EXPERIMENTAL INVESTIGATION ON PHYTOREMEDIATION OF DOMESTIC WASTEWATER USING AQUATIC PLANTS

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Abstract

Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and water. It takes the advantage of the ability of plants to concentrate elements and compounds from the environment and metabolize various molecules in their tissues. Certain plants have the ability to bio accumulate, degrade, or render harmless contaminants in soil, water, or air. Mostly the targets of phytoremediation are toxic heavy metals and organic pollutants. In this project the aquatic plants are employed and studied for the treatment of Domestic wastewater, the results recorded and compared with respect to the three different aquatic plants that are locally available abundantly. This project moved further in identifying the most efficient aquatic plant which could be employed for the domestic wastewater treatment. The plants identified to be compared in this project are Water Hyacinth (Eichhorniacrassipes), Duckweed (Lemna minor) and Water Lettuce (Pistiastratiotes).This Project study aims to improve the quality of discharged water to reach the permissible level of water to be discharged into water bodies or for agricultural land with the help of aquatic plants. Compare the properties of treated wastewater by different aquatic plants. Identify the efficient abundant available aquatic plant for phytoremediation of domestic waste water.

Introduction

The process of removing undesirable contaminants (chemical and biological), suspended solids and gases from water is termed as Water purification. Most of the time water is purified and disinfected for human consumption (drinking water), but sometimes water purification is even carried out for a variety of other purposes, such as medical, pharmacological, agricultural, chemical and industrial applications. There are several methods for water purification including physical processes such as filtration, sedimentation and distillation; biological processes such as slow sand filters; chemical processes such as flocculation and chlorination; use of electromagnetic radiation such as ultraviolet light and even use of plants such as phytoremediation.

Materials and Methods

Waste Water Samples Source

Waste water samples were collected from the Sewage Treatment plant located at Ukkadam, Coimbatore owned by the JNNURM, Coimbatore City Municipal Corporation. Several treatment processes were carried out before the treated water is sent to be used for irrigation purpose.

Raw Sewage at STP Inlet

Table 1 Raw sewage quality data from STP

SI. No	Quality Parameters	Actual Measured Value	Unit
1	Temperature	28.10	Celsius
2	PH	7.30	
3	Total Suspended Solids	280.00	mg/l
4	Dissolved Oxygen	BDL	mg/l
5	Chemical Oxygen Demand	640.00	mg/l
6	Biochemical Oxygen Demand	320.00	mg/l

Treated Sewage at STP Outlet

Table 2 Treated Sewage Quality data from STP

SI. No	Quality Parameters	Actual Measured Value	Unit
1	Temperature	29.20	Celsius
2	pH	7.80	
3	Total Suspended Solids	40.00	mg/l
4	Dissolved Oxygen	4.00	mg/l
5	Chemical Oxygen Demand	50.00	mg/l
6	Biochemical Oxygen Demand	7.00	mg/l

Collection of Plants

Water Hyacinth Setup

Water hyacinth plants reproduce quickly and can double in just two weeks. This means 10 initial plants can multiply to over 600 within 3 months. The relative growth rate (RGR) of water hyacinth ranges from 6.40–7.26%/day.

Figure 1 Water Hyacinth Setup

Water Lettuce Setup

Water lettuce reproduces vegetative by producing new rosettes on the ends of stolons, potential for flooding to cause even small ponds to overflow and allow for escape should be considered.

Figure 2 Water Lettuce Setup

Duckweed Setup

Duckweeds are extremely fast breeders that are able to double their area of coverage within 36 hours. This very efficient reproductive process results in a very rapid growth cycle.

Figure 3 Duckweed Setup

Results and Discussions

Testing of Samples

Table 3 Temperatures

SI. No	Aquatic Plant Setup	Temperature in °C			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	29.2	27.4	26.5	28.7
2	Lemna minor	29.2	26.8	27.9	29.4
3	Pistiastratiotes	29.2	28.3	27.6	28.9

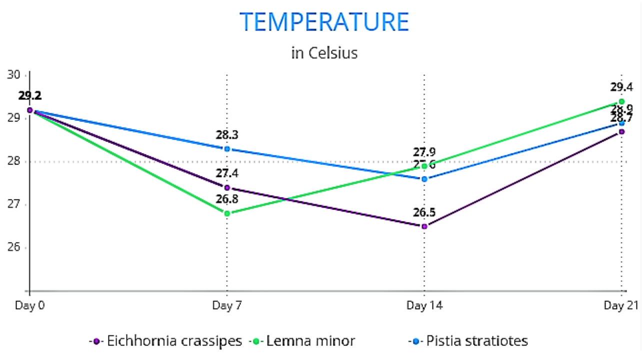

Figure 4 Temperature

PH Test

Table 4 PH Value

SI. No	Aquatic Plant Setup	pH value			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	7.80	7.60	7.80	7.70
2	Lemna minor	7.80	7.70	7.50	7.60
3	Pistiastratiotes	7.80	7.90	8.00	7.90

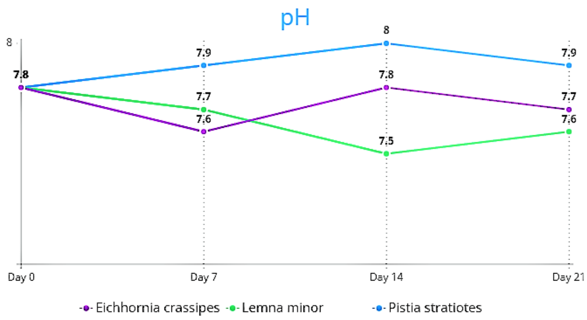

Figure 5 PH Graph

Total Suspended Solids

Table 5 Total Suspended Solids

SI. No	Aquatic Plant Setup	Total Suspended Solids in mg/l			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	40	29	20	8
2	Lemna minor	40	35	27	20
3	Pistiastratiotes	40	32	26	19

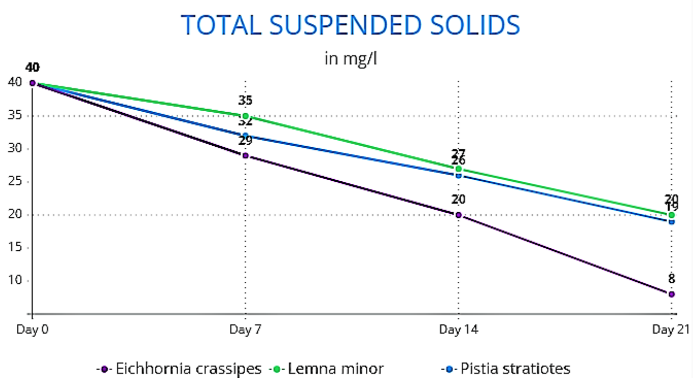

Figure 6 Total Suspended Solids

Dissolved Oxygen

Test Data

Table 6 Dissolved Oxygen

SI. No	Aquatic Plant Setup	Dissolved Oxygen in mg/l			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	4.0	4.8	5.7	6.6
2	Lemna minor	4.0	4.7	5.9	6.8
3	Pistiastratiotes	4.0	4.9	6.0	7.3

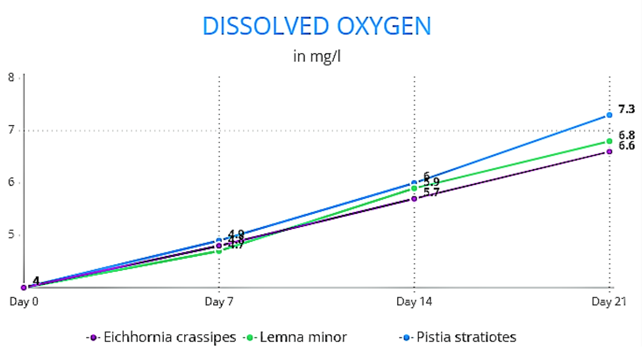

Figure 7 Dissolved Oxygen Graph

Chemical Oxygen Demand

Test Data

Table 7 Chemical Oxygen Demand

SI. No	Aquatic Plant Setup	Chemical Oxygen Demand in mg/l			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	50	44	37	28
2	Lemna minor	50	46	33	25
3	Pistiastratiotes	50	40	29	18

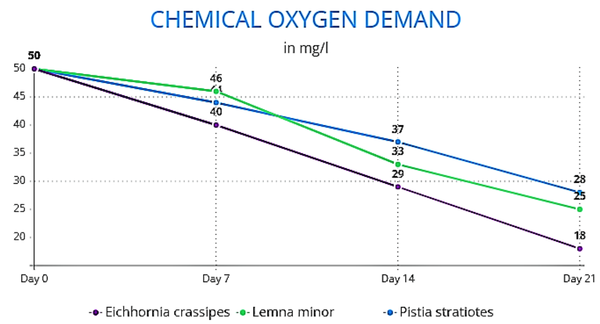

Figure 8 Chemical Oxygen Demand Graph

Biochemical Oxygen Demand

Test Data

Table 8 Biochemical oxygen demand

SI. No	Aquatic Plant Setup	Biochemical Oxygen Demand in mg/l			
		Day 0	Day 7	Day 14	Day 21
1	Eichhorniacrassipes	7	5.6	4.4	3
2	Lemna minor	7	6.2	5.6	4
3	Pistiastratiotes	7	6.3	5.8	5

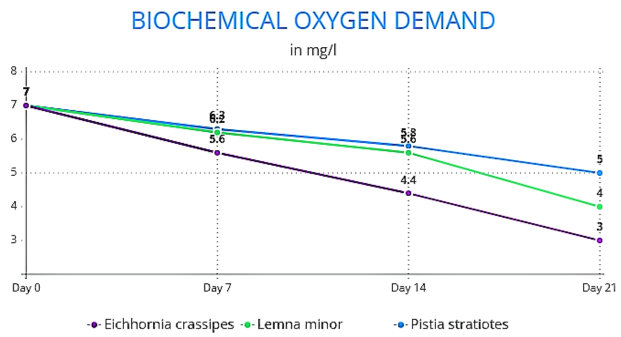

Figure 9 Biochemical Oxygen Demand Graph

Test Results Comparison

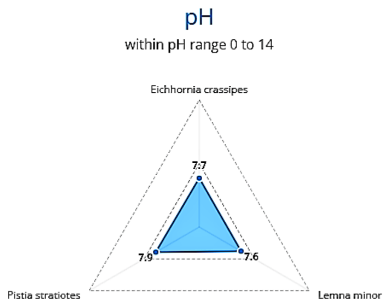

Figure 10 PH Test Comparison

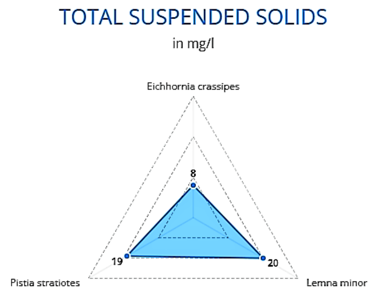

Figure 11 TSS Test Comparison

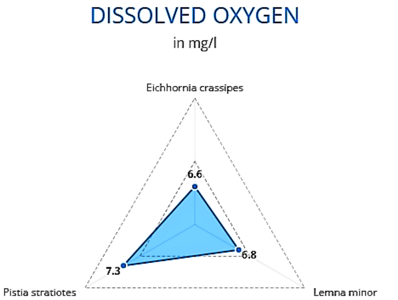

Figure 11 Dissolved Oxygen Test Comparison

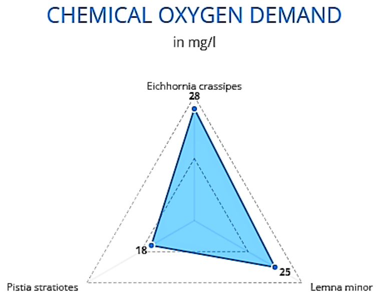

Figure 12 Chemical Oxygen Test Comparison

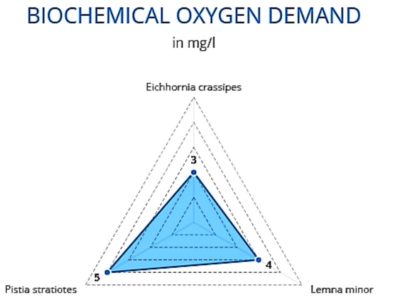

Figure 13 BOD Test Comparison

Conclusion

The three plants chosen were widely available and also they are easy to acclimate and grow. The growth of the plants varied as they all had different reactions to the atmosphere. Yet all the three were feasible to be used in the phytoremediation process. Since they are floating plats they don't require soil to grow thus reducing the contamination or accumulation of minerals in the sample water. The experimental setup after being operated for 21 days has bought out certain trustable and compelling results proving to be efficient in treating the domestic wastewater after secondary treatment and making it more susceptible to use for drinking and irrigation purposes. All the three plants absorbed pollutants from the sample to be treated and gave promising results in removing Total Suspended Solids. Surprisingly Eichhorniacrassipes reduced the Total Suspended Solids level by 80%. Each plant maintained the pH value of the sample within permissible levels despite of the surroundings. Pistiastratiotes bought down the level of Chemical Oxygen Demand by 64% and acceptable limits. Herewith all the three plants showed significant effectiveness in reducing the BOD, but still not yet enough to make it safe for drinking in the given period of time. Yet the water with such parameter level could be used for irrigation and industrial purposes.

References

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