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Experimental Investigation of floating wetland treatment on different types of Wastewater

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Abstract

The objective of this study is to identify low-cost plant species and floating materials suitable for constructing Floating Treatment Wetlands (FTWs), and to evaluate their impact on wastewater purification. To test their effectiveness, a small-scale laboratory model was developed. Many rural areas in India face significant water shortages and limited access to clean water. These regions often rely on intermittent water supply systems, which provide water for only a few hours a day. This leads to a need for water storage and leaves many communities without a consistent nearby water source.
FTWs present an innovative method for treating wastewater by leveraging the natural filtering abilities of plant roots. Larger root systems are generally more effective at filtering and removing pollutants. In this study, the commonly available water hyacinth (Eichhornia crassipes) was selected for its extensive root system and local availability. Various floating base materials were evaluated, with Teflon sheets being chosen for their suitability and performance. A lab-scale FTW system was constructed, and water quality was monitored over a period of seven days. Daily measurements of pH, turbidity, and total suspended solids (TSS) were taken. For comparison, a similar sample of wastewater was treated using aeration alone and observed over the same time period.

INTRODUCTION

Oceans and seas are the primary sources of water on Earth, containing around 96% of the planet's water, which is difficult to utilise due to the high concentration of salts in it, which is toxic to humans. Because there is no alternative supply of fresh water, many desalination techniques have been used to treat this water. A floating treatment wetland is the finest option for treating grey water at a very low cost. The approach emphasises the plant's roots; the bigger the roots, the faster the purifying rate. It is feasible to utilise non-floating plants that are very efficient in terms of water purification, have a well-developed roots system, and are unable to escape from the treatment area and colonise space in the water body [3]. Many diverse plants are available that may be utilised for therapy, and certain decorative plants also play a significant role in cleansing and aesthetic attractiveness. Because of their aesthetic appeal, ornamental plants may encourage the adoption

of decentralised technology for the treatment of home effluents, boosting the possibility to install such systems in urban settings [12]. Waste water is classified into three categories. There is black water, grey water, and yellow water.
Blackwater is faecal matter and urine-containing effluent from restrooms and toilets. Grey water is wastewater from a washbasin or bath that does not include harmful pollutants (such as those found in toilets or diapers). Yellow water is almost all pee. It is urine from specified sources that does not include any of the impurities present in greywater or blackwater such as chemicals, toilet paper, faeces, and food particles. This approach functions similarly to a natural method in that just a single plant can remove many contaminants from wastewater. Many floating plants may be utilised in a wetland to remove toxins; however, plant selection criteria vary depending on the temperature, type of the wastewater, and nutrients to be removed [9]. In nature, floating wetlands occur, which are made up of a floating organic mat that supports plant development and is buoyant due to the trapping of gases created by anaerobic metabolism and the existence of air holes in the roots of some plant species. To be sure, this is a wonderful concept for a personal house or municipal courtyard.
Floating mats of lilies, rushes, and reeds are simply lovely. However, the larger market for industrial and Municipal wastewater treatment is anybody who must adhere to particular environmental criteria. The EPA has imposed a limit for pollutants and suspended solids, and the only option to keep those limits in control is to build filtration systems, excavate a larger pond, or use phyto-remediation (cleaning services supplied by plants). Our modest opinion is that the latter is superior. Homeowners' organisations are always battling algae as a result of all the landscaping they perform. The development of floating wetlands might aid in the cleaning of ponds and rivers without the use of harsh chemicals.

METHEDOLOGY

I. Selection of Plants

Case studies have been carried out on the following plants to select the best suited plant:
Common water hyacinth:

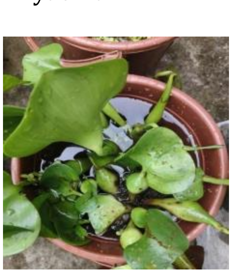


Figure 1: Common water hyacinth

It's one of the greatest macrophytes we've discovered and the only one in our testing setup. We took this macrophyte from Powai Lake, where there were numerous plants on a vast scale that might be employed if necessary. It considerably decreases turbidity, and our finding was that it requires a broad area to provide effective results, since the smaller contact area provided during testing causes it to smell and reduces its purifying impact.

Canna Indica

Fig 2 : Cana Indica

We learned about this plant from numerous publications and obtained it from a nearby place in Thane.
Because it is not an aquatic plant, it was unable to remain still in the water, so we used a stick to hold its roots in the grey water. It displays an excellent purification impact after only two days, and it was still alive and able to filter grey water after seven days.
Money Plant

Fig 3 : Cana Indica

We experimented with a money plant in a grey water in a bottle configuration, as indicated in the image. Initially, there was some plant growth and the turbidity of the water was decreased. However, it was unable to pursue purification for an extended period of time; after a few days, growth ceased, fungus was detected to settle in the bottom, and purification was terminated. **Based on the results of the previous trials, we used common water hyacinth for filtering.**
a. Selection of Floating Materials
Teflon Sheet

Figure 4: Selected Material as Teflon sheet

As thermocol is prohibited in India, Teflon sheet was tried for floating material. It was given on a base support of plastic bottles to easily float it, as well as a hole in between to allow the roots to travel deep within the grey water. It produces excellent results since the plant may easily float when utilising a Teflon sheet

Figure 5: Selected Material as Thermocol sheet

Another viable option had good results; the plant was free to float and be in contact with the atmosphere, and the roots were appropriately in contact with the grey water.
Thermocol with PVC Pipes

Figure 6: Thermocol with PVC Pipes

As previously stated, thermocol is used to suspend the plant's roots, but with a PVC pipe assembly to allow it to securely float on the water without any touch with the water and to have adequate contact with the atmosphere.
<u>Based on our studies, we chose Teflon sheet as a floating material.</u>

EXPERIMENTAL MODEL

For experiment purpose we made a small-scale model using locally available materials which are cheap and are easy to assemble. Our aim of this model was to find the compatibility of the Floating material and Filtration plant which we have chosen.
Following are the steps which we have carried out to implement this model.

Step 1

For the experiment we have selected a baby bathtub which was locally available. Many other ways also can be used for the same but we have chosen the same as it was easily available and can be used again and again for multiple purposes. The grey water was collected from the kitchen sink and wash water coming from the washing machines from our houses.

Step 2

Figure 7:Cutting of Teflon Sheet

Figure 8: Inserting plant in Teflon Sheet

We used waste teflon sheet so as to make the model economical. In the teflon sheet we made a hole at the Centre as shown in fig 3. And inserted the plant such that its lower part of root can remain into the water and the rest above the sheet as shown in fig 10. Ultimately the roots are suspended in the grey water providing the purification works and plant with the direct sunlight for its growth and nourishment.

Step 3

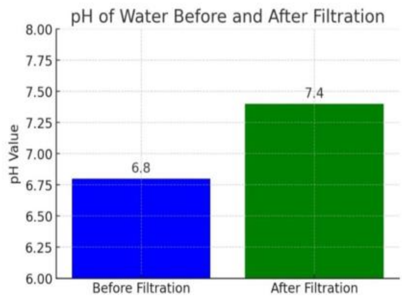
After all the arrangements plants were allowed to float on the grey water for the purification process. Step 4

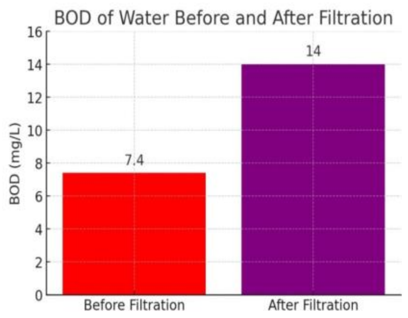
Figure 9: Aeration Process

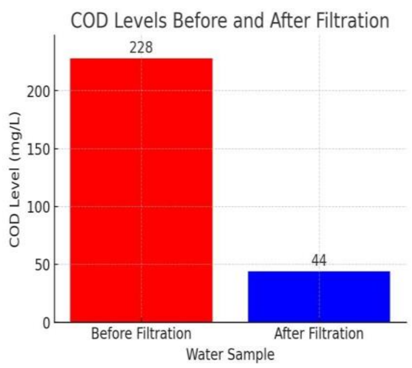
Aerator was employed to improve the oxygen content of the grey water; it also aids in the growth of the plant's roots. For 7 days, aeration was performed for 15 minutes in the afternoon and evening

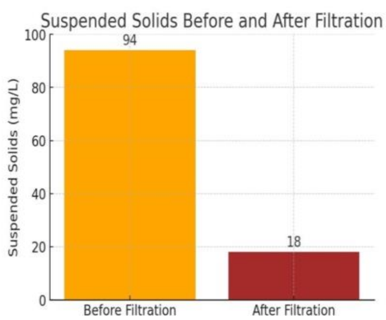
RESULT AND DISCUSSION

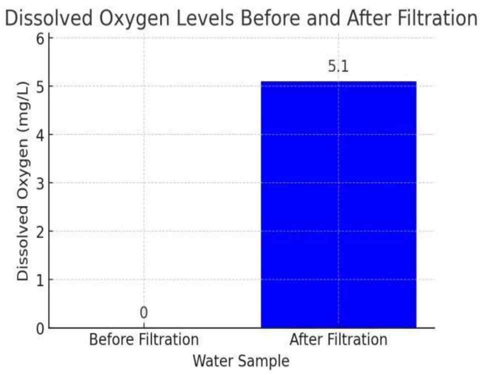
After the model set put, daily sample was taken out for the testing of results both for with and without aeration, the source of grey water was same for both with and without aeration process. The results are as follows

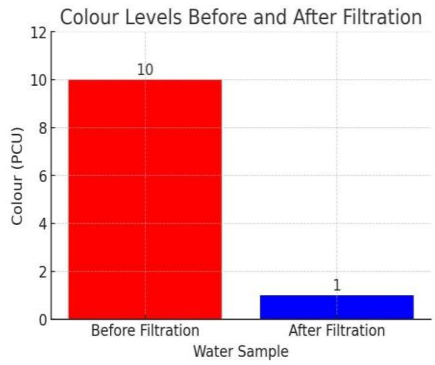


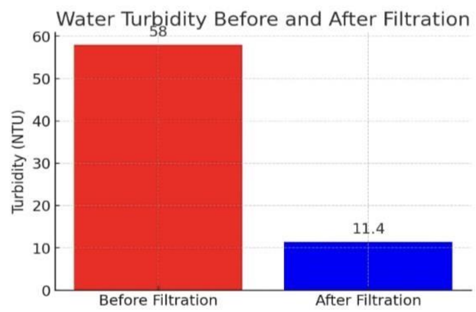


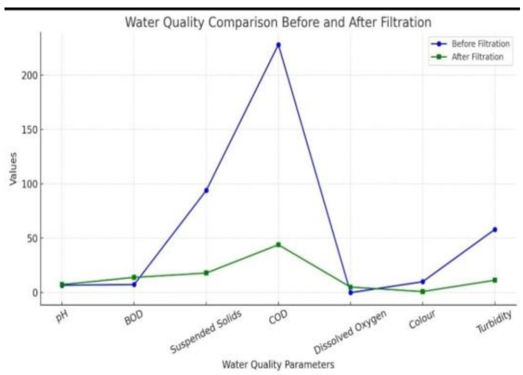












CONCLUSION

Finally, the results of our research show that Canna Indica is a great plant for grey water purification. When given enough sunshine and space to flourish, our studies show that this plant is more successful than other plants at eliminating contaminants from grey water. Canna Indica has the potential to play a critical role in improving grey water quality and lowering environmental pollution due to its high transpiration rate and capacity to absorb heavy metals and organic chemicals. As a result, we advocate more research and testing of Canna Indica as a natural, costeffective approach for grey water treatment.

We studied the effectiveness of utilizing Canna Indica to remediate greywater in this experiment. Our findings revealed that when greywater was treated with Canna Indica, many water quality indices such

As pH, turbidity, total solids, chlorine concentration, residual chlorine, BOD, COD, and dissolved oxygen improved significantly.

The Canna Indica plants were successful in removing organic and inorganic contaminants from greywater, resulting in substantial reductions in turbidity, total solids, BOD, and COD. Furthermore, the plants were excellent in removing chlorine and increasing the dissolved oxygen content in the treated water, both of which are required for a healthy aquatic habitat.

Overall, our findings show that Canna Indica is a very successful plant for treating greywater and may be utilised as a natural and sustainable wastewater treatment option. More study is needed to discover the best conditions for Canna Indica growth and water treatment efficiency in order to assess its viability as a broad application for greywater treatment.

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