Science World Journal Vol 10 (No 3) 2015
www.scienceworldjournal.org
ISSN 1597-6343



# COMPARATIVE STUDIES ON THE EFFICIENCY OF LEMNA MINOR L., EICCHORNIACRASSIPES AND PISTIASTRATIOTES IN THE PHYTOREMEDIATION OF REFINERY WASTE WATER

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**ABSTRACT**
The studies involves a laboratory experiment on the comparative study on the efficiency of *Lemna minor* L., *Eicchorniacrassipes* and *Pistiastratiotes* in the phytoremediation of a stream polluted by waste water from kaduna refinery and Petro-chemical Company. Water samples were collected from Kaduna refinery effluent point, Romi up and Romi down from June to August, 2014. The physico-chemical parameters including some heavy metals were determined before and after the treatment to help in the determination of percentage reduction. The weight of the test plants was also determined before and after treatment for the determination of Net Primary Productivity (NPP). The research shows that *Lemnaminor*is the best plant to be use in the phytoremediation of water from Kaduna Refining and Petro-chemical Company since it shows the highest percentage reduction ability and the highest net primary productivity.

**Keywords**: Net Primary Productivity, Percentage Reduction, Romi Stream, Heavy Metals

## INTRODUCTION

The waste water released from crude oil refineries are characterized by the presence of large quantities of polycyclic and aromatic hydrocarbons, phenols, metal derivatives, surface active substances, sulphides, naphthalene, acids and other chemicals (Suleimanov, 1995). As a result of ineffectiveness in the purification systems, this waste water lead to the accumulation of toxic products in the receiving waste water bodies with potentially consequences on the ecosystem (Aghalino and Eyinla, 2009; Ugya, 2012).

Kuehn *et al.,* (1995) observed that refinery effluent contaminated with aromatic hydrocarbons produces poor health and lethal toxicity in fishes and two species of tilapia. Onwumere and Oladimeji (1990) earlier demonstrated accumulation of heavy metals with accompanying histopathology in *Oreochromnisniloticus* exposed to treated petroleum refinery effluent from the Kaduna Refining and Petro-chemical Company.

*Lemna minor* L, *Pistiastratiotes, Eicchorniacrassipes* were selected for comparison in the phytoremediation of Kaduna Refining and Petro-chemical Company waste water, since the waste water have become a menace to the people of Romi and Rido communities.

### Water Sampling

Water samples were collected at three different points (point A, point B and point C); The point C samples were collected at about 8 km away from the point of discharge of the refinery effluents into the Romi stream, while the point A samples were point of discharge of the refinery effluents into the stream. The point B samples were collected at about 4 km away from the point of discharge of the refinery effluents into the stream.

### *Plant Sampling*

*Lemna minor L., Pistiastratiotes* and *Eicchorniacrassipes*were collected from 2 ponds located at Kinkinau, U/Ma'azu Kaduna, Kaduna State. These ponds were selected because it is believed that pollution in the ponds were minimal due to the fact that the ponds are abandoned ponds which dry up during dry season.

The collected plants samples were cleaned with borehole water and washed with distilled. The plants were kept in a pond with borehole water under sunlight for one week to let them adapt to the new environment, then plants of the same size were selected for the experiments.

### Plant Identification

Collected plants were identified according Penfound and Earle (1948), Holm *et al*, (1977), Hutchinson (1975), Mitchell (1976), Wolverton and Mc Donald (1979),Van and Steward (1982), Scurthorpe (1985), Kasselmann (1995), Vandiver (1999),Hugh (2002) and Simpson and Sanderson (2002)

The identified plant samples were taken to the Department of Biological Sciences herbarium, Ahmadu Bello University Zaria, Kaduna State for confirmation. Below is the accession number of the plant identified:

**Table 1:** Sampled Plants Accession Number

| SN | Plant | Common Name | Accession Number |
|---|---|---|---|
| **1** | *Lemna minor* L. | Duckweed | L.6935 |
| **2** | *Eicchorniacrassipes* | Water Hyacinth | 3268 |
| **3** | *Pistiastratiotes* | Water Lettuce | 1977 |

**Experimental Setup**
To assess the phytoremediation capacity of *Lemna minor* L.,*Pistiastratiotes* and *Eicchorniacrassipes*in the removal of refinery pollutants, an offsite culture experiment was conducted in General Biology Laboratory of Kaduna State University (KASU).

The initial weight of test plants were taken after keeping them on a filter paper to remove excess water. The plants were then transferred into a plastic trough having capacity of five litres containing waste water from different stations. The experiment was grouped into three, each group consist of 9 troughs each containing five litres of waste water from each station, the experimenting each group was divided into three sets.

Set 1: *Lemna minor* L. was inoculated in waste water of different concentration

1. 100% Wastewater
2. 75% wastewater and 25% borehole water
3. 100% borehole waters (control) (Padhi *et al*., 2012)

Set 2: *Eicchorniacrassipes* was inoculated in waste water of different concentration

1. 100% Wastewater
2. 75% wastewater and 25% borehole
3. 100% borehole waters (control) (Padhi*et al*., 2012)

Set 3: *Pistiastratiotes* was inoculated in waste water of different concentration

1. 100% Wastewater
2. 75% wastewater and 25% borehole
3. 100% borehole water (control) (Padhi*et al*., 2012)

After 21 days analysis of treated water was re-taken for physico-chemical parameters and again the fresh biomass of the plants after phytoremediation was noted for the determination of net primary productivity

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**RESULTS AND DISCUSSION**

**Table 2:** Mean Reduction Percentage of Physico-chemical Parameter (100% Waste Water)

| | ***E. crassipes*** | | | ***L. minor*** | | | ***P. stratiotes*** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Initial** | **Final** | **R%** | **Initial** | **Final** | **R%** | **Initial** | **Final** | **R%** |
| **BOD (mg/l)** | **84** | **73** | **13** | **84** | **24** | **71** | **84** | **56.3** | **33** |
| **Cd (µg/l)** | 15.3 | 0.233 | 98 | 15.3 | 0.056 | 96 | 15.3 | 0.1974 | 99 |
| **Conductivity µm/cm** | 422 | 408 | 2 | 422 | 234 | 45 | 422 | 292 | 30 |
| **COD (mg/l)** | 68.3 | 42.3 | 38 | 68.3 | 15.3 | 77 | 68.3 | 61 | 10 |
| **DO (mg/l)** | 6.1 | 5.5 | 9 | 6.1 | 2.1 | 66 | 6.1 | 3.7 | 39 |
| **Hg (µg/l)** | 6.7 | 0.151 | 97. | 6.7 | 0.8574 | 87 | 6.7 | 0.1021 | 98 |
| **Mn (µg/l)** | 56.9 | 0.920 | 98 | 56.9 | 0.5187 | 99 | 56.9 | 0.1047 | |
| **Nitrate (mg/l)** | 1.98 | 0.095 | 95 | 1.98 | 0.1003 | 95 | 1.98 | 0.0227 | 99 |
| **Pb (µg/l)** | 28 | 0.123 | 100 | 28 | 0.1794 | 100 | 28 | 0.0155 | 100 |
| **pH** | 6.9 | 7.3 | - | 8.37 | 7.5 | - | 6.9 | 7.4 | - |
| **TDS (mg/l)** | 286 | 87 | 69 | 286 | 44.6 | 84 | 286 | 78.3 | 73 |
| **TS (mg/l)** | 444 | 118 | 73 | 444 | 55.7 | 87.4 | 444 | 37 | 92 |
| **TSS (mg/l)** | 158 | 31 | 80 | 158 | 11 | 80 | 158 | 36.7 | 77 |
| **Turbidity (NTU)** | 94.3 | 73 | 23 | 94.3 | 37.3 | 60 | 94.3 | 30 | 68 |
| **Zn (µg/l)** | 72.1 | 1.166 | 100 | 72.1 | 2.5384 | 96 | 72.1 | 0.9847 | 99 |

R = % Reduction

**Table 3:** Mean Reduction Percentage of Physico-chemical Parameterss (75% Waste Water)

| | ***E. crassipes*** | | | ***L. minor*** | | | ***P. stratiotes*** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Initial** | **Final** | **R%** | **Initial** | **Final** | **R%** | **Initial** | **Final** | **R%** |
| COD (mg/l) | 115 | 30 | 74 | 115 | 20 | - | 115 | 150 | - |
| Cd (µg/l) | 8 | 0 | 100 | 8 | 0 | 100 | 8 | 0.0921 | 84 |
| Conductivity µm/cm | 561 | 520 | 7.3 | 561 | 542 | 6.6 | 561 | 86 | 85 |
| COD (mg/l) | 68.3 | 84.3 | 38 | 68.3 | 15.3 | 77 | 68.3 | 61 | 10 |
| DO (mg/l) | 1.49 | 0.4 | 73 | 1.49 | 0.4 | 73 | 1.49 | 3 | - |
| Hg (µg/l) | 5 | 0.2613 | 96 | 5 | 0.2574 | 95 | 5 | 0.0921 | 99 |
| Mn (µg/l) | 40 | 0.0577 | 100 | 40 | 0.0141 | 100 | 40 | 0.2376 | 99 |
| Nitrate (mg/l) | 0.116 | 0.023 | 80 | 0.116 | 0.0078 | 93 | 0.116 | 0.019 | 84 |
| pH | 7.39 | 7.31 | 1 | 7.39 | 7.41 | - | 7.39 | 7.5 | - |
| Pb (µg/l) | 8.4 | 0.0310 | 100 | 8.4 | 0.021 | 100 | 8.4 | 0.0245 | 99 |
| TDS (mg/l) | 445 | 9 | 98 | 445 | 18 | 96 | 445 | 180 | 59 |
| TSS (mg/l) | 16 | 8 | 50 | 16 | 9 | 43 | 16 | 6 | 63 |
| TS (mg/l) | 18 | 27 | 80 | 418 | 27 | 94 | 187 | 187 | 55 |
| Turbidity (NTU) | 195 | 21 | 89.2 | 195 | 27 | 86 | 195 | 7 | 96 |
| Zn (µg/l) | 37 | 1.0210 | 97 | 37 | 0.9283 | 97 | 37 | 0.0234 | 99 |

R = % Reduction

Comparative study of the test plants shows that *Eicchorniacrassipes* and *Lemna minor* L. perform better than *Pistiastratiotes*, as such have higher Net Primary Productivity (NPP) value than *Pistiastratiotes*. The increase in weight of *Eicchorniacrassipes* and *Lemna minor* L. is attributed to the high uptake of nitrogen and phosphorus by the plants compared to *Pistiastratiotes* (Piyush*et al*., 2012). Aoi and Hayashi. (1996) reported that N, P and Ash contents of biomass were about 1.5 times lesser in *Pistiastratiotes* than in *Eicchorniacrassipes*.

Since *Eicchorniacrassipes* and *Lemna minor* L. perform better, positive NPP was recorded for both plants while negative NPP was recorded for *Pistiastratiotes*. The negative NPP recorded by *Pistiastratiotes* 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.

The test of significant for the correlation coefficient of *Lemna minor* L., *Eicchorniacrtassipes*, and *Pistiastratiotes* at 0.05 level of significant shows that there is no significant difference between the test plants in the removal of pollutants. Aoi and Ohba. (1995) also reported that *Pistiastratiotes* and *Echhorniacrassipes* have similar nitrate removal capacity, other researchers such as Piyush *et al*. (2008), Lehn and Bopp. (1987), El-Lebondi *et al*. (2008) and Ayyasamy *et al* (2009) reported that similarities could occur in the removal of water pollutants by plants.

**Conclusion**

This research shows that Pistiastratiotes,Lemna minor L. and Eicchorniacrassipes can be effectively used 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 points.

Although, *Lemna minor* L. is better in the reduction of pollutant than *Pistiastratiotes* and *Eicchorniacrassipes* and has the highest NET Primary Productivity in comparison to both plants.

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