“ Removal of Excess Dye Using Biochar from Baby Coir”

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Abstract

Environmental pollution caused by the excessive use of synthetic dyes in industries has become a significant concern due to their toxic effects on ecosystems and human health. This study investigates the use of biochar derived from baby coir, an agricultural waste product, as a sustainable and cost-effective adsorbent for removing excess dyes from aqueous solutions. By optimizing pyrolysis conditions, characterizing the biochar’s physicochemical properties, and studying adsorption efficiency, the research evaluates its performance with various dye types (reactive, acidic, and basic). Results demonstrate that baby coir biochar is highly effective, eco-friendly, and economically viable for wastewater treatment, contributing to sustainable waste management and environmental protection.

1.Introduction

The discharge of synthetic dyes into water bodies from industries such as textiles, paper, and cosmetics has led to widespread environmental contamination. These dyes are often toxic, non-biodegradable, and resistant to conventional wastewater treatment methods. This study explores biochar derived from baby coir, an underutilized agricultural residue, as a cost-effective adsorbent for dye removal. The project aims to address two critical challenges: reducing dye pollution and valorizing agricultural waste.

2. Literature Review

Several studies emphasize the potential of biochar as an adsorbent for dye removal, given its porous structure, large surface area, and functional groups. Existing research highlights the effectiveness of biochar produced from rice husks, coconut coir, and other agricultural residues. However, challenges remain in scaling up production and optimizing adsorption parameters for various dyes. This study aims to bridge these gaps by focusing on baby coir biochar for textile wastewater treatment.

3. Materials and Methods

3.1 Preparation of Biochar

Baby coir was converted into biochar through pyrolysis under limited oxygen conditions. The process parameters, including temperature and residence time, were optimized to enhance adsorption properties.

3.2 Adsorption Studies

- Dye Solutions: Solutions of reactive, acidic, and basic dyes were prepared at varying **concentration(5 PPM)**
- Adsorption Tests: amount of biochar (1 and 3%) was mixed with 1000 mL of dye solution. The mixture was stirred for specified durations at room temperature.

- Optimization Parameters: pH, contact time, adsorbent dose, and dye concentration were varied to determine the optimal adsorption conditions.

3.3 Characterization Techniques

The biochar's properties were analyzed using techniques such as spectroscopy,scanning electron microscopy (SEM) for surface morphology and Fourier-transform infrared spectroscopy (FTIR) for functional groups, Field Emission Scanning Microscope (FESEM), X-Ray Diffraction (XRD), Energy Dispersive X-ray analysis (EDAX).

4. Results and Discussion

4.1 Adsorption Efficiency

The baby coir biochar exhibited excellent adsorption capabilities across all tested dye types, with efficiency influenced by pH, contact time, and adsorbent dosage. Reactive dyes showed maximum adsorption at neutral pH, while acidic and basic dyes exhibited peak performance at acidic and basic pH levels, respectively.

4.2 Regeneration and Reusability

The biochar maintained high adsorption efficiency after multiple regeneration cycles, underscoring its economic feasibility for long-term use.

4.3 Comparative Analysis

When compared to conventional adsorbents like activated carbon, baby coir biochar demonstrated superior performance due to its lower cost and sustainable production.

5. Conclusion

This study highlights the potential of baby coir-derived biochar as a low-cost, sustainable, and effective adsorbent for dye removal. Its high adsorption efficiency, coupled with the ability for regeneration, makes it a viable alternative to conventional methods. Future research should focus on scaling up the process, testing with real industrial effluents, and enhancing biochar performance through surface modifications.

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