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The Efficiency of *Lemna minor* L. 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 *Lemna minor* L. in the phytoremediation of a stream polluted by waste water from Kaduna Refinery and Petrochemical Company. The physiochemical characteristics of the waste water 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. *Lemna minor* L. is a suitable candidate for effective phytoremediation of water from Romi stream.

1. 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 [3]. In the refining of refinery products opportunity exist for the release of pollutants such as heavy metals, oil and grease, phenols, sulphide, sulphate, nitrate, phosphate, dissolved solids, suspended solids e.t.c [1] [2] [3] [4] in to the ecosystem. These pollutants are produced 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] [2] [5]. Physical, chemical, and biological technologies have been developed to treat oily waste water and restore environmental quality; However their costs are high and most of them are difficult to use under field conditions, hence in such a condition there is an urgent need to study natural, simple, and cost-effective techniques for control of pollution from industrial effluents [3] [6]. Viewing this fact phytoremediation was assumed to be very useful, as it is an innovative, eco-friendly and efficient technology in which natural properties of plant are used in engineered system to remediate hazardous wastes through physical, chemical, and biological processes from wastewater and sewage [7][8][4]. Phytoremedation is the utilization of plants accumulation capabilities to remove contamination from water, soil and air, the capacity of aquatic plants to remove pollutants from water is well documented [9] [10]. The recent application of phytoremediation technology by *Lemna minor* L. in water treatment and management is quite interesting and revealing [11] [12].

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

2. MATERIALS AND METHODS

2.1 Study Area

Lemna minor L. 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 Experimental Method

Lemna minor L. 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 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].

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After 21 days, 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].

3. RESULTS AND DISCUSSION

The pH was increased by the test plant at point A (from 6.29-7.4), point C (from 6.9-7.61) and point B water (6.91-7.7). This result shows that the test plant have the capacity to improve the pH of water by increasing the value. This result is contrary to the result obtained by Saygideger [16], Mahmood *et al* [17], and Nayyef and Amal [2] who recorded decrease in pH and concluded that the test plant can be used in an area were acidity of soil is high.

High EC reduction was recorded by the test plant at point C compare to point A and B (Fig 1). This EC reduction is due to salt removal by the test plant uptake or root absorption [18].

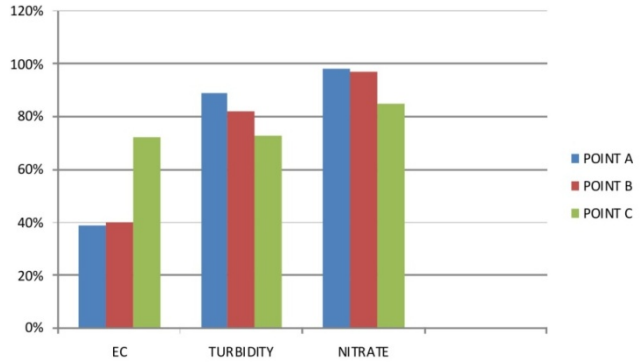

Fig. 1: reduction of EC, turbidity and nitrate at point A,B and C by *Lemna minor* L.

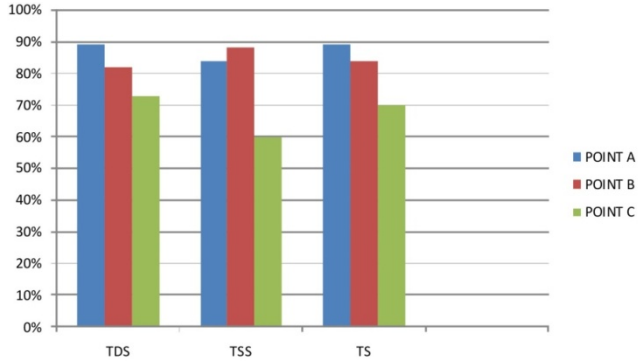

Fig. 2: reduction of TDS, TSS and TS at Point A, B and C by *Lemna minor* L.

High TDS, TSS and TS reduction was recorded in this work and this is similar to the result obtained by Nayyef and Amal [2], Pandy [19], Huang *et al* [20], AL-Sabunji and Amarashi [21], this result shows the efficiency of solids removal by the test plant.

Low turbidity removal was recorded in point C compare to point A and B (Fig 1), Nayyef and Amal [2] and Lovenson and Sivalingam [22] also reported high turbidity removal. This high turbidity removal is attributed to the high solids removal. High nitrate removal was recorded in this studies, this result is similar to the result obtain by Patel and Kanungo [4] and Nayyef and Amal [2]. This high nitrate removal shows that the test plant needs high nitrate to grow. High BOD, COD and DO removal was recorded, in agreement with the present studies Oron *et al* [23] mention that the test plant contribute to the removal of organic compounds as well as the microbial degradation process of organic materials [24]. Zimmo *et al* [24] found that BOD removal was higher in duckweed based pond than algae based pond, Korner *et al* [25] mentioned that the test plant enhanced COD removal in shallow batch system. Pandy [19] reported that COD removal was in the range of 70-80% in discharge duckweed system. The high DO removal is attributed to the high BOD and COD removal [26].

High heavy metals reduction was recorded; this is attributed to the fact that the concentration of the heavy metals present is below 5mg/l [27][28]. Similar high heavy metal reduction was recorded by Khellaf and Zerdaoui [29], Aziz [30], Mahmood [31], Hanaf [32] , Espinoza-Quinones *et al* [26], Shakar *et al* [33], Bianconi *et al* [34], Donganlar *et al* [35], Uysa [36], Stefan *et al* [37], Jafari *et al* [38], Lovenson and Sivalingam [22], Axtell *et al* [39], Horvat *et al* [40], Naumann *et al* [41] and Kaur *et al* [42].

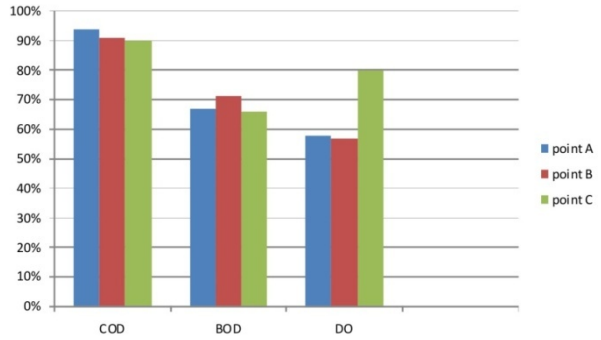

Fig. 3: Reduction of CO D, BOD and DO at point A,B and C by *Lemna minor* L.

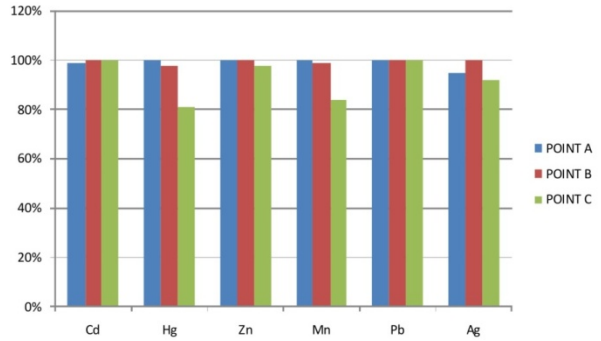

Fig. 4: reduction of heavy metals and C by *Lemna minor* L.

4. CONCLUSION

Water quality study of Romi Stream has brought to the fore some important concerns that were muted by research works like Lekwot *et al*. [43], 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 *Lemna minor* L can be use in 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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