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The Use Of *Pistia stratiotes* To Remove Some Heavy Metals From Romi Stream: A Case Study Of Kaduna Refinery And Petrochemical Company Polluted Stream.

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Abstract: *The study involved a laboratory experiment on the use of* ***Pistia stratiotes*** *in the removal of some heavy metals from a stream polluted by waste water from Kaduna Refinery and Petrochemical Company. Water sample was collected from Kaduna Refinery effluent point, Romi up and Romi down. The Bioconcentration (BCF) and Biotranslocation (BTF) Factors of each metal were determined. The experinmental study showed that Pistia stratiotes is a suitable candidate for effective removal of heavy metals (Hg, Cd, Mn, Ag, Pb, Zn) from Romi stream.*

Keywords: *Heavy metals, Romi Stream, phytoremediation, Pistia stratiotes*

I. Introduction

The world's ever increasing population and her progressive adoption of an industrial- based lifestyle has inevitably led to an increased anthropogenic impact on the biosphere (Asamudo *et al*., 2005).

Since the beginning of the industrial revolution, water pollution by toxic metals has accelerated dramatically. According to Nriagu (1996) about 90% of the anthropogenic emissions of heavy metals have occurred since 1900 AD; it is now well recognized that human activities lead to a substantial accumulation of heavy metals in water on a global scale. Man's exposure to heavy metals comes from industrial activities like mining, smelting, refining and manufacturing processes (Nriagu, 1996). A number of chemicals, heavy metals and other industries in the coastal areas have resulted in significant discharge of industrial effluents into the coastal water bodies. These toxic substances are released into the environment and contribute to a variety of toxic effects on living organisms in food chain (Dembitsky, 2003) by bioaccumulation and bio-magnification. Heavy metals, such as cadmium, copper, lead; chromium, zinc, and nickel are important environmental pollutants, particularly in areas with high anthropogenic pressure (United States Environmental Protection Agency, 1997). Water bodies has been traditionally the site for disposal for most of the heavy metal wastes which needs to be treated (Bio-Wise, 2003; Aboulroos *et al*., 2006).

In refining of refinery products opportunities exist for the release of other pollutants such as oil and grease, phenol, sulphate, suspended solids, dissolved solids, nitrates, e.t.c (Asamudo *et al*., 2005; Nayyef and Amal, 2012; Ji *et al*., 2007; Patel and Kanungo, 2010) in to the ecosystem.

These pollutants are produce in an effort to improve human standard of living but ironically their unplanned intrusion into the environment can reverse the same standard of living by impacting negatively on the environment (Asamudo *et al*., 2005; Subhashini *et al*., 2013; Xiaomei *et al*., 2004).

Refinery effluents can seep into aquifers and pollutes the underground water or where it is discharge without proper treatment into water bodies, the pollutants cannot be confined within specific boundries (Nayyef and Amal, 2012; Asamudo *et al*., 2005). They can therefore affect aquatic lifes in enormous ways.

Metallic effluents can have ecological impact on water bodies leading to increased nutrient load especially if they are essential metals. These metals in effluent may increase fertility of water leading to euthrophication, which in open water can progressively lead to oxygen deficiency, algae blooms and death of aquatic life (Pickering and Owen, 1997).

Heavy metals can bioaccumulate and through the food chain, to toxic level in man. Mercury can cause numbness, locomotory disorder, brain damage, convulsion and nervous problems. Cadmium is responsible for kidney tubular impairment and osteomalacia. Cadmium, zinc and manganese are reported to affect ion balance if present in sufficient amount (Xiaomeil *et al*.,).

This study was designed to assess the efficiency of *Pistia stratiotes* in the removal of heavy metals Romi Stream since Kaduna refinery and petrochemical company discharge it waste water directly into the stream.

II. Materials And Methods

2.1 Study Area.

Pistia stratiotes was collected from a pond located in Kinkinau Ungwar Ma'azu Kaduna state, Nigeria. Water sample was collected from Kaduna refinery and petrochemical company effluent point, Romi up and Romi down.

2.2 Experinmental Method:

Pistia stratiotes was kept on a filter paper to remove excess water and then transferred into plastic troughs having a capacity of five liters containing water from different points. Before transferring the test plant into the trough containing the water sample, the water was analyze for some heavy metals such (Mn, Zn, Ag, Cd, Hg and Pb) (APHA, 1995, 1998).

After 21 days, plant was gently removed from the pots. Stem, leaves and root was separated.

Plant stem, leaves and roots was washed with deionized water and dried at $70^{0}C$, and the dry matter was measured. Plant materials was grounded and 2g was subjected to acid digestion. All the analysis was done using the methodology of (APHA 1995, 1998).

The bio concentration factor, bio translocation factor and enrichment factor of each metal in *Pistia stratiotes* was calculated using the following formular:

Bio concentration factor = $\frac{a}{b}$

a= Metal concentration in plant root.

b= Metal concentration in waste water

Bio translocation factor =$\frac{c}{d}$

C= Metal concentration in shoot

D= Metal concentration in root (Yoon *et al*., 2006)

III. Result And Discussion

Table 1: Mean Heavy Metals BCF of Water from Various Point

SN	METAL	POINT A	POINT B	POINT C
1	Hg	3.0	17.5	24.0
2	Pb	0.4	32.1	4.4
3	Zn	0.4	1.2	0.3
4	Cd	0	3.2	0.1
5	Ag	2.1	24	1.3
6	Mn	73.2	12.8	0.8

Table 2: Mean Heavy Metal BTF of Water from Various points

SN	METAL	POINT A	POINT B	POINT C
1	Hg	0.7	1.4	0.7
2	Pb	101.8	0	0.5
3	Zn	0.5	0.3	12.4
4	Cd	0.05	0.1	9.6
5	Ag	0.7	1.3	1.5
6	Mn	0.3	0.33	2.1

In all points, the mean BCF factor of above 1 was recorded for Hg and Ag. This result indicates the efficiency of the test plant to remove Hg and Ag from all point by bioaccumulating the metals (Landis *et al*., 2011; Rand 1995). Zn and Cd were effectively removed only in point B, Manganese was effectively removed in point A and B while Pb was effectively removed in point B and C this result could be attributed to the fact that Mukhopadhyay *et al*. (2007) reported that the removal is dependent both on the contact time and the initial metal concentration. He observed a rapid initial uptake upto 48 hours and gradual attainment of equilibrium after 120 hours. Such concentration and duration dependent removal were also obtained for cadmium using water hyacinth (O'Keefe *et al*., 1984) and water lettuce (Alam *et al*., 1995) and for Hg (II) using lettuce (De *et al*., 1985). According to Mukhopadhyay *et al*. (2007) and O'Keefe *et al*. (1984), metal uptake was higher for low metal concentration and decreased thereafter with increase in metal concentration. Some researchers found similar nature of metal uptake in water lettuce for cadmium. Mishra *et al*. (2009) found water lettuce removed 80% of mercury (i.e. from 10 μg/L to 2μg/L) from the coal mining effluent in 21 days. Mercury accumulation in the roots of lettuce was about four times higher than the shoots at lower concentrations (Mishra and Tripathi, 2009; Skinner *et al*., 2007; Snow and Ghaly, 2008; Ayyasamy *et al*., 2009).

Mean BTF factor of above 1 was recorded in point B for Hg and Ag, point C for Zn, Cd and Mn and point A for Pb signifying that at this points the heavy metals were effectively moved from the water through the root to the shoot . Similar translocation ability of *Pistia stratiotes* was reported by Reddy and Debusk (1985), Aoi and Hayashi (1996), Sridhar (1986), Sen et al, (1987), Gumbricht (1993), Reddy (1983), Lu *et al*. (2011), Makhopadhyay *et al*. (2007), Alam *et al*. (1995), De *et al*. (1985), O'Keefe *et al*. (1984), Haidar *et al*. (1984), Chigbo *et al*. (1984), Liao and Chang (2004), Wang *et al*. (2002), Zayed *et al*. (1998), Greenfield *et al*. (2007), Chandra and Kulshreshtha (2004), Lindsey and Hirt (1999), Singhal and Rai (2003), Aoi and Ohba, (1995), Karpiskak *et al*. (1994) and El-Gendy *et al*. (2005)

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

IV. Conclusion

Water quality study of Romi Stream has brought to the fore some important concerns that were muted by research works like Chikogu et al. (2012) which indicated the presence of several heavy metals in high concentration to cause contamination to biotic species of flora and fauna that are found in the stream. Heavy metals (Cd, Hg, Ag, Mn, Zn and Pb) are the major contaminants in the Refinery waste water. It explores the fact that Kaduna refinery discharged waste water having heavy metal used in various processes that is toxic to the aquatic life. These studies shows that *Pistia stratiotes* can be use effectively in the removal of heavy metals present in Kaduna Refinery waste water there by reducing the toxicity on the flora and fauna.

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