A preliminary study on sewage quality improvement through water hyacinth (*Eichhornia crassipes*)

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Abstract

In the present study, the role of water hyacinth (*Eichhornia crassipes*) in reducing nutrient concentration from municipal wastewater treatment plant effluent by phytoremediation methods was evaluated. The paper is the outcome of in-situ experiments conducted on samples collected from Singh Dwar sewage pumping station Hardwar. Results indicates that water hyacinth is capable in improving water quality by reducing nutrient concentration.

Keywords: *Eichhornia crassipes*, phytoremediation, macrophyte

Introduction

Increasing urbanization, industrialization and over population are the main factors responsible for increasing pollution. Water bodies are the main receiving end for capturing these pollutants. They receive industrial wastewater, residential wastewater, surface runoff etc (Dhote and Dixit 2009). According to Central Board for Prevention and Control of Water Pollution about 90-94% (by volume) wastewater are domestic sewage where as industries produce only 6-10% wastewater (Sharma, 2007). It means water get more polluted by domestic sewage than industrial effluents. Various conventional methods are in practice for purification of water and removing these contaminants. Most of the conventional methods in practice are costly and non eco-friendly. Green plants are not only the lungs of nature with an ability to uptake, tolerate and even hyper accumulate heavy metals and other toxic substances from soil and water through their roots and concentrate them in roots, stems and leaves. These include some aquatic weeds, such as Salvinia, Lemna, Azolla, Hydrilla and Eichhornia sedges like *Typha latifolia* and some herbaceous as well as woody plants.

Phytoremediation is an alternative or complimentary technology that can be used along with or in some cases in place of mechanical conventional cleanup technologies that often require high capital inputs and are labour and energy intensive. Phytoremediation is an in-situ remediation technology that utilizes inherent abilities of living plants. It is also an eco-friendly, solar energy driven cleanup technology, based on the concept of using nature to clean. In respect to the phytoremediation aquatic macrophytes plays an important role in wastewater treatment. Each species contribute its special function and cooperate in the purification process. Some nutrients (pollutants) were absorbed by the macrophytes and were removed from the effluents. The macrophytes used for BOD removal seemed to function as fixed film reactors with the submerged plant structure of the macrophytes which can transport atmospheric oxygen from foliage into the roots. Oxygen not required for root respiration may diffuse into the wastewater and utilized by bacteria for the oxidation of BOD. Floating aquatic macrophytes are also capable of assimilating large quantities of trace elements, some of which are essential for plant growth (Reddy and Suton, 1984). Aquatic macrophytes particularly floating species, such as the water hyacinth and pennywort.
are exhibiting very high rate of growth e.g.: 10gm/sqm/day such growth rates are associated with high level of nutrient uptake and demand particularly for nitrogen and phosphorous. It has been estimated that water hyacinth are capable of removing nitrogen from the water by direct uptake 5850kg N/ha/year and of storing within their biomass between 300 kg N/ha and 900 kg N/ha. Significant quantities of phosphorus can also be removed 350-1125 kg P/ha/year and accumulation (20-57 kg P/ha).

Materials and Method
Collection of samples: Grab samples were collected from the Singh Dwar sewage pumping station.
Collection of hydrophytes: Young and healthy macrophyte were collected from pond situated at Bhadarabad.
Preparation of aquarium: Two concentration were taken for study i.e. (50% and 100%).
Set-1  50% wastewater + 50% tap water
Set-2  100% wastewater

The experiment was performed in the Department of Environmental Sciences, KGM, Hardwar (U.K.). All the parameters were analysed every week during the study schedule.

Results and Discussion
Phytoremediation refers to the natural ability of certain plants hyper accumulators to bio-accumulate, degrade or render harmless contaminants in water, air or soil. Contaminants such as metals, pesticides, solvents, crude oil and its derivatives have been mitigated in phytoremediation projects worldwide. It is considered a clean, cost-effective and eco-friendly technology, as mechanical cleanup methods, such as pumping polluted ground water or soil excavation. A new technology of purification of sewage by water hyacinth (Eichhornia crassipes) is a possible solution (Alade and Ojoawa, 2009). In the present study the parameter considered for the study were turbidity, pH, TDS, hardness, DO, BOD, COD, total kjeldhal nitrogen, chlorophyll-a and chlorophyll-b. From table 1 and 2 it is evident that turbidity was decreased from 35 NTU to 9.6 NTU in 50% concentration and 21.6 NTU to 15.9 NTU in 100% concentration by using water hyacinth.

The reduction in turbidity is due to the reduction in total dissolved solids (Dhote and Dixit, 2007). Reduction in turbidity is due to the roots hairs which have electrical charges that attract opposite charges of colloidal paricles such as suspended solids and cause them to them to adhere on the roots where they are slowly digested and assimilated by the plants and micro-organic.Total Dissolved Solids were decreased from 1200 mg/l to 665 mg/l in 50% concentration and 1800 mg/l to 790 mg/l in 100% concentration (table 1 and 2). Besides enabling growth of microbial colonies root system is also good medium for filtration and adsorption of suspended materials, nutrients and heavy metals.

Table 1: Effect of Eichhornia crassipes on some parameters in 50% concentration

<table>
<thead>
<tr>
<th>S.N</th>
<th>Parameters</th>
<th>0 day</th>
<th>7th day</th>
<th>14th day</th>
<th>21st day</th>
<th>28th day</th>
<th>35th day</th>
<th>42nd day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turbidity (NTU)</td>
<td>35±0.23</td>
<td>20±0.46</td>
<td>18±0.87</td>
<td>15±0.37</td>
<td>13±0.84</td>
<td>10.5±0.45</td>
<td>9.6±0.82</td>
</tr>
<tr>
<td>2</td>
<td>TDS (mg/l)</td>
<td>1200±1.27</td>
<td>1050±1.48</td>
<td>970±1.38</td>
<td>810±1.64</td>
<td>776±0.92</td>
<td>8.68±1.19</td>
<td>6.65±0.83</td>
</tr>
<tr>
<td>3</td>
<td>pH</td>
<td>6.82±0.48</td>
<td>7.9±0.57</td>
<td>7.8±0.83</td>
<td>7.65±0.93</td>
<td>7.56±0.18</td>
<td>7.46±0.28</td>
<td>7.3±0.38</td>
</tr>
<tr>
<td>4</td>
<td>Hardness (mg/l)</td>
<td>330±0.98</td>
<td>300±0.27</td>
<td>275±0.86</td>
<td>235±0.72</td>
<td>198±0.38</td>
<td>159±0.72</td>
<td>148±0.94</td>
</tr>
<tr>
<td>5</td>
<td>DO (mg/l)</td>
<td>3.4±1.72</td>
<td>3.9±1.28</td>
<td>4.3±1.19</td>
<td>4.8±1.38</td>
<td>5.1±1.47</td>
<td>5.3±1.76</td>
<td>5.5±1.84</td>
</tr>
<tr>
<td>6</td>
<td>BOD (mg/l)</td>
<td>43±1.83</td>
<td>54.8±0.98</td>
<td>48.3±0.87</td>
<td>41.5±1.68</td>
<td>37.5±0.92</td>
<td>32.2±1.15</td>
<td>28±0.93</td>
</tr>
<tr>
<td>7</td>
<td>COD (mg/l)</td>
<td>170±0.00</td>
<td>123±0.00</td>
<td>110±0.00</td>
<td>98±0.00</td>
<td>85±0.00</td>
<td>71±0.00</td>
<td>52±0.00</td>
</tr>
<tr>
<td>8</td>
<td>TKN (mg/l)</td>
<td>3.5±0.00</td>
<td>3.0±0.00</td>
<td>2.8±0.00</td>
<td>2.5±0.00</td>
<td>2.2±0.00</td>
<td>1.8±0.00</td>
<td>1.5±0.00</td>
</tr>
<tr>
<td>9</td>
<td>Chl.a</td>
<td>9.91±0.36</td>
<td>9.71±0.83</td>
<td>9.45±0.75</td>
<td>8.20±0.47</td>
<td>6.39±0.41</td>
<td>6.15±0.18</td>
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<tr>
<td>10</td>
<td>Chl.-b</td>
<td>4.11±0.47</td>
<td>4.09±0.16</td>
<td>3.58±0.71</td>
<td>3.16±0.58</td>
<td>2.65±0.19</td>
<td>2.05±0.38</td>
<td>1.85±0.17</td>
</tr>
</tbody>
</table>

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pH was decreased from 7.9 to 7.3 in 50% concentration and 8.12 to 7.22 in 100% concentration. Dhote et al. (2009) also reported same decreasing trend in pH in lake water by using water hyacinth (Eichhornia crassipes) and hydrilla (Hydrilla verticillata). Hardness decreased from 330 mg/l to 148 mg/l in 50% concentration and 386 mg/l to 168 mg/l in 100% concentration (table 1 and 2) by using water hyacinth. Dar et al. (2011) also reported same decrease in trend of hardness. They reported 54% reduction in 50% concentration and 45% reduction in 100% concentration in sewage treatment potential of water hyacinth.

The level of DO in any water shows the condition of pollution level. In the present study, water hyacinth increased the DO level in both the sewage concentration of sewage. DO was increased from 3.14 mg/l to 5.5 mg/l in 50% concentration and 1.21 mg/l to 5.2 mg/l in 100% concentration (table 1 and 2) by using water hyacinth. BOD is the worst problem of sewage. BOD was decreased from 43 mg/l to 28 mg/l in 50% concentration and 75 mg/l to 35.2 mg/l in 100% concentration (table 1 and 2) by using water hyacinth. Dhote et al. (2007) reported the reduction of 75% in BOD in lake water. COD also reduced from 170 mg/l to 52 mg/l in 50% concentration and 285 mg/l to 80 mg/l in 100% concentration. Total nitrogen was decreased from 3.5 mg/l to 1.5 mg/l in 50% concentration and 5.6 mg/l to 2.8 mg/l in 100% concentration (table 1 and 2). Water hyacinth is capable in assimilating both ammonium and nitrate. The impact of sewage on the plant is observed by plant chlorophyll estimation. At a very first day the chlorophyll-a was 9.9156 mg/dry wt. and chlorophyll-b was 4.1188 mg/dry wt. in 50% concentration, while in 100% concentration chlorophyll-a was 9.915 mg/dry wt. and chlorophyll-b 4.2136 mg/dry wt.

But after 7 weeks chlorophyll-a was 4.3265 mg/dry wt. and chlorophyll-b was 1.8589 mg/dry wt. in 50% concentration where as in 100% concentration chlorophyll-a was 3.31 mg/dry wt. and chlorophyll-b was 1.1372 mg/dry wt. so the result shows that the sewage affects the plant severely.

**Conclusion**

Water has been polluted and is suffering from ongoing chronic pollution. This has become one of the most pervasive environmental problems throughout the world. High cost technologies though effective cannot be employed by most developing countries including India. So, we have to find alternative cost effective methods; one such system could be phytoremediation. Phyto remediation is a potential remediation strategy that can be used to treat water contaminated with pollutants. In the present study, various physical, chemical and biological parameters were studied and it was
observed, that water hyacinth is a potential tool for treating municipal wastewater. The plant performed well in 100% wastewater. It may be used for at least primary and secondary treatment. This plant might be utilized as an efficient, economical and ecological alternative to accelerate the removal and degradation of agro-industrial wastewater pollutants.

References


