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Phytoremediation of Landfill Leachates Using *Pistia Stratiotes*: A Case Study of Kinkinau U/Ma'azu Kaduna, Nigeria

Adamu Yunusa Ugya[1], Agamuthu Priatamby[2]

[1]Biological Sciences Department, Bayero University Kano, Kano, Nigeria

[2]Institute of Biological Sciences, Faculty of Sciences, University of Malaya, Kaula Rumpur, Malaysia

Email address:
ugya88@gmail.com (A. Y. Ugya) profagamuthu@gmail.com (A. Priatamby)

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Abstract: The study involved a laboratory experiment on the use of *Pistia stratiotes* in the phytoremediation of leachates collected from Kinkinau landfill. The physiochemical characteristics of the leachates were determined before and after the treatment. The experiment lasted for three weeks and was repeated for about six times the rate of the mean reduction was recorded. The highest rate of mean reduction was for heavy metals. Other physico-chemical parameters were drastically reduced. *Pistia stratiotes* is a suitable candidate for effective phytoremediation of water from Romi stream.

Keywords: Leachates, Kinkinau, Treatment, Phytoremediation, Pistia Stratiotes

1. Introduction

Rapid development, an increase in population, rural-urban migration, affluence and the rate of consumption have brought about an increase in waste generation and pollution which has badly affected man and environment [1].

Landfill leachate is generated when rainwater mixes with the waste in a landfill [2] [3] It can cause great environmental degradation if it gets into groundwater, because it has large concentration of organic matter (both biodegradable and non-biodegradable carbon), ammonia-nitrogen, heavy metals, and chlorinated organic and inorganic salts [4].

However, some of these pollutants can be degraded by microorganisms [5] [3] while others may not be degraded and may persist in the landfill for long period. It is estimated that the total volume of leachate generated in Malaysia is 3.0 million per day [3]. The leachate exhibits extremely high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values ranging from 2000 to 30,000 mg/L for and 300 to 60,000 mg/L respectively [4].

Due to the high pollutant loads, leachate treatment has become an important issue and several treatment configurations have been investigated for many years [6] [7].

Treatment of leachate is an important aspect in municipal waste management system. This is because of the high ratio of COD/BOD which is 2.2 while ammonia nitrogen (NH_3-N) is at 0.43, which posed major difficulties in biological treatment of leachate [8] The best method of leachate treatment depends on the characteristics of the leachate. There are different methods of treatment of leachate, one of which is the physical - chemical process [9]. This study was designed to assess the efficiency of *Pistia stratiotes* in the phytoremediation of landfill leachates.

2. Materials and Methods

Study Area

Pistia stratiotes was collected from a pond located in Kinkinau Ungwar Ma'azu Kaduna state, Nigeria. Water leachates was collected from a landfill located in Kinkinau Ungwar Ma'azu Kaduna from April to September, 2016.

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 liters containing the leachate. Before transferring the test plant into the trough containing the leachate sample, the leachate characteristic were determined by analyzing some physiochemical parameters like TSS, TDS, BOD_5, COD, Conductivity, pH, Turbidity, Nitrate, Total phosphorus, Sulphate and some heavy metals such (Cd, Cu, Cr, Pb, and Co) [10] [11].

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 [12] [13].

3. Result and Discussion

The pH value was drastically reduced (Fig 2). These reduction of pH is shows that the test plants have convert alkaline pH into neutral pH. Similar result were reported by researchers such as Mahmood *et al* [14], Dipu*et al*., [15], Piyush *et al* [16] and Ugya [17].

The BOD and COD were drastically reduced (Fig 2). This reduction could be due to the fact stated by Reddy (1981) that the presence of plants in waste water depletes dissolve CO2 during photosynthetic activities which favours aerobic bacterial to reduce BOD and COD [14]. Researchers such as Dar *et al* [18], Shah *et al* [19], Trivedy and Pattanshetty [20] among others also recorded reduction in BOD and COD as a result of aquatic macrophytes in waste water.

Total solids were significantly reduced (Fig1). These significant reduction in solids is could be attributed to the property of proper particle sedimentation by the test plants or the ability of the test plant to retain both coarse and fine particles present in the leachates [16] [21]. The high solid removal is highly correlated to the reduction in turbidity and clear colour of the leachates.

High Nutrient (Phosphate, nitrate and sulphate) (Fig 3). The significant Nitrate removal is attributed to the use of the nitrate, phosphate and sulphate by the test plant for growth as reported by Maine et al., [22], O'Keefe [23] and Ayyasamy et al [24].

The significant removal of both phosphorus and sulphate shows that the test plant is able to utilize both phosphorus and sulphate for growth [21] Ayyasamy et al [24].

The high reduction efficiency of heavy metals is associated to the presence of these metals below 5mg/l as reported by Ugya*et al* [25], Ugya*et al* [26], Ugya*et al* [27] Mane *et al* [28], Zhu *et al* [29], Mishra *et al* [30], Valipour *et al* [31], Lissy and Madhu [32]. The BCF and BTF value for all the heavy metals were above 1 signifying efficient accumulation and removal of heavy metals by the test plants [33] [34] [35].

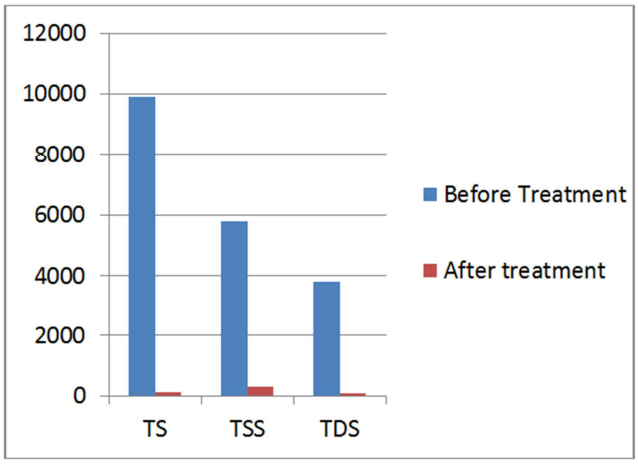

Figure 1. *Total solid % reduction by the test plant.*

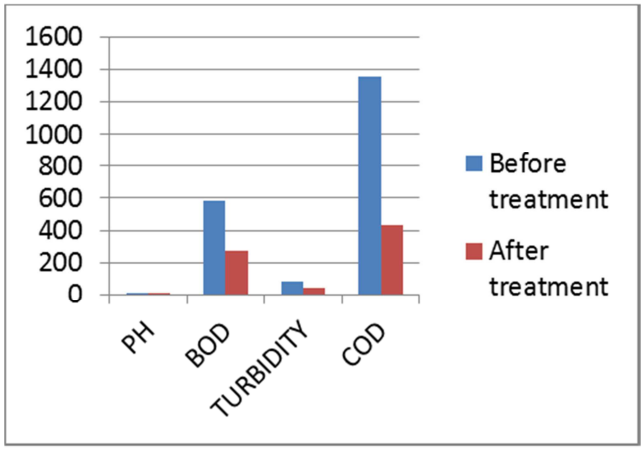

Figure 2. *% reduction of some physico-chemical parameters from leachates.*

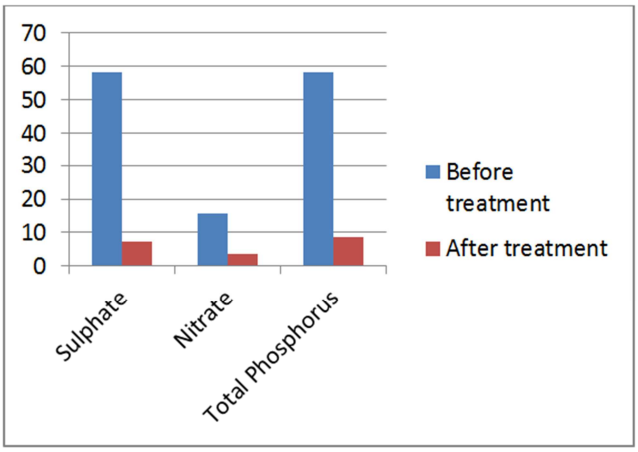

Figure 3. *% Nutrient removal from leachates.*

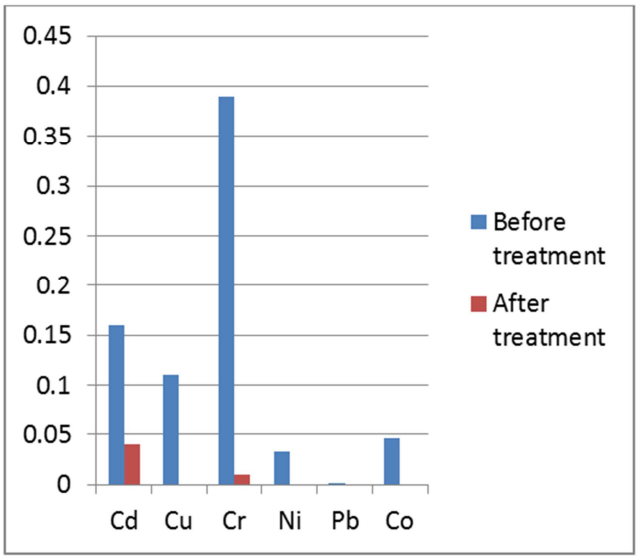

Figure 4. *% reduction of Heavy metals from the leachates.*

4. Conclusion

Leachate can cause significant environmental damage becoming a major pollution hazard when it comes into contact with the surrounding soil, ground or surface waters. This leachate often contains a high concentration of organic matter and inorganic ions, including nutrients and heavy metals Treatment of leachate is an important aspect inmunicipal waste management system. This studies shows that the test plant is able to take up heavy metal and efficiently reduce the concentration of pollutants in the leachates. It is thereby recommended that the planting of *Pistia stratiotes* should be encourage to help prevent the seeping of heavy metals and pollutants from leachates into aquifers to pollute underground water or aquatic bodies during eventual runoff or discharge.

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