International Journal of Engineering & Technology, 7 (3.34) (2018) 160-162

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Textile Industry Wastewater Color Removal Using Lemna Minor L and Lemna Minuta L

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Abstract

The influence of various nutrient dosages, dilution ratios and pH values was evaluated with different contact time against colour removal from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L. The optimum nutrient dosage, dilution ratio, and pH value was found to be 50 mg, 8 and 8 respectively. The maximum colour removal corresponding to the optimum process parameters value observed using *Lemna minor* L as 82.85 % and using *Lemna minuta* L as 89.5 %. Further, verification was done and showed that the maximum colour removal percentage from textile industry wastewater is lower than colour removal from an aqueous solution. The results of this study concluded that *Lemna minuta* L removed more colour than *Lemna minor* L and both were identified to reproduce the obtained optimum process parameters and for removing colour in a textile industry wastewater.

***Keywords**: Colour, Constructed wetland, Textile industry wastewater, Lemna minor L., Lemna minuta L.*

1. Introduction

The textile industry wastewater comes from various wet processes like scouring, sizing, bleaching, dyeing and printing operations. The wastewater contains more organic and inorganic matter that is entering into the land and water environment when it was not treating properly. Sivakumar, Irina, and Smita [1, 2, 3] were observed that out of all pollutant, colour in textile industry wastewater dominates because of its appearance; therefore it is to be treated before discharge on land or nearby waterbodies.
The conventional treatment approaches to eliminate colour from textile industry wastewater are aerobic and anaerobic microbial degradation and coagulation method was studied by Guendy [4], absorption studies were conducted using aquatic plants by Sivakumar and Sivakumar, et al., [5,6], granular activated carbon was used in treating the textile industry wastewater by Syafalni [7], electrochemical processes was studied by Dogan [8], reverse osmosis method was used by Ramesh Kumar [9].
Further, the ozonation method was assessed by Guendy [10], bioadsorption studies were conducted by Shankar and Sivakumar [11, 12], catalytic oxidation was used for assessing the textile industry wastewater by Hussein [13] and the application of membrane processes was studied by Abdulraheem [14] etc. The above said methods having disadvantages because of their high treatment cost. One of such cost effective treatment method is phytoremediation and it was studied by Sivakumar, Shaikh Parveen, Patel and Sivakumar [15, 16, 17, 18]. Most of the studies concentrated on aqueous solution for the removal of colour, whereas, this study concentrated on removal of textile industry wastewater colour by *Lemna minor* L and *Lemna minuta* L. Also verified colour removal from aqueous solution (same dye used in textile industry) using *Lemna minor* L and *Lemna minuta* L for their reproducibility.

2. Methods and Materials

2.1 Lemna Minor L and Lemna Minuta L Collection

Small duckweeds *Lemna minor* L and *Lemna minuta* L has very small leaves and short roots, has bright green in colour. Lakes, ponds are the regions where these plants are growing abundantly. These can survive in cool climate to moderately temperate climate. *Lemna minor* L and *Lemna minuta* L collected from nearby pond and both were washed with deionized water and then both were stabilized for a period of 15 days in a plastic container. The plastic container represents the constructed wetland filled with 5 inch soil collected from local lake.

2.2 Textile Industry Wastewater Collection

Airtight sterilized bottles were used for collection of wastewater from textile industry. The wastewater collected at clarifier from textile industry, located at Kanchipuram, Tamil Nadu. The samples were kept in refrigerator at the temperature of 278 K and then it was analysed for various parameter particularly colour. The colour of the wastewater is due the presence of Acid orange 10 dye, which was used by the textile industry.

2.3 Adsorption Experiments

100 g of each *Lemna minor* L and *Lemna minuta* L collected from stabilized tank and the same was put into the constructed wetland, which was similar to stabilized tank made up of plastic. Three representative samples were maintained for analysis of colour removal using *Lemna minor* L and *Lemna minuta L*. The removal of colour was observed over 7 days period with 1 day interval.

The selected process parameters are nutrient dosages (10, 20, 30, 40, 50, 60 and 70 g), dilution ratio (2, 4, 6, 8, 10, 12 and 14) and pH (4, 5, 6, 7, 8, 9 and 10).

Activated sludge was used as nutrient for this study. 2, 4, 6, 8, 10, 12 and 14 represents well water with wastewater. 0.1 M of NaOH and 0.1 M of HCl was used to adjust the pH value. The wastewater colour of textile industry using *Lemna minor* L and *Lemna minuta* L was determined by APHA, 2005 [19]. The formula used for the adsorption removal is

$$\text{Percentage Removal} = \frac{(C_1 - C_2)}{C_1} X100 \quad (1)$$

in which C_1 and C_2 are the wastewater colour of textile industry before and after treatment with *Lemna minor* L and *Lemna minuta* L respectively. The wastewater colour reduction in a textile industry was measured by UV spectrophotometer at 486 nm wavelength. The colour intensity measured as 45 mg/l.

3 Results and Discussion

Lemna minor L and *Lemna minuta* L were used for removing colour from textile industry wastewater against process parameters like nutrient dosages, dilution ratios, pH values for different time of contact.

3.1 Effect of Nutrient Dosage

The nutrient dosages were changed from 10 g to 70 g with dilution ratio of 6 and pH of 6 for removing colour from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L. This study was conducted against time of contact from day 1 to day 7 and observed as day 4 showed colour removal maximum percentage from wastewater of textile industry using *Lemna minor* L and *Lemna minuta* L (results expect day 4 were not presented in this study).

From Fig. 1, it could be noted that maximum colour reduction from textile industry wastewater was occurred at the nutrient dosage of 50 g for both *Lemna minor* L and *Lemna minuta* L. Beyond which there was no such variation and hence, an optimum nutrient dosage found to be 50 g and corresponding the maximum removal of colour at an optimum nutrient dosage of 50g by *Lemna minor* L is 68.2 % and by *Lemna minuta* L is 76.3 % (Fig. 1).

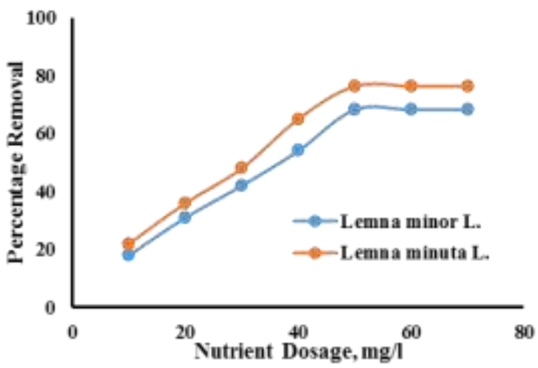

Fig. 1: Percentage Removal of Wastewater Colour from Textile Industry by *Lemna minor* L and *Lemna minuta* L against Nutrient Dosage

3.2 Effect of Dilution Ratio

The dilution ratios were changed from 2 to 14 with optimum nutrient dosage (50 g) and pH (6) for removing colour from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L. This study was conducted with different time of contact day 1 to day 7 and observed as day 4 showed the colour removal maximum percentage from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L.

From Fig. 2, it could be distinguished that maximum colour reduction from wastewater occurred at dilution ratio of 8 for both *Lemna minor* L and *Lemna minuta* L. Beyond which there was no such variation and hence, an optimum dilution ratio found to be 8 and corresponding the maximum removal of colour at an optimum dilution ratio 8 by *Lemna minor* L is 76.8 % and by *Lemna minuta* L is 83.4 % (Fig. 2).

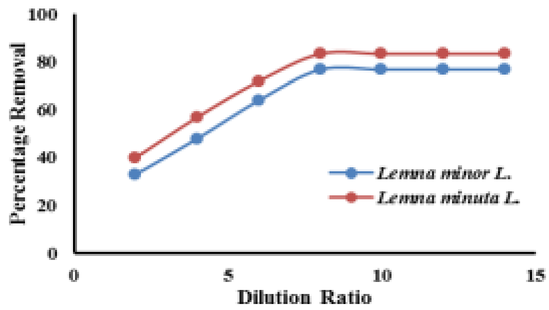

Fig. 2: Percentage Removal of Wastewater Colour from Textile Industry by *Lemna minor* L and *Lemna minuta* L against Dilution Ratio

3.3 Effect of Ph

The pH values were changed from 4 to 10 with the optimum nutrient dosage (50 g) and optimum dilution ratio (8) for removing colour from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L. This study was conducted against time of contact day 1 to day 7 and observed as day 4 showed colour removal maximum percentage from textile industry wastewater using *Lemna minor* L and *Lemna minuta* L.

From Fig. 3, it could be distinguished that maximum colour reduction from textile industry wastewater was occurred at pH of 8 for both *Lemna minor* L and *Lemna minuta* L. Beyond which there was no such variation and hence, an optimum pH values found to be 8 and corresponding the maximum removal of colour at an optimum pH by *Lemna minor* L. is 82.85 % and by *Lemna minuta* L. is 89.5 % (Fig. 3).

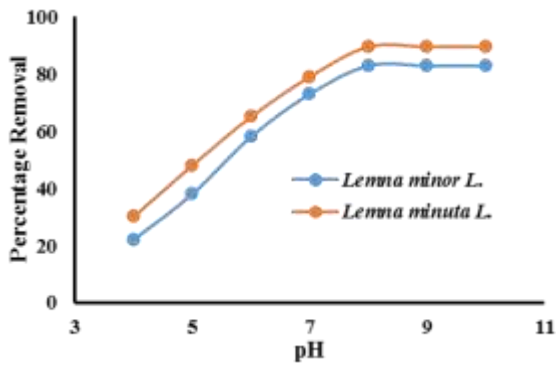

Fig. 3: Percentage Removal of Wastewater Colour from Textile Industry by *Lemna minor* L and *Lemna minuta* L against pH

3.4 Verification Experiment

An experiment was conducted in an aqueous solution for removing colour using *Lemna minor* L and *Lemna minuta* L (Fig. 4) with the process parameters like optimum nutrient dosage of 50g, dilution ratio of 8, pH of 8 with contact time of 4 days. An initial concentration of Acid Orange 10 colour aqueous solution was prepared with equivalent concentration of textile industry wastewater and it was measured as similar to colour determined in a textile industry wastewater with the UV spectrophotometer (λ_{max}= 486 nm).

The maximum removal percentage of Acid Orange 10 colour in an aqueous solution is found to be 86.35 % and 92.1 % respectively by *Lemna minor* L and *Lemna minuta* L. Further, *Lemna minuta* L produced higher removal percentage than *Lemna minor* L. No other competitive parameters present in an aqueous solution and the same are influencing maximum colour removal rate in an aqueous solution. Based on verification test results, it could be established that the *Lemna minor* L. and *Lemna minuta* L. could be used to remove not only the colour along with associated parameters from textile industry wastewater against the optimum process parameters values.

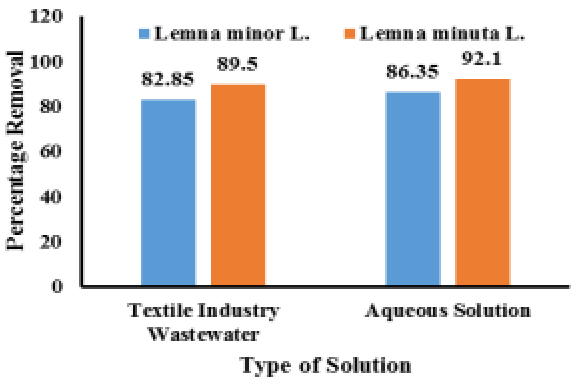

Fig. 4: Wastewater Colour removal Maximum Percentage from Textile Industry and from Aqueous Solutions by *Lemna minor* L. and *Lemna minuta* L. against optimum process parameters values.

4 Conclusions

Lemna minor L and *Lemna minuta* L aquatic plants were used for this study to remove textile industry wastewater colour against the process parameters nutrient dosages, dilution ratios and pH values with different contact time. Maximum removal of textile industry wastewater colour at an optimum nutrient dosage of 50g, dilution ratio of 8 and pH of 8 with contact time of 4 days was found to be 82.85 % and 89.5 % by *Lemna minor* L and *Lemna minuta* L respectively. The same results were observed in aqueous solution. Thus, the study was concluded that *Lemna minor* L. and *Lemna minuta* L. may be used as potential candidate for removing colour along with other associated parameters from textile industry wastewater.

Acknowledgement

The Authors express their thanks to Management of Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College, Avadi, Chennai, Tamil Nadu, India, for their provisions to finish this study successfully.

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