DESIGN AND DEVELOPMENT OF SUSTAINABLE PLANT BASED CELLULOSE FILTERS FOR WASTEWATER PURIFICATION

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Keywords

Water Remediation; Heavy Metals; Cellulose based filters; Bioremediation; Sustainable water treatment methods. *Eichhornia crassipes.*

Introduction

Water pollution poses a significant global challenge, with half of the world's population expected to face water-stressed demand by 2025. Lack of access to clean drinking water affects 785 million people worldwide. Various pollutants, including toxic gases like sulfur oxides, contaminate water sources, while sea and ocean waters are tainted with heavy metals, microplastics, and organic molecules. Governments, organizations, and communities invest heavily in water treatment infrastructure to ensure clean water access, particularly in developing regions. Sustainable water treatment methods prioritize resource efficiency and environmental impact reduction, utilizing natural and eco-friendly techniques. *Eichhornia crassipes*, or water hyacinth, offers promise for bioremediation due to its pollutant-absorbing properties, especially in managing nutrients and heavy metals. Harvesting and processing water hyacinth into cellulose-based filters or pellets provide innovative solutions for water remediation. Integration of water hyacinth-derived cellulose in ex-situ treatment systems enhances efficiency, offering a holistic approach to addressing water pollution challenges.

Objectives

- Collection of Plant Sample (Water hyacinth)
- Extraction of cellulose by chemical method
- Extraction of cellulose fibres using water hyacinth stem
- Removal of residual components with ethanol
- Bleaching to remove natural colour
- Preparation of Filter

Methodology:

The process of extracting cellulose from water hyacinth involves harvesting the plant and separating its components, followed by chemical treatment to remove debris and microbes. The plant material is dried, ground into powder, and chemically treated with Sodium Hydroxide, Sodium Hypochlorite, and Hydrogen Peroxide to bleach the cellulose. Phosphorylation enhances its properties for heavy metal binding. Cellulose fibres are obtained by drying the plant, soaking it in Hydrogen

Peroxide, and boiling to separate fibres from the stem's fleshy part, maintaining flexibility. Filter paper preparation involves mixing phosphorylated cellulose with water to create a slurry, adding natural resin for stability, pressing the slurry between layers of cloth on a sieve, and drying to obtain the filter paper. This meticulous process ensures the production of effective and sustainable filter paper from water hyacinth, offering a biodegradable solution for water remediation and pollution control.

Fig. 1: Extraction of cellulose and Fibres from Water Hyacinth

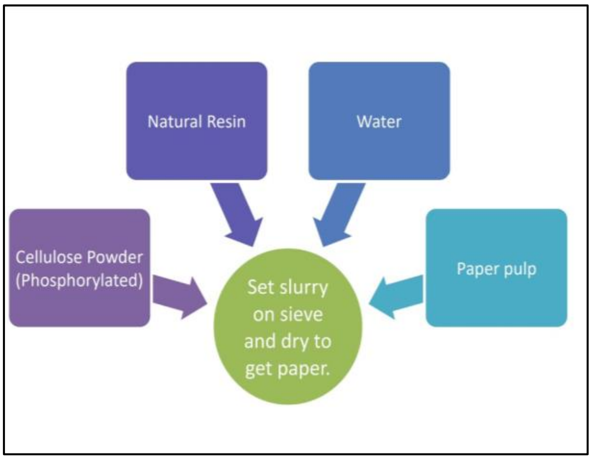

Fig. 2: Production of Filter Paper

Result and Conclusion

The project focuses on developing sustainable plant-based cellulose filters to purify wastewater, thereby improving water quality by eliminating contaminants and pollutants. By utilizing plant-based materials, the project contributes to environmental sustainability, reducing reliance on synthetic materials and minimizing ecological footprints in wastewater treatment. The implementation of cellulose filters offers a cost-effective solution for wastewater purification, potentially lowering operational costs while maintaining high efficiency. Resource conservation is promoted using renewable materials, reducing waste generation, and contributing to the circular economy in wastewater management. Purified water from cellulose filters enhances public health by minimizing harmful contaminants, ensuring safer water for drinking, agriculture, and industrial processes. The project's outcomes positively impact communities by providing access to cleaner water resources, enhancing overall well-being, supporting sustainable development, and building resilience against water-related challenges.

Innovation in the project

Water hyacinth is a weed that has high growth rate and is invasive in nature that is harmful to the environment. The use of water hyacinth as a source material for the cellulose used in the production of the filter is a novel approach. Moreover, the active use of the nature of water hyacinth i.e., its natural affinity to bind to heavy metals and many other complex molecules of chemical and biological nature, to produce a filter with high efficiency of pollutant removal has high value for economically efficient use of resources.

Future work scope

The research on cellulose-derived materials for water treatment presents promising avenues for addressing key challenges in industrial-scale water purification. Further investigations are warranted to transition from laboratory-scale to industrial-scale production of plant-based cellulose filters, leveraging the abundance and cost-effectiveness of cellulose as a bioresource. Specifically, future efforts should focus on optimizing production methods to meet the demands of large-scale water treatment facilities. Moreover, the potential of water hyacinth fibres in removing heavy metal ions, dyes, and oil from water underscores the need for comprehensive studies to understand their efficacy and scalability in real-world applications. Research into microbial-based biosurfactants incorporated into cellulose filters offers a novel approach to enhancing oil removal efficiency, with implications for oil spill remediation and wastewater treatment. Additionally, exploring the antimicrobial properties of water hyacinth fibres presents a valuable future direction, with opportunities to further improve the filters' capacity for reducing microbial contamination in wastewater. By advancing these areas of research, the development of sustainable and effective cellulose-based filters for industrial-scale water treatment can be accelerated, contributing to the preservation of water quality and ecosystem health for generations to come.