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Phytoremediation of Grey Water

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Abstract*: Greywater, generated from domestic activities excluding toilet waste, presents a significant challenge for water management due to its diverse contaminants and potential environmental impact. Conventional treatment methods often fall short in addressing the complex composition of greywater while maintaining sustainability. Phytoremediation, a green technology that utilizes plants and their associated microorganisms, offers a promising and ecofriendly alternative for greywater treatment.*
This paper reviews the principles, mechanisms, and applications of phytoremediation in the context of greywater treatment. Various phytoremediation techniques such as rhizofiltration, phytoextraction, and phytodegradation are discussed, highlighting their efficacy in removing pollutants such as organic matter, nutrients, pathogens, and heavy metals from greywater. The role of specific plant species with remediation potential and their physiological mechanisms in contaminant uptake and transformation are examined.
Case studies and experimental findings from greywater phytoremediation projects around the world are presented to demonstrate the practicality and effectiveness of this approach. Factors influencing phytoremediation performance, including plant selection, hydraulic conditions, nutrient availability, and system design, are analysed to optimize greywater treatment efficiency.

Keywords: Greywater management, Plant-based greywater treatment, Greywater quality improvement, Greywater reuse

I. INTRODUCTION

Phytoremediation is an environmental cleanup technique that uses plants to remove, degrade, or contain pollutants from soil, water, or air. The term combines "Phyto," meaning plant, with "remediation," indicating a process of correction or removal of contaminants.

There are different types of phytoremediation, depending on the specific process and pollutants involved:

Phytoextraction: Plants absorb contaminants from soil or water through their roots and accumulate them in their tissues. This approach is commonly used to remove heavy metals.

Phytodegradation: Plants break down contaminants through metabolic processes, converting them into less harmful substances.

Phytostabilization: Plants are used to stabilize contaminated sites, preventing the spread of pollutants through erosion or leaching. -Phytovolatilization: Plants absorb volatile pollutants and release them into the atmosphere in a less harmful form.

Rhizofiltration: Plant roots are used to filter contaminants from water.

II. LITERATURE REVIEW

Sr. No	Project Title	Methodology	Conclusion
1.	Phytoremediation of samples extracted from wastewater plants and treatment of their socioeconomic impact 2020 Hayfa Rajhi, Anouar Bardi.	The physio-chemical and bacteriological quality was evaluated in wastewater samples before and after treatment by microalgae	Decrease in the quantity of mineral salts and phosphorus in the treated wastewater. These elements were assimilated by microalgae during their growth.

		enrichment.	In addition, the heavy metal contents were completely eliminated after the enrichment of the microalgae culture. very significant fall in coliforms, faecal streptococci and Pseudomonas.
2.	Verm filtration as a natural, sustainable and green technology for environmental remediation: A new paradigm for wastewater treatment process 2021 Sudipti Arora a, Sakshi Saraswat b	Verm filtration is an extension of soil filtration or a biofilter with earthworms to speed up the decomposition processes, to utilize organics to produce fresh manure which can be utilized in agriculture to support healthy plant production. Wastewater passes throughthe active layer, where the organic matter is converted into humus vermicompost enriched by the earthworms.	Earthworms change the properties of biofilm present in the active layer by their burrowing activity and ingestion. They also help in the degradation of organic matter by symbiotic and synergistic reactions into reactions with the indigenous microbes. It has beensuccessfully applied for the treatment of municipal and industrial sewage.
3.	Phytoremediation Potential of Macrophytes of Urban Water Bodies in Central India 2019 Sandeep K. Pandey.1 Ritambhara Upadhyay 2 K.	A field sampling-based study was conducted to analyse water quality, heavy metals and bioconcentration and bioaccumulation in the roots and shoots of naturally growing vegetation in an urban lake, Laxmi Taal. The lake receives domestic sewage from Jhansi city in Central India	The present study examined naturally growing vegetation in a domestic wastewater receiving lake, Laxmi Taal, in Jhansi, and indicated that parameters of wastewater in the lake were within the prescribed limit of water quality standard IS- 2296 grade-D water. The bioconcentration factor study revealed that all of the values were approaching 1 or 1, thus T. angustifolia and E. Cassius are primary bio accumulator plants.
4.	Ecological and Economic Potential of Major Halophytes and Salt Tolerant Vegetation in India-2020 V. Vineeth, Shravan Kumar	Halophytes identification study and	halophytes and other saline vegetation have paramount importance to ensure economic returns and maintain ecological balance, India has a very rich source of halophytic, mangrove and other saline vegetation which has huge potential in monetary as well as environmental terms.
5.	Performance Evaluation of Three Different Grasses for Use as Willows in Greywater Treatment in Semi-arid	The grasses were watered daily with 1.5L of greywater collected from a hall of residence on the	The results indicated that only the effluent from lemon grass met the WHO guideline value of 50mg/1 for wastewater. Removal

	Ghana ADONADAGA TAKRAMAH -2020- M-G,	university campus	efficiency for TDS was between 70% and 84% while that for the nutrients ranged between 8% and 81%. Overall, lemon grass had the highest removal efficiency followed by elephant grass and then giant blue stem.
6.	Sustainable wastewater treatment via phytoremediation: Current status and future perspectives-2020: Hao Hua, Xiang Li	Comparing traditional and phytoremediation methods	latest advances in the development of phytoremediation of different types of livestock wastewater, and the characteristics and hazards. phytoremediation of livestock wastewater is a remarkable and sustainable management approach.
7.	Recent studies applications of aquatic weed plants in phytoremediation of wastewater: A review 2020: article Hauwa M. Mustafa a, Gasim Hayder	s. Phytoremediation technique is a branch of bioremediation that employs the application of plants for the remediation of wastewater. Aquatic plants have the capacity to absorb excess contaminants such as organic and inorganic, heavy metals, and pharmaceutical pollutants present in agricultural, domestic and industrial wastewater. Among the aquatic plants, Salvinia molesta and Pistia stratiotes have been widely used	Phytoremediation is a promising technique employed to remove or recover excess nutrients from polluted water. The application of aquatic plants in sephytoremediation of wastewater is beneficial because they have tremendous capacity to absorb and degrade pollutants (nitrates, phosphates, heavy metals etc.) from wastewater.
8.	Efficiency of Five Selected Aquatic Plants in Phytoremediation of Aquaculture Wastewater 2020: Nurul Umairah Mohd Nizam 1. Marlin Mohd Hanafiah 1	phytoremediation study examined the ability of five aquatic plants Cantele asiatica, Ipomoea aquatica, Salvinia molest, Eichhornia crassipes, and Pistola stratiotes to remove three pollutants total suspended solids (TSS), ammoniacal nitrogen (NHN), and phosphate from aquaculture wastewater	The removal rates of TSS, NH-N, and phosphate were determined by using five selected aquatic plants as phytoremediation agents. These plants were chosen due to their great ability in removing pollutants from various wastewater. As stated by Manan et al., C. asiatica leaves, roots, and stems are good pollutant accumulation agents. Since it needs extra nutrients, such as zinc and lead, for biochemical processes, especially photosynthesis, the roots actively translocate nutrients to the leaves, making C. asiatica an efficient

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			phytoremediation agent.
9.	PHYTOREMEDIA TION IN SEWAGE TREATMENT-201 9: Harshal Patil, Saurabh Shukla	Sewage From Common Effluent Treatment Plant (CETP). Thane-Belapur Association has been selected to treat. Depending on the characteristics of wastewater, two plants have been selected, namelyDuckweed and Water Hyacinth Combined	From the studies mentioned above, it could be concluded that 2 numbers of plants can be used to treat wastewater effectively with optimum HRT of 2 days. Hence 5 plants can be effectively used to treat 10 litres of waste water with 100% dilution.
10.	Adsorption Phytoremediation System for Treatment of Laundry Wastewater-2019 Eko Siswoyo, Andiny Widya Utari	The combination adsorption and phytoremediation system used in the current study	Based on the results of the current study, it could be concluded that adsorption combined with a phytoremediation system could remove COD, phosphate, and surfactant up to 77.5%, 54.3%, and 99.9%, respectively.

III. METHODOLOGY

Selection Plant Species:

Plant Selection Criteria: Water hyacinth, Cymbopogon, and Typha were chosen based on documented phytoremediation capabilities

Water Hyacinth

Typha

Cymbopogon

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Experimental Setup:

Design of Experimental Setups: -

Design: Tanks with the following dimensions are used:

Length: 2ft 7in, **Breadth**: 1ft 1in, **Height**: 1ft 4.5in.

Construction: 3 chambered treatment processes is incorporated as an assembly of drums and pipe-network.

Settling tank- Opaque plastic drum with top opening with lead is used and has provisions for sludge outlet.

Phytoremediation chamber- - At the bottom, we placed a 4 cm layer of charcoal.

- Above that, there's an 8 cm layer of coarse aggregate.
- Finally, on top, we added an 8
cm layer of sand.

Collecting tank- Water after phytoremediation is released in the collecting tank.

Fig: Phytoremediation setup

Fig: Phytoremediation chamber

Working of remediation unit

To improve the original remediation process, incorporating an initial screening step for coarse solids and updating the sedimentation tank setup, along with a more comprehensive filtration system, is an excellent adjustment. Here is an updated version of the process:

1. Coarse Screening: Greywater from kitchen sinks, bathrooms, and clothes and utensils washing is first passed through a coarse screening process. This step removes floating solids and large debris, like food particles, and other materials, to prevent clogging in subsequent stages.
2. Sedimentation Tank: After screening, the greywater enters a sedimentation tank. The tank is designed to allow particles to settle due to gravity, forming a sludge layer at the bottom. This step can last several hours, typically between 4 to 24 hours, depending on the level of suspended solids in the water. The clearer water, called supernatant, remains above the sludge.
3. Phytoremediation Chamber: The clear supernatant is then passed to the phytoremediation chamber, a critical treatment unit with a multi-layered filtration system. This system contains:

Bottom Layer (4 cm of Charcoal): Charcoal acts as an adsorbent, removing impurities and Odors from the greywater.

Middle Layer (8 cm of Coarse Aggregate): This layer provides structural support and facilitates water flow while filtering larger particles.

Upper Layer (8 cm of Sand): Sand acts as a fine filter, removing smaller particles from the water.

4. Phytoremediation Process: In the same chamber, water plants such as Water Hyacinth, Clitoris Ternate and Typha are planted. These plants play a key role in the phytoremediation process, absorbing nutrients, breaking down contaminants, and providing additional filtration through their root systems. The water is allowed to flow through this chamber and interact with the plants.
5. Supervision and Rotation: The phytoremediation process involves a cycle of supervision and plant growth. In this setup, plants are monitored for 16 days in the first chamber, then rotated to a second chamber for another 16 days. This

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cycle ensures optimal plant growth and nutrient absorption, and it allows for efficient rotation and maintenance of the system.

6. Treated Water Collection: After passing through the phytoremediation chamber, the treated water is collected for further use or safe discharge. This water can be used for irrigation, landscaping, or other non-potable applications, contributing to water conservation.

Observation

Phytoremediation using Water Hyacinth

The project commenced with the planting of water hyacinth in the filter media tank.

The plants were allowed to grow and remediate the grey water for a period of 16 days. Regular checks were conducted to monitor the water level, growth of roots, leaves, and flowers on the water hyacinth plants. Significant growth was observed in the roots, leaves, and flowers of the water hyacinth plants. The plants exhibited signs of healthy growth and adaptation to the grey water environment.

On the 17th day of the project, water was transferred from Tank 1 to Tank 2 using a valve/pipe, and water hyacinth plants were carefully shifted to continue the phytoremediation process. Prior to the transfer, measurements such as weight, size, root length, and leaf count of the water hyacinth were taken to gauge their growth and effectiveness in treating the greywater. These parameters serve as key indicators of plant health and performance. The plants continued their remediation activities in Tank 2 for an additional 16 days, with regular monitoring to track their progress and assess the water quality. Observations during this period showed that the water hyacinth successfully adapted to the new environment and demonstrated signs of growth and vitality. The initial data suggest that the plants are effectively removing contaminants from the greywater, indicated by physical changes in the plants and noticeable improvements in water quality.

Phytoremediation using Water Hyacinth

Water Hyacinth Observation

WATER HYACINTH	Before Plantation	After 16 Days	After 32 Days
Plant Weight	837 grams	1033 grams	1800 grams
Leaves Length	3-4 cm	5-7 cm	7-8 cm
Roots Length	2-3 cm	9-10 cm	9-10 cm

Treated water sample Report

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Phytoremediation using Typha

The project aimed to use Typha, a common wetland plant, to remediate greywater over a 10-day period. The objective was to assess Typha's effectiveness in treating greywater by monitoring plant growth and remediation capabilities.

Observations

After 3-4 days of planting, the Typha plants were observed to be in a dry state.In response to the dry state, the water level was increased and the plants were observed for another 3-4 days. Despite the increased water level, there was no significant growth or recovery in the plants.

Phytoremediation Using Typha

Phytoremediation using Cymbopogon

The project focused on using Cymbopogon also known as ***lemon grass*** to remediate greywater over a 30-day period. Initially, the plants were grown in a filter media tank for 15 days, with regular monitoring of water levels, root growth, leaves, and flowers. The plants showed healthy growth and adaptation to the greywater environment.

On the 16th day, water was transferred from Tank 1 to Tank 2 using a valve/pipe, and the Clitoris Ternate plants were carefully moved. Prior to the transfer, measurements such as weight, size, root length, and leaf count were taken to track growth and effectiveness in treating greywater.

In Tank 2, the plants continued their remediation for another 15 days. Monitoring showed that the Clitoris Ternate adapted well and displayed healthy growth, suggesting effective contaminant removal. The observed improvements in water quality indicated that Clitoris Ternate can be a valuable option for phytoremediation, offering effective treatment along with aesthetic appeal due to its vibrant flowers.

Cymbopogon	Before Plantation	After 16 Days	After 32 Days
Plant Weight	652 grams	876 grams	1230 grams
Leaves Length	20-25 cm	28-30 cm	35-40 cm
Roots Length	5-6 cm	8-9 cm	9-10 cm

Result of Grey Water

Parameter	Greywater	Treated Water Using Water Hyacinth	Treated Water Using Lemon Grass
Calcium	187mg/l	80mg/l	87mg/l
Chloride	286mg/l	90mg/l	86mg/l
Colour	Clear	Blackish	Clear
ElectricalConductivity	3640us/cm	1619us/cm	640mg/l
Fluoride	0.98mg/l	0.98mg/l	0.98mg/l
Magnesium	110mg/l	43.74mg/l	46mg/l
Nitrate	1mg/l	1mg/l	1mg/l
pH	6.8	6.8	6.8
Total Dissolved Solids (TDS)	2333mg/l	1019mg/l	1103mg/l
TotalAlkalinity	464mg/l	204mg/l	233mg/l
TotalHardness	640mg/l	260mg/l	240mg/l
Turbidity	2.3NTU	0.2NTU	0.3mg/l
Iron	0.01mg/l	0.01mg/l	0.01mg/l
Sulphate	74mg/l	48mg/l	50mg/l

IV. CONCLUSION

Comparison of Results

	Conclusion	
Parameter	**Greywater**	**Treated water**
Hardness	High total hardness indicates hard water, which tends to cause scaling.	Lower total hardness suggests softer water, generally more suitable for a wide range of uses without scaling issues.
TDS and Salinity:	High TDS and chloride levels indicate significant dissolved salts, which might cause corrosion in pipes and appliances.	Lower TDS and chloride suggest a broader range of applications, including industrial uses, irrigation
Turbidity:	Turbidity of NTU indicates noticeable cloudiness due to suspended solids.	Turbidity of NTU indicates clear water with minimal suspended particles.
Total Alkalinity	High total alkalinity, suggesting a strong buffering capacity but contributing to hardness.	Has lower total alkalinity, indicating less buffering capacity and possibly lower hardness.
Electrical Conductivity	Has high electrical conductivity, reflecting its high dissolved salt content.	Has lower electrical conductivity, suggesting less

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REFERENCES

[1]. Treatment Of Grey Water Using Technique ofPhytoremediation.Randhir Bute1, Ekta Waghmare2, Ajay Sarode IRJET e-ISSN: 2395 -0056.

[2]. WasteWater Treatment by Phyto-Remediation Technique. Aditya Vikram Chopra, Umang K Shah Andjs Sudarsan at SRM University, Chennai,Tamil Nady, INDIA ISSN 0974-5904, Volume 09, No. 03, June 2016, P.P.393-3

[3]. Phytoremediation and phytostabilization potential of water hyacinth in a tropical wetland.Renuka, C., Prasad, M. N. V., Vithanage, M., & Seneviratne, M. 39(4), 847-859.

[4]. Phytoremediation of industrial mines wastewater using Water hyacinth.Priyanka Saha, Omkar Shinde,Supriya Sarkar, 19:1,87-96,

[5]. Application of aquatic plant–microbial reactors in wastewater treatment.Tiwari, S., & Gupta, A. Journal of Environmental Management, 112, 230-245.

[6]. Effectiveness of typha latifolia for phytoremediation of cadmium in acid mine drainage.Maharani Permata Putri and Setyo SarwantoMoersidik**.** Conf.Ser.1811 012025.

[7]. Low-cost treatment of sewage using root zone technology-2014. Vame Ashok L. and Wagh KK

[8]. Ecological and Economic Potential of MajorHalophones and Salk Tolman Vegetation in India-2020. TV. Vineeth, Shrvan Kumar.

[9]. Purslane Weed (Portulaca oleracea) A Prospective Plant Society of Narration,Omega3 Fatty Acid, and Antonidant Attributes-2013 Md. Kamal Uddin. Abdul Shuker Jursimi.

[10]. Potential of Helanthus annuus for phytoremediation of multiple pollutants in the environment. A Review-2018 Priti Chauhan and Jyoti Mathur

[11]. Application of Wetland System for Treatment of Industrial Wam-2017 Prof Swan Patili, Suraj P. Ahira

[12]. Performance Evaluation of There Differ Grasses Jos Use as Willows in GrzywaterTreatment in Semi-arid Ghana -2020, Adenadaga, M-, rakamah

[13]. Phytoremediation of urban wastewater by model wetlands with ornamental hydrophysis-2006 ZHANG Xiao-bin LII Peng

[14]. Phytoremediation. An ecological solution to organic chemical contamination-2002 Seidhur Susarla a Vicar F. Medina

[15]. Phytoremediation of lead from water wing squame plans-2012: Doya Singh. Archana Tiwari and Richa Gupta

[16]. Perspectives of phytoremediation using water hyacinth for removal of busy metais, organic and inorganic pollutants in wastewater-2015- ShahabaldineRezanaMołunadossPanraj

[17]. Recent studies on applications of aquatic weed plants in phytoremediation of wanewster. A review-2020 article Hausa M. Mustafa, Gasim Hayder

[18]. Bioremediation of aquacultural effluents using bryophytes 2019. Haidara AM, Magami IM, Saruda

[19]. US EPA: 2019 Accessed 21 October 2019 211 Heavy metal uptake potential of aquatic plants through phytoremediation technique review. I BioremediatBiodegrad 2017 Wani RA, Canai BA. Shah MA, Uqab B.

[20]. Perspectives of phytoremediation using water hyacinth for removal of heavy metals, organic and inorganic pollutants in warwater-2015. Shahabuddin Rezanis a, b. Mohanadons Ponraj.