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Comparative Study of Uptake of Heavy Metals in Three Wetland Plants in Banks of two flowing Rivers and a Stream in Southern Nigeria

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ABSTRACT
Comparative study of uptake of heavy metals in three wetland plant growing in banks of two flowing rivers and a stream in Akwa Ibom State was carried out in the month of August, 2012 to access the pollution status of these wetlands and to evaluate the uptake potential of these plants. Heavy metals in plants leaves were analyzed using Atomic Absorption Spectrophotometer (AAS) method. Iron and Nickel were the most abundant of all the heavy metals in the leaves of the three wetland plant. The concentration of Iron (Fe) ranged between (23.18 ± 0.93) mg/kg to (78.79 ± 71.80) mg/kg, Nickel ranges between (1.65 ± 0.53) mg/kg to (1.86 ± 0.20) mg/kg, Lead (Pb) ranges between (1.23 ± 0.27) mg/kg to (1.48 ± 0.31) mg/kg, Chromium (Cr) ranges between (0.60 ± 0.43) mg/kg to (0.80 ± 0.32) mg/kg and Mercury (Hg) ranges between (0.20 ± 0.15)mg/kg to (0.81 ± 011)mg/k. Acroceros zizanoides had the highest uptake potential for iron and mercury while Tristemna spp has the least uptake potential for these heavy metal but the highest for chromium, nickel and lead with Acroceros spp and Cyclosporium having the least for these. The results shows high uptake potential of heavy metals by the three wetland plants and hence could be used in heavy metal mop up in environmental management of heavy metal pollution.

KEY WORDS: *uptake potential, heavy metals*,***, wetland, environmental pollution, anthropogenic,***

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I. INTRODUCTION

Environmental pollution is a global problem posing risk to man. The development of modern technology and the rapid industrialization are among the foremost factors promoting environmental pollution (Karplan *et al*., 2010).
Heavy metal toxicity has been reported as one of the major environmental pollutants of health concern. It is more dangerous due to its bio-accumulation tendency in food chain (Aycicek *et al*., 2006).

Various anthropogenic activities such as burning of fossil fuel, mining and metallurgy industries and transport sectors accounts for redistribution of toxic heavy metals into the environment. Heavy metals can persist for a considerably long period before they are transported to different components of the environment (Kaplan *et al*., 2010). Vital organs of man such as the liver, and kidney are good accumulators of heavy metals like AS Cd, Pb and Hg (Alloway and Ayres, (1993), Bansazek *et al*., (2000), Weis and Weis,2004; Kaznina, *et al*., (2005); Kotwal *et al*., (2005); Liphadzi and Kirkham, (2006); Andra *et al*., (2010).
Alkaline precipitation, ion exchange columns, electrochemical removal, filtration and membrane technologies are some current available technologies for heavy metals removal.

Phytoremediation of metals is a cost-effective "green" technology based on the use of specially selected metal accumulating plants to remove toxic heavy metals from soils and water.

Wetland plants are plants that grows on wetland soils, they are technically referred to as hydrophytes or hydrophytic vegetation. Wetland plants are important tools for heavy metal removal. Wetland plants are preferred over other bio-agents due to their low costs, frequent abundance in aquatic ecosystems and easy handling. The extensive rhizosphere of wetland plants provides an enriched culture zone for the microbes involved in degradation. The wetland sediment zone provides reducing conditions that are conducive to the metal removal pathway. Wetland species can be split into two categories; emergent (floating) or submerged. The emergent species are used for phytotranspiration, phytoextraction and phytovolatilisation and are easily to harvest, if so desired (Kadiec *et al*., 1999). Submerged species do not transpire water but they do provide more biomass for the uptake and absorption of heavy metal contaminants through phytoextraction. Submerged plants are able accumulate metals in their tissues than the rooted emergent plants because their foliage is exposed to the water (Qian *et al*., 1998). Emergent wetland plants include cattails and rushes. It is suggested that a good metal accumulator would be a plant that has the ability to absorb the metals through the leaf surface (Qian *et al*., 1999). Since leaf uptake is directly related to the amount of leaf surface area that is exposed to the water, plants that have a higher surface area and have a high planting density make good accumulators of heavy metals and other contaminants. Also the rate at which a plant accumulates biomass is critical to predicting if it will be a good accumulator of metals.

Heavy metals can exercise an influence on the control of biological functions such as effect on hormonal system and growth of different body tissues (Underwood, 1977).These physiological function and role of heavy metal has prompted this studies which is aimed at accessing the pollution status of these wetlands and to evaluate the uptake potential of these wetland plants.

II. MATERIALS AND METHOD

Description of study location:

The study was restricted to three industrialized and highly populated local government areas of Akwa Ibom State.

Description of Sampling Station

Station 1 is located at the bank of Inyang Ufok Ibok Ikot Ebiyak river in Etinan Local Government Area, Station 2 at the bank of Inyang Udo Nsinia rivers in Afaha Nsit village in Nsit Ibom Local Government Area and the bank of Ikot Okobo village stream in Nsit Ubium Local Government Area as station 3. Sampling was done during the rainy season (August 2012).

Sampling Procedure

Three dorminant wetland plants namely (*Acroceras zizanoides*, *Tristemna mildbraedii* and *Cyclosporium striatus* were collected from banks of three rivers and a stream in akwa ibom state. The plants were collected by uprooting thereafter they were carefully transferred into a polythene bag. The leaves of the collected plants were then separated from other parts such as stem and roots and were dried in the open within a temperature range of 37^0C and 40^0C until the leaves were properly dried. They were turned into powder form by grinding in a mortal. Powdered form were then placed in a clean sample bottles and labeled accordingly. These were then taken for laboratory analysis for heavy metal analysis.

Determination of Heavy Metals

Heavy metals were analysed by (AAS) using unicam 939 atomic absorption spectrophotometer according to the methods described in Adeniyi, (1996)

III. RESULTS

The results of comparative study on uptake of heavy metals in three wetland plants investigated in this study are illustrated in fig 1-5.

Mercury (Hg)

The mean concentration of mercury (fig 1) varied within the three stations, the highest value of 0.20 $\pm$ 0.15mg/kg was recorded in station three while the least value of 0.18 $\pm$ 0.11mg/kg was recorded in station one. Mercury concentration was highest in *A. zizanoides* (0.330mg/kg) and lowest in *T. mildbraedii* (0.030mg/kg)

Lead (Pb)

The highest mean concentration of lead (fig 2) was recorded in station three (3) (1.48 $\pm$ 0.31) mg/kg and the least (1.25 $\pm$ 0.30mg/kg) was recorded in station two. The highest value (1.830mg/kg) was recorded in *T. mildbraedii* at station three while *C. striatus* had the least concentration of lead at station one. The variation in these concentration was significant at (P>0.05).

This high content of lead could be attributed to corrosion of water pipes, industrial waste as well as domestic activities which are predominant in these study areas.

Nickel (Ni)

Nickel was more abundant in station two with a mean concentration of (1.89 $\pm$ 0.59) mg/kg (fig 3). Maximum uptake of 2.430mg/kg was recorded in *T. mildbraedii* while the least mean concentration of 1.170mg/kg was recorded in *C. striatus* at station one

Chromium (Cr)

Relative abundance of chromium in leaves of wetland plants are depicted in fig 4. The highest mean value (0.80 ± 0.32) mg/kg of Chromium was recorded in station one while station three had the least mean value of 0.58 ± 0.25mg/kg. These variations were significant at ($P > 0.05$). *T. mildbraedii* from station 1 has the highest chromium content of (1.140mg/kg) while *A. zizanoides* has the least concentration of (0.300mg/kg)

Iron (Fe)

The highest means concentration of 78.79 ± 1.80mg/kg was recorded in station three while the least value of 23.18 ± 0.93mg/kg was recorded in station 1. *A. zizanoides* had the highest value of Iron 151.956mg/kg and *T. mildbraedii* had the least value (2.00mg/kg) fig 5.

In this study, five (5) heavy metals reported TO HAVE health consequencies were used to evaluate the heavy metal load(pollution status) of three wetland in Etinan, Nsit Ibom, and Nsit Ubium Local Government Areas in akwa ibom state. the pollution levels between the three stations(l.g.a) varied significantly at ($P> 0.05$).

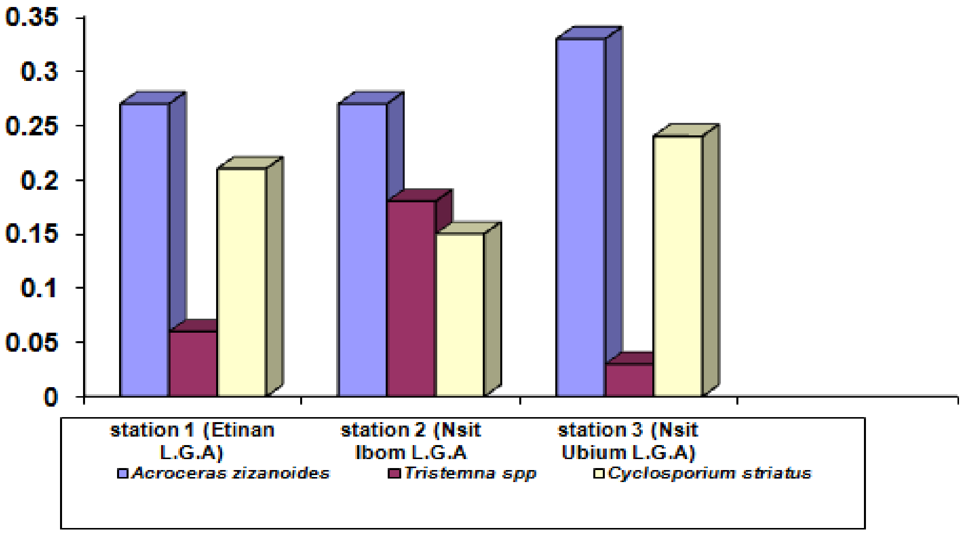

Figure 1: Comparative variation of Mercury (Hg) in three wetland species

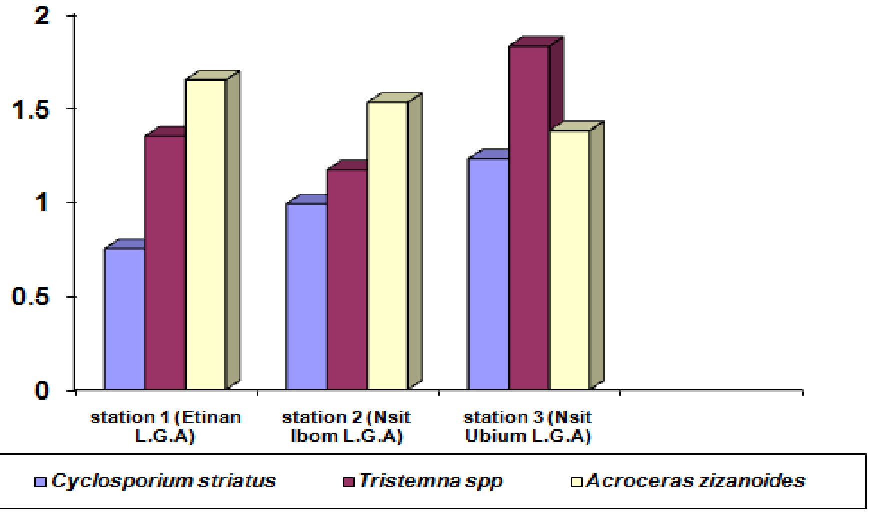

Figure 2: Comparative variation of Lead (Pb) in the three wetland species

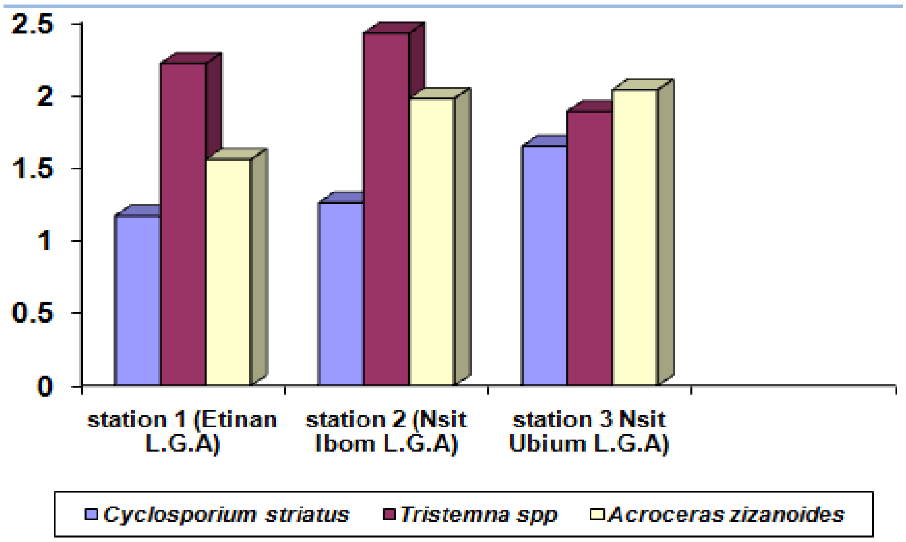

Figure 3: Comparative variation of Nickel (Ni) in the three wetland species

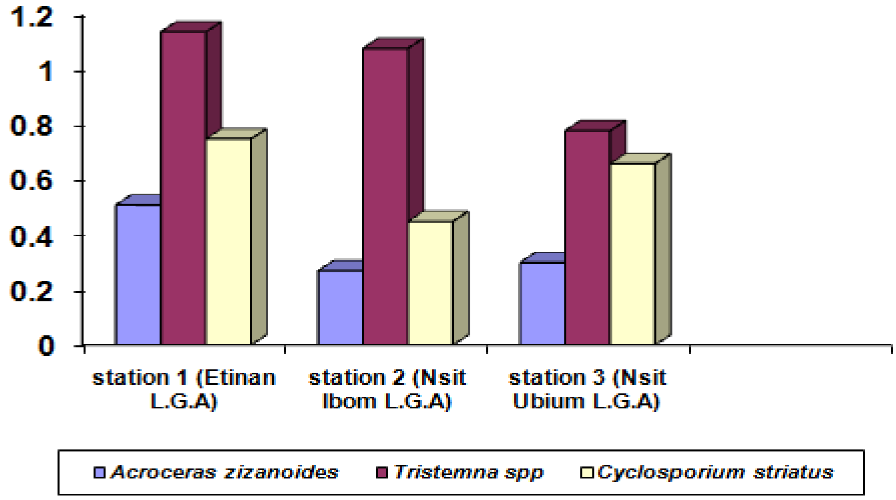

Figure 4: Comparative variation of Chromium (Cr) in the three wetland species

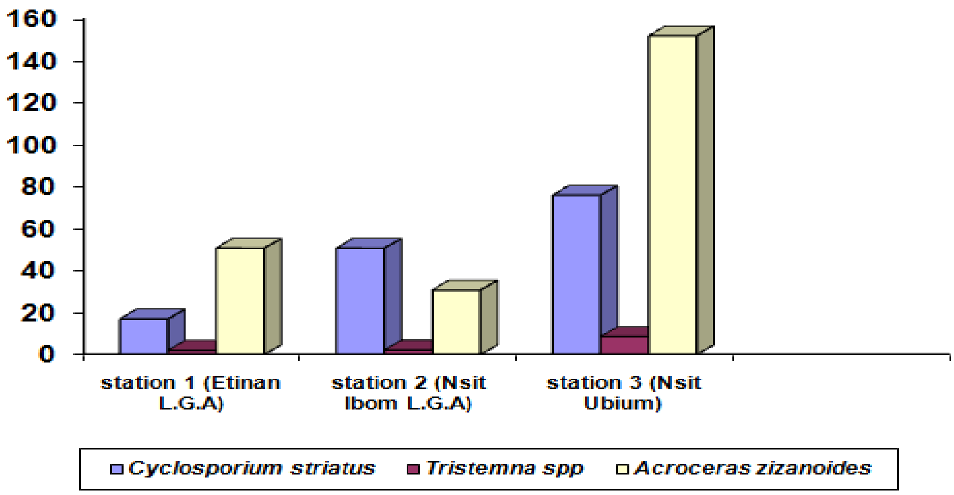

Figure 5: Comparative variation of Iron (Fe) in wetland species

IV. DISCUSSION

Plants that grow in polluted environments may show stress symptoms due to bioaccumulation of metals through direct uptake by the plants roots, stems, or shoot, Godbold *et al*., (1984) Baker, (1987); Dahmani-muller *et al*., (2000), Monni *et al*., (2001). However, metals accumulate in the soil and are drawn up into the tissues of plant and exert long-term effect. In general some wetland plants are very good accumulators of metal and some have the potential to convert toxic forms of the metal to non-toxic forms (Qian *et al*., 1999).

Iron, Mercury and Lead were higher at station 3 (Nsit Ubium local government area) and lower at stations 1 (Etinan) and Station 2 (Nsit Ibiom local government area). Chromium and Nickel were higher at Stations 1 and 2 and lower at 3. This pattern is an indication of difference IN pollution load of these heavy metals at the various L.G.A, this can be trace to the various industrial activities such as crude oil drilling and other related crude oil prospecting activities in these locations. This high amount is an indication of increased heavy metal load in the various locations. The highest amount of uptake was recorded at Nsit Ubiom L.G.A. This could be due to reduction in water current of wetland. Water current was minimal in this wetland. Deposition from run off would probably have increased the level and with the sence of maximum stream flow transportation and distribution to other areas will be minimal, this could have accounted for this pattern and could had leads to high content in these station

Iron (Fe) was the highest heavy metal in the three wetland plants. This could be due to comparative uptake ability of the three wetlands plants for iron than any other heavy metal investigated. *A. zizanoides* from (station 3) accumulated the highest concentration of iron (151.956mg/kg) and the lowest of 30.632mg/kg from (station2) accumulated. the reason for these high levels of accumulations could be due to the plants physiological makeup. Also,the plant may have developed certain strategies in order to withstand the high level of accumulation recorded. According to Sharma *et a*l; (2001) high rate of metal accumulation could result from soil texture, temperature, nutrient availability, pH, and organic matter content. From the observation, it can be deduced that *A.zizanoides* is more tolerant to high concentrations of iron than other two wetland plants.

The reason for low amount of mercury (0.030mg/kg and 0.330mg/kg.) in all stations could be as a result of reduced pollution load of mercury in the wetland than other heavy metals.

The high content of lead (range of 0.750mg/kg and 1.830mg/kg) could be attributed to corrosion of water pipes, industrial waste as well as domestic activities which are predominant in these study areas.

The concentration of nickel ranged between 1.170mg/kg to 2.430mg/kg,in the plant tissues in all the stations indicates high pollution level of nickel in the wetland. This could be due to industrial waste in form of effluent released into the wetland.

Chromium concentration ranges between 0.270 mg/kg in station two and 1.140mg/kg in station one. This is an indication that metal pollution is higher at station one. This could be due to domestic waste, run off and agro chemical from farm lands.

V. CONCLUSION

Comparatively, there was generally significant difference in uptake of heavy metals by the three wetland plants investigated. Iron was the most accumulated in all three stations. *A. zizanoides* had the highest uptake potential for iron and mercury while *T. mildbraedii* has the least uptake potential for these heavy metal but the highest for Chromium, Nickel and Lead with *A. zizanoides* and *C. striatus* having the least for these.

REFERENCES

[1]. Adeniyi, a. a. (1996). determination of cd, cu, fe, pb, mn and zn in waterleaf (*talinium triangulare)* in dumpsite. environment, 22(2): 259-262.

[2]. Alloway, b. j., ayres, d. c. (1993). chemical principles of environmental pollution blackie academic and professional, glasgons, u. k.

[3]. Andra, s. s. sarkar d, makris k. c and bach s. b. (2010). synthesis of phylochelatins in vetivar grass upon lead exposure in the presence of phosphorus. *plant soil 326: 171-185.*

[4]. Aycicek, M. O., Kaplan, O. and Yaman, M. (2006). Effect of Cadmium on germination, seedling, growth and metal contents of sun flower (*Helianthus annus* L.) *Asian J. Chem., 20:* 2663-2672.

[5]. Baker A. J. M. (1987). Metal Tolerance. New Phytol; 106: 171-185.

[6]. Banaszak, A., Lajeunesse, T., and Trench. R. (2000). The Synthesis of Mycosporine-jike Amino acids (MAAs) by Cultural, Symbiolic Dinoflagelletes. *J. Exp. Mar. Bcol. Ed. 249:*219-233.

[7]. Demchik, M. and Garbutt, K. (1999). Growth of woolgrass in Acid mine drainage, *J. Environ. Quality. 28:* 443-449.

[8]. Godbold, D. L., Horst, W. J., Collins, J. C., Thurman, D. A. and Marschner, H. (1984). Accumulation of Zinc and Organic acids in roots of Zinc tolerate and non-tolerate Ecotypes of *Deschampsia caespitosa J. Plant Physiology 116:* 59-69.

[9]. Karplan, O., Yildirim, N. and Cimen, M. (2010). Toxic elements in animal products and environmental health. *Asian Journal of animal Veterinary Advance.*

[10]. Kaznina, N. M., Laidinen, G. F., Tifov, A. F. and Talenov, A. V. (2005). Effect of lead on the photosynthetic apparatus of annual grasses ser. Biol., 2: 184-188.

[11]. Kotwal, S. K. (2005). Industrial Pollutants and Animal Health Review Indian *J. Anim Sci 75:* 713-722.

[12]. Liphadzi, M. S, and Kirkham, M. B. (2006). Heavy-metal Displacement in Chelate-treated Soil with Sludge during Phytoremediation *J. Plants. Nut. Soil Sci. 169 (6):* 737-744.

[13]. Monni, S., Uhlig, C., Hansen, E. and Magel, E. (2001). Ecophysiological Responses of *Empetrum nigrum* to Heavy metal Pollution. *Environment Pollution 112:* 121-129.

[14]. Qian, W. M., Zayed, A., Zhu, Y. L. and Terry, N. (1999). Phytoaccumulation of trace elements by wetland plants. *J. Environmental Quality, 28:* 1448-1455.

[15]. Sharma, P. Dubey (2001). Level Toxicity in Plants. *Plants Physiology 17:* 35-52.

[16]. Terry, N. Lytle, C. M., Lytle, F. W. and Zayed, A. (1998). Reduction of Cr (Vi) to Cr (III) by wetland pants. *Environ. Sci. and Technol., 32:* 3087-3093.

[17]. Underwood, E. J. (1977). Trace element in human nutrition. P. 545.

[18]. Weis and Weis, P. (2004). Metal uptake, transport and release by wetland plants. Implications for phytoremediation and restoration. *Environ. Int., 30:* 685-700.