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PHYTOREMEDIATION EFFECT OF PISTIA STRATIOTES (WATER LETTUCE) ON SOME HEAVY METALS FROM A POLLUTED RIVER

[1]ALIKALI, A. A. AND [2]MOHAMMED, A. K .
Department of chemical engineering, Chemical science Department, The Federal Polytechnic Bida, Niger State, Nigeria.

Abstract
The laboratory experiment was performed on the use of Pistia stratiotes in the removal of some heavy metals (Cr,Mn,Pd,Cu,Ni,Fe and Zn) from river Kusogi in Doko town, Niger state. The water sample was collected from this river and Pistia stratiotes was subjected into the water and allowed to stand for 21 days. The concentration of heavy metals present in the polluted water sample was analysed using Atomic Absorption Spectrophotometer (AAS). It was observed that there was an appreciable decrease of Pb from 0.70mg/L, to 0.57mg/L, Mn from 0.69mg/L to 0.23mg/L, Fe from 2.50mg/L to 0.58mg/L and Zn from 0.08mg/L to 0.02mg/L and Cu was completely removed from the polluted water sample. This shows that P. stratiotes has an effective phytoremediation properties in sanitizing water bodies polluted with the presence of heavy metals.

Keywords; *heavy metals, phytoremediation, concentration and sanitizing.*

INTRODUCTION
The world's ever increasing population and her progressive adoption of an industrial based life style has inevitably led to an increased anthropogenic impact on the biosphere (Asamudo *et al.,* 2005). The improper sewage disposal is a big environmental concern which is impossible to solve with conventional methods as these methods are expensive and labor intensive.

Waste disposal is a major concern in developing countries like Nigeria. The only solution is to device a system based by using aquatic plants to treat waste water as suitable alternative which is cost effective and safe to treat sewage (Reddy and Smith, 1987; Cooper and Findlater, 1990).

Phyto-technologies involving the use of plants for pollutants removal has gained importance in the last two decades. Contaminations such as petroleum hydrocarbon, heavy metals, pesticides and solvents have been rendered less harmful in phytoremediation. It is considered a natural cost-effective and non-environmental destructive technology as opposed to conventional cleanup methods (Edaigbini *et al.,* 2015).

Pistia stratiotes also known as 'Jal kumbi', water cabbage, water lettuce, sanbogi in Nupe and kainuwa in hausa is a free floating aquatic plant of streams, lakes and ponds. Due to its stolonniferous nature, it is always found enclosed to the hydro soil when the water level recedes and in the marsh land conditions and love alkaline/ lime rich water. *P. stratiotes* belongs to Arum/Araceae family (Quattrochi and Umberto, 2000). As a floating weed, it forms dense mats on surface of water bodies, disrupting aquatic flora and fauna underneath and thus adversely affects the water ecosystem and hinders water flow, fishing, swimming, boating, water sports and navigation (Bruner, 1982; Sharma, 1984). It lowers available oxygen and pH of water and thus damages rice crop when enters into paddy fields, develop roots in the soil and compete with crop under shallow water conditions (Hussain *et al*., 2000). It replaces the native hydrophytes in ponds and other water reservoirs.

Phytoremediation from ancient greek word phyto meaning "plant" and latin remedium meaning "restoring balance" describe the treatment of environmental problems (bioremediation) through the use of plants that mitigate the environmental problems without the need to excavate the contaminant material and dispose it elsewhere(Burkenz *et al*., 2012).

Phytoremediation involves or consist mitigating pollutant concentrations in contaminated soils, water or air with plants able to contain, degrade or eliminate metals, pesticides, solvents, explosives, crude oil and its derivatives and various other contaminants from the media that contain them (Burkenz *et al*., 2012). Phytoremediation from ancient greek word

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PHYTOREMEDIATION PROCESSESS

A range of processes mediated by plants or algae are useful in treating environmental problems (Salvapathy and Skeedler, 1991).

- **Phytostabilization:** reducing the mobility of substances in the environment. For example by limiting the leaching of substances from the soil.
- **Phytostimulation:** Enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with roots. This process is also known as rhizophere degradation. Phytostimulation can also involve aquatic plants supporting active population of microbial degrades as in the stimulation of atrazine degradation by hornwort.
    - **Phytoextraction:** uptake and concentration of substances from the environment into the plant biomass.
    - **Phytotransformation:** chemical modification of environmental substances as a direct result of plant metabolism often resulting in their inactivation, degradation (phytodegradation) or immobilization.
    - **Phytovolatilization:** removal of substance from soil or water with release into the air, sometimes as a result of phytotransformation to more volatile and or less polluting substances.

APPLICATION OF PHYTOREMEDIATION

Phytoremediation may be applied whenever the soil or static water environment has become polluted or is suffering on going chronic pollution (Allam and Charterjjee, 1995). Example where phytoremediation has been used successfully includes the restoration of abandoned metal

mine workings reducing the impact of contaminants in soil, water or air. Contaminants such as metals, pesticides, solvents, explosives (Allam and Charterjjee, 1995) and crude oil derivatives have been mitigated in phytoremediation project worldwide.

Many pollutants such as mustard plants, alpines pennycress, water lettuce, hemp and pigweed have been proven to be successful at hyper accumulating contaminants at toxic waste sites (APHA, 1998).

Over the past twenty years, this technology has become increasingly popular and has been employed at sites with soils contaminated with lead, nickel, uranium, copper and arsenic, while it has the advantage that environmental concerns may be treated in-situ; one major disadvantage of phytoremediation is that it requires a long term commitment as the process is dependent on a plant's ability to grow and thrive in an environment that is not ideal for normal plant growth (Allam and Charterjjee, 1995).

P. stratiotes (water lettuce) is capable of removing nutrients and heavy metals from sewage sludge and drainage ditches. It is the most suitable plant for waste phytoremediation in tropical areas. Fonkou *et al*. (2002) reported that the physicochemical parameters reduce progressively from the influent to effluent ponds like turbidity, phosphate level, total iron, sulfates and suspended solids. It takes up large amount of inorganic nutrients (especially nitrate, sulphate, phosphates, etc (Reddy, 1983) and heavy metals (such as cadmium, cupper, mercury, iron, zinc, etc) as a consequence of the growth requirements (Nakajuma *et al*.,1981; Prasad, 1995; Sakaguchi *et al.,*1981; Skinner *et al*.,2007) and decrease the concentration and ultimately lowering down the pH etc.

This research work is aimed at studying and analyzing the effectiveness of *Pistia stratiotes* in the treatment of water contaminated with heavy metals from river Kusogi in Doko town, Niger state with a view to provide baseline data on the level of some selected heavy metals in the polluted water body analyzed. The outcome of this study is of great interest to the environmental agencies, agricultural societies and the host communities that make use of this water for domestic and irrigation purposes.

Clean water is the desire of all who has to do with water, this includes plants and animals. Hence, this study justifies the use of *P. stratiotes* which is less expensive and non-hazardous to human health for the treatment of polluted water as compared to the use of chemicals such as alum, chlorine, Uv light, etc which are dangerous to human health.

MATERIALS AND METHOD

Preparation of samples before and after treatment.

Pistia stratiotes was kept on a filter paper to remove excess water and then transferred into plastic troughs having a capacity of five litres containing water from different points. Before transferring the test plant into the trough containing the water sample, the water and the plant were analyze for some heavy metals ; (Mn, Zn, Ni, Cr, Fe Sand Pb) (APHA, 1995, 1998). After 21 days, plant was gently removed from the pots. Plant leaves were washed with deionized water and dried at 70^0C, and the dry matter was grinded into fine powder.

Digestion of samples

About 2g of grinded *P. stratiotes* before and after treatment was measured using a weighing balance into a beaker; 2.5ml of HNO_3 was added followed by 7.5ml of H_2SO_4. The beaker was then placed on a hot plate until the mixture was almost dry before removing from the hot plate. Small quantity of deionized was added to the beaker and filtered through Whatman filter into another beaker. It was transferred into a sample bottle, made up to 50mls and then labeled accordingly.

About 10mls of the polluted water was measured out using a measuring cylinder into a beaker. The above procedure was repeated with 10mls of polluted water before and after treatment and was labeled appropriately.

Heavy metals analysis.

The heavy metal concentration of digested plant and water samples were analyzed using Atomic Absorption Spectrophotometer (AAS), (Ugya *et al.,* 2015).

Table 1: Concentration of heavy metals in the polluted water and *P. stratiotes* before and after treatment

Heavy metals	Conc. In polluted water (mg/g)		Conc in plant *P.stratiotes* (mg/g)	
	Initial	Final	Initial	final
Lead	0.70	0.57	5.68	9.73
Chromium	0.69	0.23	2.30	4.53
Zinc	0.08	0.20	21.10	30.02
Iron	2.50	0.58	11.01	22.20
Copper	0.05	0.00	5.78	8.43
Nickel	0.00	0.00	1.40	2.43
Manganese	0.90	0.63	19.65	24.86

DISCUSSIONS

P. stratiotes can be considered as hyperaccumulator plant for metals such as Cr, Cu, Fe, Mn, Ni, Pb and Zn (Lu *et al.,* 2011).

From the table above, it was observed that there was an appreciable decreased of Pb from 0.70mg/l to 0.59mg/l, Mn from 0.69mg/l to 0.23mg/l, Fe from 2.50mg/l to 0.58mg/l and Zn from 0.08mg/l to 0.02mg/l, and Cu was completely removed which corroborated with the study of Ugya *et al.* (2015) . This could be attributed to the fact that Mukhopadhyay *et al.* (2007) reported that the removal of the heavy metal is dependent both on the contact time and the initial metal concentrations. Maine *et al.* (2001) found *P. stratiotes* to efficiently remove chromium from water, because of the great availability of soluble ferrous iron species in the anoxic conditions (Ponnanperuma, 1972) and leakage of oxygen from the roots of the aquatic macrophytes (Armstrong, 1979); iron tends to precipitate in the oxidized zone of roots surface, forming Fe oxyhydroxides

as coating on roots, which is often termed iron plaque. Once formed, the large surface area of the metal plaque provides a reactive substrate to sequester metal such as Zn, Cu and Ni (Edaigbini *et al.,* 2015).

Many studies revealed that heavy metals are not only retained in the roots but transferred through the shoots and deposited in the leaves at concentrations 100-1000 fold higher than those found in non-hyper-accumulating species (Rascio & Izzo, 2012; Mansuri *et al.,* 2012; Kumar *et al.,* 2008; Naseem & Tahir, 2001).

The inconsistency in the increase of heavy metal concentrations in the plant after treatment could be due to leaching of heavy metals from the clay pot used.

CONCLUSION AND RECOMMENDATIONS

Water quality is of importance to plants and animals and hence its purification is of paramount importance. Results of the present study on the phytoremediation effect of *Pistia stratiotes* on some heavy metals (Zn, Mn, Cu, Fe, Pb, Cr and Ni) from River Kusogi in Doko town supported the previous findings that aquatic plants can be used efficiently in phytoremediation technology.

Following the efficiency of *P.stratiotes*, in the removal of heavy metals from a polluted water, it can be recommended that:

- Aquatic macrophytes should be employed in the treatment of water since the technique is non-hazardous to human health.
- The plant should be used in areas (e.g Niger Delta) whose water bodies are polluted with oil spillage
- The inhabitants of rural areas should be oriented on the use of plants to purify water since it does not require any technical know-how and is less expensive
- Further research can be carried out using other macrophytes to test for their efficiency in phytoremediation.

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