Utilization of Pistia Stratiotes for Textile Wastewater Nitrates and Phosphates Removal

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Abstract
Textile industry effluent contains a variety of organic and inorganic pollutants. Effluents largely containing high concentration of dyestuffs, salts, acids, bases, surfactants, dispersants, humectants, oxidants and detergents render these waters aesthetically unacceptable and unusable. Treatment of high volumes of wastewater becomes crucial because textile dyes are well known mutagens and carcinogens posing risks to various ecosystems, animals' health and agriculture. This situation has necessitated the development of effective and efficient wastewater treatment strategies without further stressing the environment and endangering other life forms. Phytoremediation catalyzed by green plants and their associated metabolic processes has emerged as a comparatively new approach and has proven to be one of the most effective environmental friendly strategies for removal and detoxification of contaminants. Several aquatic macrophytes have been found to effectively minimize the pollutant concentration in waste water. The present study was conducted to investigate the feasibility of Pistia stratiotes for treating textile wastewater in reducing the concentration of nitrates and phosphates. The result revealed that concentration of nitrates and phosphates reduced considerably upon phytotreatment.

Keywords: Textile industry, effluents, phytoremediation, Pistia stratiotes, nitrates and phosphates.

I. INTRODUCTION
Water is the most vital resource for all kinds of life, but it is being adversely affected both quantitatively and qualitatively. Today, most of the rivers receive millions of litre of sewage and industrial effluents containing varying characteristics from simple nutrients to highly toxic substances. The world’s ever increasing population and progressive adoption of industry based lifestyle has inevitably led to an increased anthropogenic impact on the biosphere(Pavithra and Kousar, 2016). With the increased demand for textile products, the textile industry and its wastewaters have been increasing proportionally, making it one of the main sources of severe pollution problems worldwide. The textile industry is one of the most important and rapidly developing industrial sectors in India (Husain and Husain, 2012), accounting for about 20% of the total industrial production. It consumes large quantities of water and produces large volume of wastewater from different steps in the dyeing and finishing processes. Due to the danger of the entry of chemicals into wastewater, it must be treated before the final disposal. Many physical, chemical and biological methods have been developed for the treatment of wastewater. It is reported that biological methods are more interesting for wastewater treatment and one of the branches of biological method for wastewater treatment is phytoremediation (Roongtanakiat et al., 2007).

Phyto-remediation is the utilization of plant to remove and accumulate contaminants from environment. It includes the use of plants to mitigate, transfer, stabilize or degrade pollutants in soil, sediments and water. Recent studies on biomass of some selected plants, particularly macrophytes and rhizomes, provide leading clues on means of improving the quality of wastewater (Misbahuddin and Farduddin, 2002; Mohan et al., 2006; Dana, 2014; Alade and Ojoowo, 2009; Aremu et al., 2012).

Phosphorous is one of the major nutrients contributing to the increased eutrophication of lakes and natural waters. Its presence causes many water quality problems including increased purification costs, decreased recreational and conservation value of an impoundment, loss of livestock and the possible lethal effect of algal toxins on drinking water. (Metcalf and Eddy, 1991; Gray, 2005). Controlling phosphorous discharged from municipal and industrial wastewater treatment plants is a key factor in preventing eutrophication of surface waters. Usually, the removal of phosphorous from wastewater involves the incorporation of phosphate into total suspended solids and the subsequent removal from these solids. Phosphorous can be incorporated into either biological solids (e.g. micro organisms) or chemical precipitates.
Large input of nitrogen, to ground and surface waters may result in excessive growth of algae and other aquatic weeds. Moreover, a build-up of nitrate in drinking water supplies poses a health hazard to humans particularly infants, as well as livestock. Nitrate causes “Methemoglobinemia” or “Blue baby disease” among infants. Nitrate determination is essential to ascertain the state of decomposition of organic matters present in wastewater. It is used to assess the self-purification properties of water bodies and nutrient balance in surface water and soil. Nitrate is a highly mobile anion formed by microbial conversion of nitrite. Drinking water Standards have recommended a permissible nitrate value of 10 mg/l (Kotaiah and Swamy, 1994).

The present study was conducted to investigate the feasibility of *Pistia stratiotes* reducing for the concentration of nitrates and phosphates in textile wastewater. The plant commonly known as water lettuce has an extensive root system that aggressively accumulates contaminants and nutrients in its surrounding waters. This plant is currently employed in many parts of the world for heavy metal removal from wastewater and has shown promising results for the degradation of organic and inorganic wastes from contaminated water sources (Odjegba and Fasidi, 2004; Gupta et al., 2012).

II. MATERIALS AND METHODS

A. Collection of Plants:
*Pistia stratiotes* was collected from a natural pond near Shimoga. Same sized young and healthy plants were collected and acclimatized in laboratory conditions for three days. Later they were introduced into the effluent.

B. Collection of Samples
The sample for the analysis was collected from a textile industry near Shimoga. It was brought to the laboratory and analysed for various physico-chemical parameters including COD.

C. Method
Different concentrations (10% to 70%) of effluent were used for treatment, while the control was maintained separately. Plastic troughs of 10 litre capacity were filled with 7 litre of different concentration of effluent. The plants were allowed to grow in laboratory model ponds for 7 days, after which they were taken out and the plant treated effluent was analyzed for the efficiency of *Pistia stratiotes* in reducing Phosphate and Nitrate.

1) Phosphate :-
Phosphate (Total Phosphate as PO₄) was determined by Spectrophotometric method (IS:3025(p31)) before and after the treatment.

2) Nitrate :-
Nitrate (Nitrate Nitrogen as N ) was determined by Spectrophotometric method (IS:3025(p34)) before and after the treatment.

III. RESULTS
The present study investigates the capability of *Pistia stratiotes* in reducing phosphate and nitrate concentration in textile wastewater. The result clearly indicates that *Pistia stratiotes* is extremely potent in reducing concentration of phosphate and nitrate as there was a significant reduction in their concentration. Concentration of total phosphates and nitrates of effluent after treatment with *Pistia stratiotes* is represented in Table 1 .The percentage of phosphate reduction is represented in Figure 1 and nitrate reduction in Figure 2.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Phosphate reduction</th>
<th>Nitrate reduction</th>
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<tbody>
<tr>
<td>10% concentration</td>
<td>4.55±1.732</td>
<td>13.6±4.525</td>
</tr>
<tr>
<td>20% concentration</td>
<td>6.1±2.192</td>
<td>22±5.656</td>
</tr>
<tr>
<td>30% concentration</td>
<td>8.25±2.793</td>
<td>33±7.778</td>
</tr>
<tr>
<td>40% concentration</td>
<td>10.2±3.111</td>
<td>41±9.192</td>
</tr>
<tr>
<td>50% concentration</td>
<td>12.4±3.676</td>
<td>54±11.313</td>
</tr>
<tr>
<td>60% concentration</td>
<td>15.66±4.426</td>
<td>72.2±14.0007</td>
</tr>
<tr>
<td>70% concentration</td>
<td>18.2±4.6690476</td>
<td>92±16.970</td>
</tr>
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</table>
IV. DISCUSSION

Results indicated that phytoremediation was effective in reducing N and P concentration in textile water. The finding was consistent with other studies on phytoremediation, whereby hydrophytes were found to absorb and accumulate superfluous nutrients like N and P (Xu et al., 1999). These findings indicate that phytoremediation could promote the removal of N and P from the textile mill effluent. The released nutrients are absorbed by plants, and the contaminants in water will gradually be diminished. The study has shown that Pistia stratiotes could remove a large amount of nutrients from textile wastewater and purify it by means of remobilization, assimilation and metabolizing (cf. Li et al., 2000).

V. CONCLUSION

The feasibility of P. stratiotes to treat textile effluent was investigated and it was found to be efficient in reducing the concentration of Phosphate and Nitrate within 7 days of treatment. Hence, P. stratiotes could be used for treating textile mill effluent.

REFERENCES


