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Case Report

The Efficiency of *Pistia Stratiotes* in the Phytoremediation of 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 phytoremediation of 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 from June to August, 2014. The physiochemical characteristics of the water samples were determined before and after the treatment. The experiment lasted for three weeks and the rate of reduction was recorded. The highest rate of mean reduction were for heavy metals accounting 99.6%, 93.3%, 99.3%, 94.3%, 100% and 95.4% of Cd, Hg, Zn, Mn, Pb and Ag respectively. Other physiochemical parameters include Total Dissolved Solids (TDS) 81.3%, Chemical Oxygen Demand (COD) 91.6%, Nitrate 93.3%, Biochemical Oxygen demand (BOD) 68%, Conductivity 50.3%, Total suspended Solids (TSS) 77.3%, Turbidity 85%, 81% Total Solids (TS) and the pH were increase from 6.29 to 7.7, *Pistia stratiotes* also recorded a mean net primary productivity (NPP) of -0.6. *Pistia stratiotes* is a suitable candidate for the effective phytoremediation of water from Romi stream.

Key words: Efficiency, *Pistia stratiotes*, Phytoremediation, Romi Stream, Net Primary Productivity

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. [1]

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, etc. [1-4] into 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. [1,5,6]

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. [1,2] They can therefore affect aquatic lives in enormous ways.

Several technologies are available to remediate water that is contaminated by pollutant. However, many of these technologies are costly (e.g. excavation of contaminated material and chemical/physical treatment) or do not achieve a long-term nor aesthetic solution. [7,8] Phytoremediation can provide a cost-effective, long-lasting and aesthetic solution for remediation of contaminated sites. [9]

In many cases, especially in tropical or subtropical areas, invasive plants such as the water hyacinth (*Eichhornia crassipes*) and water lettuce (*P. stratiotes* L.) are used in these phytoremediation water systems. [10,11] This is because, compared to native plants, these invasive plants show a much higher nutrient removal efficiency with their high nutrient uptake capacity, fast growth rate, and big biomass production. [12] In the active growth season, for instance, water hyacinth plants can double in number and biomass in 6 to 15 days. [13]

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

MATERIALS AND METHODS

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.

Experimental Method:

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 mass of the plant was determine and the water characteristic were determined by analyzing some physiochemical parameters like TSS, TDS, BOD5, COD, Conductivity, pH, Turbidity, Nitrate and some heavy metals such (Mn, Zn, Ag, Cd, Hg). [13,2]

After 21 days, the mass was re-determined and the water was re-analyses. The value before phytoremediation was noted as initial value while the value after phytoremediation is indicated by final value. All the analysis was done using the methodology of. [14,15]

The pollutant removal capacity of *Pistia stratiote* was determined as reduction percentage. The initial and final concentrations of the physiochemical parameters of water were use in the following formula:

$$\frac{A-B}{A} \text{ X } \frac{100}{1}$$

Where A= initial concentration

B= final concentration [215]

The Net primary productivity of *Pistia stratiote* was also determined using Harvest Method.

$$\text{NPP} = \frac{Bf - Bi}{dt}$$

Bf= final biomass

Bi= initial biomass

dt= no. of days of culture. [2]

RESULTS

Figure 1, 2 and 3 show the result obtained in this study.

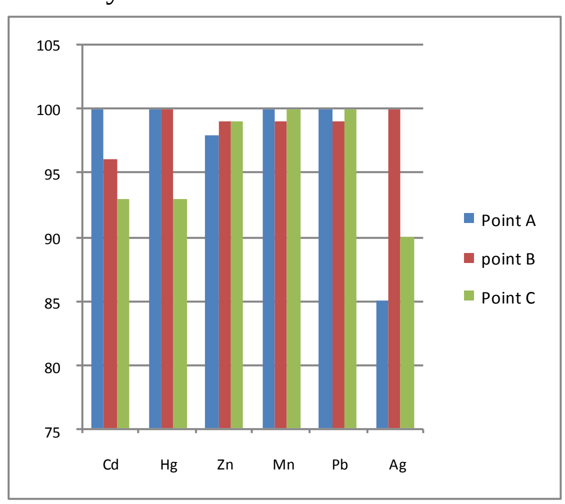

Figure 1: % Reduction of Heavy Metals by Pistia stratiotes (100% waste water).

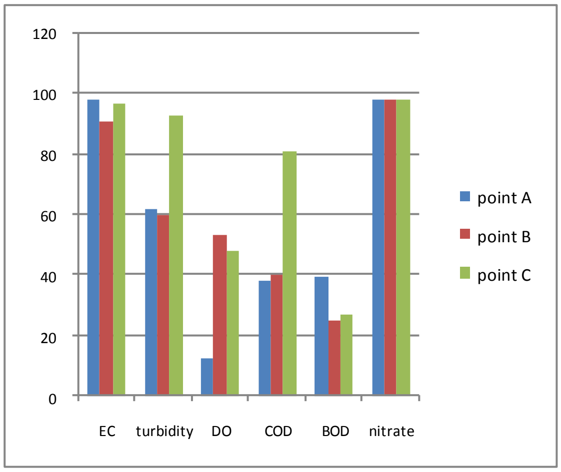

Figure 2: % Reduction of Physiochemical Parameters by Pistia stratiotes (100% waste water).

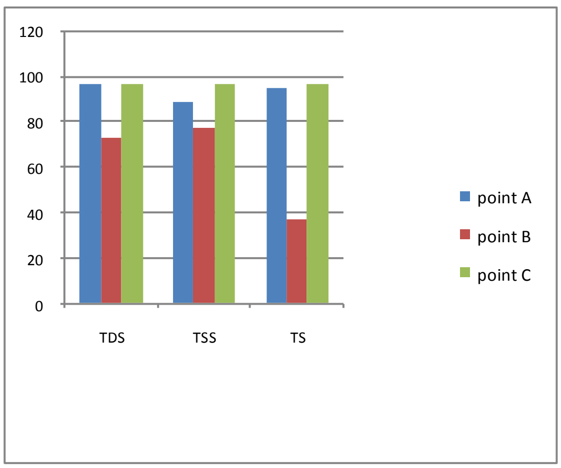

Figure 3: % Reduction of Solid by Pistia stratiotes (100% waste water).

DISCUSSION AND CONCLUSION

The mean pH was increased from 6.29 to 7.7, Similar result was reported by Dipu *et al.* [16] and Mahmood *et al.* [17] This increase shows that *Pistia stratiotes* change acidic pH to neutral pH. Mahmood *et al.* [17] reported that reduction in pH is attributed to absorption of nutrient and other salts by the plant or by simultaneous release of H+ with uptake of metal ion, [14] while increase in pH is attributed to the fact that H+ was release into the waste water as nutrients are absorbed as stated by Mahmood *et al.*, [17] Hence the main reason why pH was increase in this studies. This increase in pH could also be the reason why mean negative Net primary productive was recorded in all point.

High EC reduction was recorded in water from point A, B and C. Lu. [18] Also reported high EC reduction.

The high EC reduction is attributed to the growth of the test plant which decreases EC in the waste water by uptake or root adsorption. [18]

High Turbidity reduction was recorded in 100% waste water from Point C compare to point A and B. similar result obtain in this studies was reported by Lu. [18] This reduction in turbidity is attributed to the fact that algae and phytoplankton were minimal in the waste water due to the ability of the test plant to prevent the inflow of sunlight into the waste water. [18]

High COD removal was recorded in water from point C compare to point A and B. Awuah *et al* [19] reported high COD reduction of about 59%.

Low BOD reduction was recorded in water from point A, B and C. The reduction in both BOD and COD is attributed to the reduction of pH recorded since reduction of pH favors microbial action to degrade BOD and COD in the waste water. According to Reddy [20] the presence of plants in waste water deplete CO_2 during the process of photosynthesis and increase DO of water thus creating aerobic condition in the waste water which favors COD and BOD reduction. [17] Dipu *et al* [16] reported 93% and 59% BOD and COD removal respectively.

The high DO reduction reported is similar to the result obtained by Fonkou *et al.*, [21] this high DO reduction is attributed to the reduction in COD and BOD.

The high nitrate reduction is similar to the result obtained by Dipu *et al.* [16] who recorded 70% reduction, Baker and Ingersoll [22] report nitrate removal by the test plant from 31%- 51%. This result signifies the rapid use of nitrate by the test plant.

High Solid removal was recorded in waste water collected from all point. This high solid removal is attributed to the ability of the root of the test plant to retain or articulate organic materials present in the waste water supporting it growth. [23]

High reduction efficiency of heavy metals was recorded in all point; this could be because the concentration of the metals present was below 5mg/l. [24,25] Similar high reduction efficiency of heavy metals by the test plant was reported by Mukhopadhyay *et al*., [26] O'Keefe *et al*., [25] Mishra *et al.*, [27] Mishra et al. [28] Mishra and Tripathi., [29] Maine, [30] De et al. [31] and Alam *et al.* [32]

The negative NPP recorded by *Pistia stratiotes* shows that the rate of decomposition or respiration by the plant over powered the rate of carbon absorption. This rapid decomposition or respiration could be attributed to the fact that the plant was grown in the laboratory as such no abundant sunlight. [33-35]

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*., [36] which indicated the presence of several heavy metals in high concentration to cause contamination to biotic species of flora and fauna that, abound in the stream. Other parameters monitored such as the oxygen characteristics of the water in terms of COD, BOD and DO are all indicating toxicity above the threshold that can be purified by the stream. These studies shows that *Pistia stratiotes* can be use effectively in the treatment of the Kaduna Refinery waste water there by reducing the toxicity on the flora and fauna since it is able to remove and degrade pollutants present in the stream to a significant level in all point.

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