around Veritas University, Abuja, Nigeria was investigated using Atomic Absorption Spectrophotometer (AAS). The results obtained indicated the following ranges for the metal in the farm sites soil (in mg/kg): Farm site A: Cu(0.12), Fe(0.1), Zn(2.62), Ni(0.18), Pb(0.01), Cd(0.001) and Cr(0.001); Farm site B: Cu(0.26), Fe(0.18), Zn(1.51), Ni(1.06), Pb(0.02), Cd(0.003) and Cr(0.002); Farm site C: Cu(0.03), Fe(0.13), Zn(1.84), Ni(0.51), Pb(0.06), Cd(0.006) and Cr(0.002); Farm site D: Cu(0.06), Fe(0.11), Zn(1.22), Ni(0.16), Pb(0.05), Cd(0.002) and Cr(0.002); Farm site E: Cu(1.02), Fe(0.21), Zn(2.21), Ni(0.22), Pb(0.05), Cd(0.002) and Cr(0.003).The concentrations of the metals analyzed in the different farm sites were greater than those obtained in the control sample, but however, the obtained values were all within the NAFDAC/WHO permissible limits. The effects and environmental health implications of these heavy metals on humans are also discussed.

Keywords: Talinum triangulare, Heavy metals, Permissible limit, Farm sites, Environmental health

INTRODUCTION

The role of heavy metals in the soil system is increasingly becoming an issue of global concern, especially as soil constitutes a crucial component of industrial establishment[1]. Soil contamination with heavy metals through the repeated use of untreated or poorly treated waste from industries is one of the most severe ecological problems in the developing countries. Heavy metals constitute a main group of soil pollutants that their contamination in the environment affects all ecosystem components[2]. Although heavy metals are present as natural components of soils, toxic contamination may frequently occur at industrial and mining sites[3,4].

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition[34]. Heavy metals constitute an ill-defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni)[19]. Soils are the major sink for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon (IV) oxide by microbial action, most metals do not undergo microbial or chemical degradation[22] and their total concentration in soils persists for a long time after their introduction. Changes in their chemical forms (speciation) and bioavailability are, however, possible. The presence of toxic metals in soil can severely inhibit the biodegradation of organic contaminants. Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through:

direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil-plant-animal-human), drinking of contaminated ground water, reduction in food quality (safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems.
Heavy metals such as Cu, Zn, Mn and Fe are essential for plant growth; many of them do not have any significant role in the plant physiology. The uptake of these heavy metals by plants is an avenue of their entry into the human food chain with harmful effects on health[1,6]. Living organisms require trace amounts of some heavy metals such as cobalt, copper, iron, manganese, molybdenum, vanadium, strontium and zinc. Excessive levels of such essential metals however can be detrimental to the organism. Other heavy metals such as lead and cadmium have no vital or beneficial effect on organisms and their accumulation over time in the body of mammals can cause serious illness[2]. The presence of heavy metal ions in waste waters has generated considerable concern in recent years because of their toxicity to aquatic organisms at trace concentrations.

The heavy metals of widespread concern to human health are lead, copper, mercury, cadmium, arsenic, chromium, as well as zinc[21]. These are stable metals that cannot be destroyed or degraded in the environment and get passed up into the food chains to humans. At present, these toxic metals have polluted our atmosphere, our water, our soil and our food chain, and have been reported to be highly toxic even at low concentration[8]. For instance, exposure to Lead causes anemias, disease of the liver and kidney, brain damage and ultimately death, while, prolonged inhalation of Cu(II) spray is claimed to cause an increase in the risk of lung cancer[5]. One primary concern is that of marine animals which readily absorb these heavy metals in waste water and directly enter the human food chains causing high health cost of living to consumers. Therefore it is important to apply an efficient method for heavy metal reduction to a very low concentration. Those metals are important since they are capable of decreasing crop production due to the risk of bioaccumulation and bio-magnification in the food chain. Knowledge of the basic chemistry, environmental and associated health effects of these heavy metals is necessary in understanding their speciation, bioavailability, and remedial options. The fate and transport of a heavy metal in soil depends significantly on the chemical form and speciation of the metal. Once in the soil, heavy metals are adsorbed by initial fast reactions (minutes, hours), followed by slow adsorption reactions (days, years) and are, therefore, redistributed into different chemical forms with varying bioavailability, mobility, and toxicity[8].

The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation. Contemporary legislation respecting environmental protection and public health, at both national and international levels, are based on data that characterize chemical properties of environmental phenomena, especially those that reside in our food chain. While soil characterization would provide an insight into heavy metal speciation and bioavailability, attempt at remediation of heavy metal contaminated soils would entail knowledge of the source of contamination, basic chemistry, and environmental and associated health effects (risks) of these heavy metals. Risk assessment is an effective scientific tool which enables decision makers to manage sites so contaminated in a cost-effective manner while preserving public and ecosystem health[24]. Immobilization, soil washing, and phytoremediation techniques are frequently listed among the best demonstrated available technologies (BDATs) for remediation of heavy metal-contaminated sites[18]. In spite of their cost-effectiveness and environment friendliness, field applications of these technologies have only been reported in developed countries. The specific type of metal contamination found in a contaminated soil is directly related to the operation that occurred at the site. The range of contaminant concentrations and the physical and chemical forms of contaminants will also depend on activities and disposal patterns for contaminated wastes on the site. Other factors that may influence the form, concentration, and distribution of metal contaminants include soil and ground-water chemistry and local transport mechanisms. Soils may contain metals in the solid, gaseous, or liquid phases, and this may complicate analysis and interpretation of reported results[30]. The level of contamination may be reported as leachable metals as determined by leach tests, such as the toxicity characteristic leaching procedure (TCLP)[31]or the synthetic precipitation-leaching procedure, or SPLP test[29]. Wold Health Organization has reported soil concentration ranges and regulatory guidelines for some heavy metals (Table 1)[31]. In Nigeria, in the interim period, whilst suitable parameters are being developed, the Department of Petroleum Resources has also recommended guidelines on remediation of contaminated land based on two parameters intervention values and target values (Table 2).

Several technologies exist for the remediation of metal-contaminated soil. These include soil washing[9,13,23,31], phytoremediation[10,11,26] and immobilization techniques[4,7,16,28] since they are among the best demonstrated available technologies (BDATs) for heavy metal-contaminated sites. In recent years, however, the adsorption of heavy metals from the soil using *Talinumtriangularae* has been extensively studied for its technical visibility as adsorbents[25,27]. *Talinumtriangularae* is an erect perennial herb with swollen roots and succulent stems, 30-100 cm tall. The branches have two lateral basal buds. The leaves are spirally arranged to nearly opposite, often crowded at the top of the stem. The waterleaf is fast growing and once established, easily reseeds itself. *Talinumtriangularae* flowers early year-round, and is mainly self-pollinating. The flowers are pink in colour and open in the morning. The aim of this work is to utilize *Taliniumtriangulare* (water-leaf) in accessing the level of heavy metals in some selected farm sites around Veritas University, Zuma II – Abuja.

MATERIALS AND METHODS

PREPARATION OF CONTROL

Five different farm-sites were located and designated A – E for the research. The water—leaf sample used for this work was obtained from a local market in Bwari Area Council of the FCT. These were divided into six different portions. One portion of the sample (Control was screened and washed several times in running tap water to remove debris and then rinsed with de-ionized water. The water-leaf stalk was cut into small pieces after which it was dried in an oven at 50° C for 48hrs. The stalk were grounded to fine powder with an electric blender, sieved and stored.5.0g of the grinded sample was dissolved in 100ml of deionize water and was shaken properly with a Rotary Shaker and allowed to stand for 24hrs. The content of each beaker was filtered using a Whatman No. 1 filter paper and after which the concentrations of the metal ions in the filtrate was determined using Atomic Absorption Spectrophotometer (AAS).

Sample collection and preparation

The *Talinumtriangulare* samples were harvested from the five selected Farm-sites after5 weeks of planting. *Talinumtriangulare* was first washed in running tap water to remove debris and then rinsed with de-ionized water. The fresh stalk of the plants were removed, cut into small sizes and oven dried at about 60°C. In the preparation of the aqueous solution, 5.0g of each of the five samples was dissolved in 100ml of deionised water and was shaken properly with a Rotary Shaker for 12hrs and allowed to stand for 24hrs. The content of each beaker was filtered using a Whatman No. 1 filter paper and after which the concentrations of the metal ions in the filtrate was determined using Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

The results obtained from this study are presented in the Table 3 and depicted in Figure 1.The concentration of the heavy metals in the soils of the four farm sites (A,B,C and D) around Veritas University and that of Zuma IIFarm site (E) are presented in Table 3. The results showed a high level of heavy metal concentrations from the farm site in Zuma II (sample E) when compared to those from the University Farm sites. These may be due to high vehicular movement and human activities in Zuma II. Figure 2, is the bar chart showing the concentration of heavy metals in the different farm sites. From the results, it can be deduced that, Zinc (Zn) concentration is higher in all the sites compare to other heavy metals; Copper (Cu) is higher in the Zuma IIFarm site and lower around the boys hostel; Iron (Fe) is higher in the sample from Zuma IIFarm site and lower around the school Block; Nickel (Ni) is higher around the girls' hostel and lower around the chapel; Cadmium (Cd) concentration is higher around the boys hostel and lower around the class room block; Chromium (Cr) concentration is higher in the sample from the local market and lower around the class room block; Lead (Pb) is higher around the boys hostel and lower around the class room block. Comparing the heavy metal concentrations with the control sample values as shown in Table 3, all the sample concentrations exceeded the control concentration which is probably due to the adsorption of heavy metals by *Taliniumtriangulare.* Comparing the level of heavy metal concentrations with the World Health Organization (WHO)/National Agencies for Food and Drug Administration and Control (NAFDAC)standards for heavy metals in the soil as shown in Table 4, none of all the samples exceeded the limits as well as the stipulated ranges for the heavy metal concentrations. The values of all the metals analyzed for samples from Farm sites were higher than those from the control site suggesting possible mobility of metals from Farm sites to water leaf, but were below values recommended by the World Health Organization (WHO, 1991), but there is need for further monitoring since the inhabitants depend on these areas for farming.

CONCLUSIONS

In this study the following trend of heavy metal concentration was established Zn>Ni>Cu>Fe>Pb>Cd>Cr for the soil samples studied. The concentration of Zn was found to be much higher than all the other elements. It can be concluded that there is low impact of automobile exhaust emission on these soil around the selected location. Result from this study does not indicate any serious pollution or contamination risk on the selected soil. Relatively moderate concentration should be checked to determine when bioaccumulation occurs.

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Table 1: Soil concentration ranges and regulatory guidelines for some heavy metals by WHO

Elements	Copper	Lead	Nickel	Zinc	Cadmium	Iron	Manganese
Acceptable Concentration in Mg/Kg	1.5-3.0	0.1	1.037	15	3.0	10	2.005

Table 2: Soil concentration ranges of some heavy metals by Department of Petroleum Resources in Nigeria

Elements	Acceptable Limits (µ/g)	Wave length (nm)	FAAS Dekition limit(mg/l)
Copper (Cu)	30-40	324.80	0.077
Nickel (Ni)	30-70	232.00	0.140
Lead (Pb)	85-450	217.00	0.190
Zinc (Zn)	135-150	213.90	0.018

Table 3: Concentration (mg/kg) of Heavy Metals in *Taliniumtriangulare* samples

Farm site	Cu	Fe	Zn	Ni	Pb	Cd	Cr
A	0.12	0.14	2.62	0.18	0.03	0.001	0.002
B	0.26	0.18	1.51	1.06	0.02	0.003	0.003
C	0.05	0.13	1.84	0.51	0.06	0.004	0.001
D	0.06	0.16	1.32	0.19	0.07	0.002	0.002
E	1.02	0.21	2.21	0.22	0.05	0.002	0.003
Control	0.03	0.10	1.22	0.16	0.01	0.001	0.001
AVE	0.257	0.153	1.787	0.387	0.040	0.002	0.002

Keynote: Farm sites and their locations
A Around VUA academic block
B Around VUA girls' hostel block
C Around VUA boys' hostel block
D Around VUA Chapel block
E Farm site in Bwari, Abuja

Table 4: Soil concentration ranges and regulatory guidelines for some heavy metals by WHO and NAFDAC

Metals	WHO/FAO standard (mg/kg)	NAFDAC standard (mg/kg)	Normal range in plant
Cd	1	0.5	<2.4
Cu	30	20	2.5
Pb	2	2	0.5-30
Zn	60	50	20-100
Fe	48	40	400-500
Ni	1.03	0.6	0.02-50
Cr	0.60	0.5	0.05-2.4

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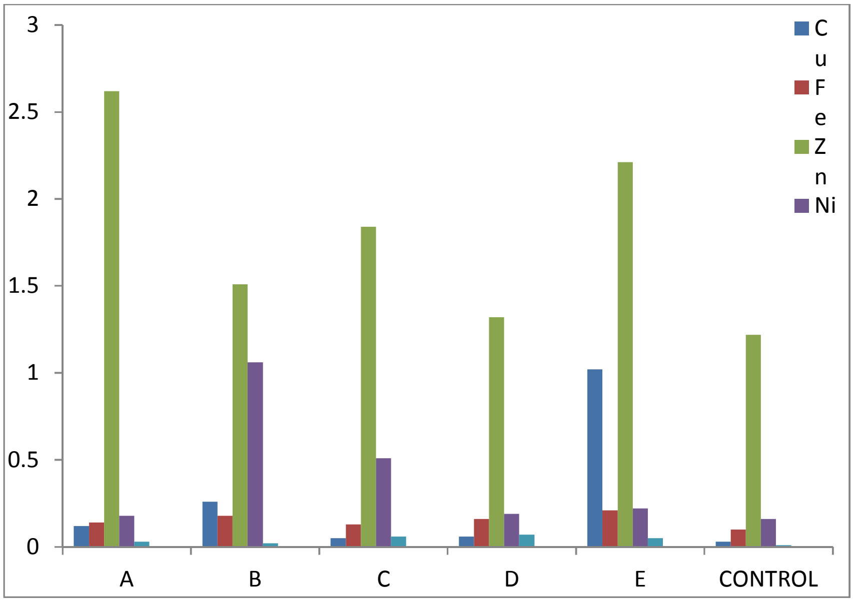

Figure 1: Concentration of Heavy metals in *Taliniumtriangulare* samples