Sustainable Adsorption of Textile Dyes Using Agricultural Waste

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*Note: All diagrams/images created by author unless otherwise noted

Research Question

Problem: Industrial wastewater, especially from textile industries, releases harmful synthetic dyes like methylene blue into aquatic systems.

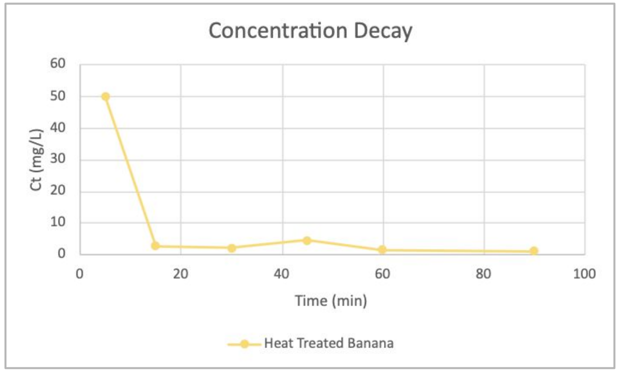
Research Question: Does thermal heat-treatment and magnetization improve the adsorption efficiency of agricultural byproducts for removing methylene blue dye from water?

Aim: To improve dye removal from water using heat-treated and magnetized agricultural byproducts.

Hypothesis: Heat-treated biochar, made from agricultural byproducts, will demonstrate higher adsorption capacity than raw powder while magnetization will allow for easy removal.

Hou Min, et al.

Data Analysis & Results



- ➢ Graphs were created by plotting adsorption of MB across six different experimental groups.
- ➢ On the left is an example of the concentration of dye left after the magnetized, heat treated banana
- ➢ Residual concentration stayed below 5 mg/L

Methodology

- ➢ Prepare agricultural byproducts (e.g., banana peels, potato peels, or similar biomass), wash, dry, and grind into fine powder
- ➢ Heat-treat a portion of the powder at 400–500°C for 2 hours to create biochar, store in airtight containers
- ➢ Mix biochar with Fe_3O_4 (iron III) nanoparticles using chemical co-precipitation, dry and magnetize for easy separation
- ➢ Prepare methylene blue dye solutions at known concentrations, add measured amounts of raw powder, thermal biochar, or magnetized biochar, stir for fixed intervals at room temperature
- ➢ Measure dye concentration using UV-Vis spectrophotometry at 665 nm

Interpretation & Conclusions

- ➢ This project demonstrates that **agricultural byproducts** can be transformed into **highly efficient bioadsorbents** for removing methylene blue dye from water.
- ➢ Thermal treatment reduced moisture content and increased carbon content, enhancing **binding affinity** for cationic dyes, confirming that pyrolysis significantly enhances surface area and active sites.
- ➢ Magnetization **improves recovery**, making the process more scalable
- ➢ The combination of heat-treatment and magnetization offers a scalable, resource-efficient strategy for rapid industrial dye remediation