Assessment of Selected Heavy Metals Concentration in Sediment and Leaves of *Alternantherasessilis*.

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Abstract: **- A study was carried out on sediment and leaves of an aquatic plant "*Alternantherasessilis*" in FarinGada stream, Jos. To determine and assess the level of concentration of metals. Fe, Cu, Cd and Co in the samples.The result obtained indicates a moisture content of 33.99± 0.46% and 20.90±0.10% for leaves and sediment respectively, and dry matter of 66.01±0.53% leaves and 79.10±0.82% sediment. The ash content was found to be 4.44±1.42% for leaves and 75.57±1.90% for sediment and the corresponding organic matter are 95.56±1.42% for leaves and 24.43±1.90% for sediment. Fe was 809.80±9.89mg/kg, Cu 24.80±0.2mg/kg, Cd 10.80±1.18mg/kg and Co 38.30±9.38mg/kg for leaves while for the sediment samples Fe was 1041.00±4.35mg/kg,Cd 8.58±2.68mg/kg, Cu 9.20±0.71mg/kg and Co 39.50±4.70mg/kg for sediment. The concentrations of Cd and Cu were higher in the leaves than in the sediment. The aquatic plant is a good bio indicator and also bio accumulator of Cd and Cu.**

Keywords: **Accumulation, Assessment, Heavy metals, Aquatic plant, Sediment, *Alternantherasessilis*, Composition.**

I. INTRODUCTION

Over the last few decades, there has been growing interest in determining heavy metal levels in the marine environment by different individual, organizations and higher institutions of learning, and focus is placed on measurement of contamination levels in public food supplied from water body. Heavy metal is a widely known term and it's applied to the vast spread contaminants of terrestrial and fresh water ecosystem. Many of these heavy metals are toxic to organisms at certain concentration. The concentration of various elements in the air, water and soil may be increased beyond their natural level due to the agricultural, domestic and industrial effluents which usually contains most of these elements.

Metals and many other fluvial contaminants in suspension or solution do simply flow down the stream they form complexes with other compounds settle to the bottom and ingested by plants and animals absorbed to sediments. Water and sediments are commonly used as indicator for the state of pollution of aquatic ecosystem.

Sediments deposited on the bank and flood plains of a river is often mineral rich and makes excellent farmland. The fertile flood plains of the Nile in Egypt and of the Mississippi river in the United States have flooding river to thank for their excellent soils (U.S. Geological survey 2013). On the other side, when rivers flood, they leave behind many tons of wet, sticky heavy and smelling mud,not something you would want in your basement (U.S. Geological survey, 2013).

Aquatic plants are plants that have adapted to living in aquatic environments (saltwater or fresh water). They are also referred to as hydrophyte or macrophytes. These plants require special adaptations for living submerged in water, or at the water's surface, the most common adaptation is aerenchyma, but floating leaves and finely disserted leaves are also common. Aquatic plants can only grow in water or in soil that is permanently saturated with water, they are common of wetlands. The principal factor controlling the distribution of aquatic plants is the depth and duration of flooding, other factors, however may also control their distribution and abundance, including nutrients,disturbance from waves, grazing and salinity.

Alternantherasessilis is an aquatic plant known by several common names, including sessilisjoyweed and dwarf copper leaf, it is used as an aquarium plant. The plants occur around the world;the leaves are used as vegetable. Young shoots and leaves are eaten as a vegetable in south east Asia (Grubben et al., 2004). Occasionally it is cultivated for food or for use in herbal medicines. This specie is classified as a weed in parts of the southern states of the USA. It is usually found in wet or damp sports.Heavy metals, although they occur naturally they come from different sources; some mining industries, burning of fossil fuels, burning garbage, or tobacco and even forest fires, release heavy metals into the environment. Heavy metals last forever, except when broken down by radiation. They do not disappear but rather move around the environment; air and water can move heavy metals over great distance to places where originally they are not present. Agricultural materials also constitute one of the very important non-point source of heavy metals. The main source are impurities in fertilizers; Cd, Pb, Zn, pesticides; As, Hg and Mn based fungicides, wood preservations, compost and manures, corrosion of metal objects e.g. galvanized metals roots and wire fences.

II. AIM AND OBJECTIVES

The aim of this study is the assess the level of selected heavy metals concentration in the sediments and leaves of *Alternantherasessilis*. The objectives of the research are;

i. To determine the presence of Fe, Cu,Cd and Co and the extent to which they are available
ii. As the stream is a source of water for irrigation, the content of the metals in the aquatic plant will help to establish if the produce from the irrigation farming will have any effect on the consumers, as plants tend to accumulate metals present in the water used in watering them and the soil.
iii. The result obtained will help to proffer solutions as regards to the disposal of both domestic and industrial waste into the stream and also the used of the water for irrigation farming.

III. MATERIALS AND METHODS

Sampling

The sediment and the aquatic plant's leaves were collected at 9:00am from Faringada stream in the morning. Each of the samples was collected at an interval of some distance away from each point of collection and along the stream.

Sediment sample was collected by digging a depth of 0-15cm from the location, about 100-120g of the sample was transported in polythene bags and air dried in a dust free room. Sample was the ground to fine powder using pestle and mortar as they were not of uniform size. A fine mesh sieve was used to sieve the ground sample and stored in plastic bottles for sub-sequent analysis.

About 300g of the aquatic plant's leaves were collected from the stream and was placed in a clean plastic bag and was then identified.It was dried in a dust free room after which it was then ground to fine powder using pestle and mortar. The powder was stored in plastic bottles for subsequent analysis. The plant was identified and named as *Alternantherasessilis* by Mr. J.J.Azila of the Herbarium Department Federal College of Forestry, Jos.

Determination of Moisture and Dry Matter Content

A clean oven dried Petri-dish was weighed and 5g sample of the loose fresh sediment was placed in the Petri-dish. The Petri-dish and their content were placed in an air oven and dry at a temperature of 105-160^{0}c for 6-8 hours, after which they were removed, cooled in a desicator and weigh. The sample was then returned until a constant weight was obtained for each sample and recorded. The dried samples were kept in a desicator until needed.

Calculations

The weight lost during drying represented the moisture content of the samples.

Weight lost (g) = moisture content

The value of % moisture obtained was subtracted from 100% to obtain dry matter content of the sample

Dry matter = 100% - moisture content

Determination of Ash and Organic Matter Content

The ash content was determined on the dried samples. A dry clean porcelain crucible was placed in a muffle furnace at 600^{0}C for 5 minutes and transferred to a desicator to cool, after which it was weighed. About 2.00g-4.00g each of the dried samples were weighed into the pre-weighted crucible.

The weighed crucible and its content was then transferred into a muffle furnace whose temperature was gradually raised until it was 600^{0}C, which was then maintained for about 5-6 hours (to destroy organic matter content). The crucible with the residue were removed, cooled in a desiccator and re-weighed. The weight of the residue in the crucible corresponds to the ash content of the sample

Calculation

$$Ash\ content\ \% = \frac{weight\ of\ ash(g)\ x\ 100}{weight\ of\ sample\ (g)}$$

The loss in weight during ashing represents the organic matter content.

Organic matter (%) = 100%- ash content

TREATMENT OF SAMPLES

Digestion of Sample for Heavy Metal Determination

About 1g of the sediment sample was weighed into a 50cm^{3}kijeldahl's flask, and a mixture of HNO_3: $HClO_4$: H_2SO_4 ratio was added in the ratio 5:1:1, the mixture was then heated in a fume cupboard gently until the fume of the mixture is evolved and the residue becomes completely white. The solutuion was then diluted with 20cm^3 of distilled water and filtered into a 50cm^3 volumetric flask. The filtrate was then made up to the mark with distilled water and the resultant solution was preserved for the determination of Fe, Cd, Cu, and Co. The same procedure was repeated for the aquatic plant sample.

PREPARATION OF STANDARD SOLUTION

Blank Solutions for Heavy Metals

The blank reagent solution was prepared by the mixture of concentrated HNO_3: $HClO_4$: H_2SO_4 in ratio 5:1:1, all in volume (cm^3) in a digestion tube, which was heated in a fume cupboard until the appearance of white fumes. The flask was set inside to cool and its content transferred to 50cm^3 volumetric flask which were then diluted to mark with distilled water.

Iron Solution and Determination

A 1000ppm solution of iron was prepared by dissolving 1g of iron powder or granules in 20cm^3 of 5MHCl and 5cm^3 HNO_3 and the solution diluted to1litre in a volumetric flask with deionized water. The solution was stored in polythene bottle.

Both standard solutions and sample solution were aspirated into AAS at 248.5nm. A calibration curve was prepared from the readings of the standards. The sample solution concentration was extrapolated from the curve.

Calculation

$$Fe\ \% = \frac{Conc(ppm)\ x\ solution volume(cm^3)}{10^4\ x\ sample\ weight}$$

Cadmium Solution and Determination

A 1000ppm cadmium solution was prepared by dissolving 2.3862g of cadmium sulphateoctahydrate ($CdSO_4.8H_2O$) in distilled water. The solution was then diluted and made to mark with distilled water in a 1dm^3 volumetric flask. Further dilutions were made to obtain 02ppm, 0.4ppm, 0.6ppm. These were stored in polythene bottles.

Both standards and sample solutions were aspirated into AAS at 229nm. A calibration curve was prepared for the reading of the standards. The sample concentration was extrapolated from the calibration curve.

Calculation

$$Cd\ \% = \frac{Conc(ppm)\ x\ solution\ volume(cm^3)}{10^4\ x\ sample\ weight(g)}$$

Copper Solution and Determination

A 1000ppm copper solution was prepared by dissolving 1g of fine copper metal in 5cm^3 nitric acid and the resulting solution made up to mark with distilled water in a 1dm^3 volumetric flask. Further dilution of the stock solution was made to obtain 0.25ppm, 0.5ppm, 0.75ppm Cu. The solutions were stored in polythene bottles.

Both standards and sample solution (as in 3.5.1) were aspirated into AAS at 325.8nm. A calibration curve was prepared from the reading of the standards. The sample solution concentration was extrapolated from the calibration curve.

Calculation

$$Cu(\%) = \frac{Conc(ppm)\ x\ solution\ volume(cm^3)}{10^4\ x\ sample\ weight(g)}$$

Cobalt Solution and Determination

A 1000ppm cobalt solution was prepared by dissolving 4.0230g of cobalt (ii) chloride ($CoCl_2\ 6H_2O$) in 200cm^3 deionized water and the solution diluted to 1 litre in a volumetric flask with deionized water. The solution was stored in polythene bottle for sub-sequent dilution to obtain 0.25ppm, 0.5ppm, 0.75ppm Co solution

Both standards and sample solution were aspirated into AAS at 289.6nm.and a calibration curve was prepared for the reading of the standards. The sample solution concentration was extrapolated from the calibration curve.

Calculation

$$Co(\%) = \frac{Conc(ppm)\ x\ solution\ volume(cm^3)}{10^4\ x\ sample\ weight(g)}$$

IV. RESULTS AND DISCUSSION

Moisture and Dry Matter

The moisture and dry matter content of the samples are shown in Table 4.1

Table 1 Moisture and Dry Matter content of Plant leaves and Sediment Samples

	Moisture content(%)	Dry matter(%)
Plant	33.99±0.46	66.01±0.53
Sediment	20.90±0.10	79.10±0.82

From Table 1, it can be observed that the moisture content for plant leaves and sediment are 33.99±0.46 and 20.90±0.10 respectively. The moisture content of the plant leaves is higher than for the sediment, possibly because plants tend to store water in their roots, stems and leaves. The corresponding dry matter for plants and sediment were 66.01±0.52 and 79.10±0.82 respectively. This indicates plant leaves has lower dry matter than the soil.

The result obtained from moisture content for the plant leaves is lower than the value obtained for some plant samples 91.37-94.69% and the value obtained for the soil is higher than that obtained for soil samples 7.31-11.93% (Salami et al 2001). The value obtained for dry matter is higher than the 7.78-10.18% and 11.56-12.87% obtained for water lily and water lettuce species respectively (Salami et al., 2000).

Ash and Organic Matter Content

The ash and organic matter content of the samples are shown in Table 2

Table 2: Ash and Organic Matter Content

	Ash content(%)	Organic matter(%)
Plant	4.44±1.42	95.56±1.42
Sediment	75.57±1.90	24.43±1.90

Table 2 above shows the ash content and organic matter of plant and sediment, from the result obtained, it was observed that the sediment has higher ash content and lower organic matter while the plant has lower ash content and higher organic matter. The ash content is a reflection of the metallic element level of the sample. The ash content of soil is higher than that of plant because they are composed of mainly organic substances.

Heavy Metal Concentration

Table 3: Heavy metal concentration in plant and sediment (mg/kg)

	Plant	Sediment
Fe	809.80±9.89	1041.00±4.35
Cd	10.80±1.16	8.58±2.68
Cu	24.80±0.20	9.20±0.71
Co	38.30±9.38	39.50±4.70

Tables 3 shows the concentration of the metals Fe, Cd, Cu and Co in plant and sediment samples. The result obtained for the concentration of Fe in plant and sediment are 809.80±9.80 and 1041.00±4.35 which shows that the sediment sample has higher concentration of Fe than the plant. Fe can be attributed to the mine wastes which often gets into water and absorbed by the sediment, though the concentration of Fe in plant is lower than the sediment, substantial amounts of Fe from soil are absorbed by the plant. The concentration of Fe in the samples is compared with WHO safe maximum limit 425mg/kg and showed that the concentration of Fe in both plant and sediment are higher than the tolerance limit.

The result obtained for the concentration of Cd in the plant and sediment sample are 10.50±1.16 and 8.58±2.68mg/kg, which indicates that the concentration of Cd in the plant sample is higher than that in sediment which also implies that plant is a good indicator of Cd. The concentrations of Cd in the samples is compared with the Chinese Department of preventive medicine maximum tolerance limit 0.05mg/kg. the concentration of Cd in both plant and sediment samples are higher than the tolerance limit. Acute doses (10.30mg/kg per day) of cadmium can cause severe gastro intestinal irritation, vomiting, diarrhea, and excessive salivation and 25mg of Cd/kg body weight can cause death (Chinese Department of preventive medicine 1995).

The concentration of Cu in plant and sediment samples are 24.80±0.2 and 9.20±0.71 respectively which also show that the plant has higher concentration of Cu than sediment. The element is useful to plants as a component of several enzymes for ascorbic acid oxidanse. The concentration of Cu in both samples when compared with the Chinese Department of preventive medicine maximum tolerance limit 10mg/kg showed that the concentration of Cu in plant is higher than the tolerance limit while the concentration for sediment falls within the tolerance limit. When Cu exceeds the tolerance limit, it can cause sporadiac fever, hypertension etc and from this study it revealed that concentration of Cu in the plant is above the Chinese Department of preventive medicine safe limit.

The result obtained for Co showed that the plant and sediment have concentration of 38.38±9.38 and 39.50±4.70mg/kg which showed that the concentration of Co in plant is slightly lower than that in the sediment sample.

IV. CONCLUSION AND RECOMMENDATION

Conclusion

The study has shown that the aquatic plant and sediment obtained from FarinGada stream located in Jos North Local Government Area of Plateau State contained varying concentration of these metals Fe, Cd, Cu and Co. The result obtained from this analysis revealed that the level of accumulation of these metals by the aquatic plant and sediment are above the WHO threshold values and the Chinese Department preventive medicine maximum tolerance limit except for the concentration of Cu 9.20±0.71mg/kg in the sediment sample which is within the ranged of the tolerance limit value by Chinese Department of preventive medicine. The analysis also revealed that Cd and Cu have high concentrations in plant sample while Co and Fe have high concentrations in sediment sample.

Determination of heavy metals concentration in plants, sediment, water, etc, is importance for health risk assessment during food consumption as these plants have the ability to absorbed and accumulate these metals from soil, sediment or water which can cause severe health complications when consumed in quantities above the tolerance maximum limit.

Recommendation

The present study has indicated the need to monitor the trace metal content of water, soil, on which plant are grown as substantial amount of the soil’s metallic elements are absorbed by the plants. In some cases, the elements are accumulated by the plant to an extent that at higher than those for soils as the case of Cu and Cd. Also the disposal of both domestic and industrial wastes into the stream should be avoid as the stream as serve for this purpose which result in the high concentrations of the metals in the aquatic plant and sediment. Since the water from the stream is used as source of irrigation water by farmers, there is need to highlight them of the danger of using water from the stream for farming which plants can accumulate it and cause health problems on consumption.

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