Repurposing the Allergenic Weed *Parthenium hysterophorus* as a Carbon-Based Filter for Pharmaceutical Contaminant Treatment

Category: Environmental Engineering

1. Abstract

Pharmaceutical residues in water create a need for treatment materials that can make use of unwanted plant biomass. *Parthenium hysterophorus* is a problematic weed associated with allergic contact dermatitis. This study evaluated its carbonized biomass as a filter-paper coating, using ciprofloxacin as the test pharmaceutical. The objective was to determine whether the coated filter could produce a measurable change in the UV-visible signal during flow-through filtration. Carbon was prepared using a choline chloride-ferric chloride deep eutectic solvent and solvothermal treatment at 200°C for 18 hours. Approximately 15 mg of carbon was dispersed in ethanol, sonicated and deposited onto Whatman Grade 41 paper by vacuum filtration. A 25 mL ciprofloxacin feed at a nominal concentration of 100 mg/L passed through the coated paper in 9 minutes 30 seconds. Initial and filtrate samples were analysed by UV-visible spectroscopy after identical twofold dilution. At 272 nm, absorbance decreased from 2.190 to 1.368, corresponding to a 37.5% relative absorbance decrease. Lower absorbance was also observed across neighbouring principal-band wavelengths and at 320 nm. FTIR was used to characterize the prepared carbon, with band regions consistent with O-H, aliphatic C-H and C-O vibrations. These preliminary findings establish an optical screening result for the coated-filter system. Follow-up experiments will compare coated and uncoated paper, repeat the measurements and vary feed concentration and coating amount. The approach links the reuse of an undesirable weed with a measurable method for developing pharmaceutical-contaminant treatment.

2. Introduction and Objective

Pharmaceutical residues enter waterways through medicine manufacture, use and disposal. A global river survey found concentrations exceeding aquatic-effect or antimicrobial-resistance concern thresholds at 25.7% of sampled sites [2]. *Parthenium hysterophorus* presents a second challenge: the untreated weed is associated with allergic contact dermatitis [3]. Converting this plant into carbon provides a way to investigate material reuse alongside water treatment. The objective was to prepare a carbon coating on filter paper and determine whether passage of a ciprofloxacin feed produced a measurable decrease in UV-visible absorbance. The working hypothesis was that the coated filter would lower the measured signal. Further objectives are to evaluate coating amount and feed concentration, compare coated and uncoated supports, and extend testing to additional pharmaceutical preparations.

3. Innovation

This project repurposes biomass from the allergenic weed *Parthenium hysterophorus* as a carbon coating for pharmaceutical-contaminant treatment. Its central idea is to turn an undesirable plant into a useful water-treatment material, combining biomass reuse with a simple flow-through filter. Washed solvothermal carbon is used directly on paper, without additional high-temperature activation or metal-oxide modification. The coating brings the carbon into contact with a ciprofloxacin feed during filtration. The project examines this pharmaceutical-focused application and aims to improve performance by varying feed concentration and coating amount.

4. Methodology

Carbon was prepared following the published solvothermal method [1]. Leaf powder (2 g) was combined with 4 g deep eutectic solvent (choline chloride:$FeCl_3$, 1:2 molar ratio), heated at 80°C for 1 hour, and added to 50 mL distilled water. The mixture was treated in a Teflon-lined autoclave at 200°C for 18 hours and cooled to room temperature. Recovered solid was washed three times with 1 M HCl, three times with distilled water and twice with ethanol-water (4:6), then dried at 80°C overnight. Approximately 15 mg carbon was dispersed in 20 mL ethanol, sonicated in two 15-minute cycles, and deposited on Whatman Grade 41 paper by vacuum filtration. One Ciprodac 500 tablet labelled Ciprofloxacin Tablets IP 500 mg was crushed and made up to 100 mL with water, giving a nominal 5000 mg/L stock based on labelled content. A 0.5 mL aliquot plus 24.5 mL deionised water produced a 25 mL, 100 mg/L feed. The entire feed was filtered in approximately 570 seconds. Each initial and filtrate measurement sample contained 1 mL sample plus 1 mL water. Exported UV-visible spectra from the Shimadzu UV-1900 covered 200-800 nm at 2 nm intervals. Matched-wavelength percentage absorbance decreases were calculated. FTIR characterized the carbon using a KBr pellet.

5. Results and Conclusions

At 272 nm, initial and filtrate absorbance were 2.190 and 1.368, respectively, giving a 37.5% relative decrease. Decreases at 270 and 274 nm were 35.1% and 38.6%; at 320 nm, absorbance changed from 0.810 to 0.535, or 34.0%. FTIR band regions were consistent with O-H, aliphatic C-H and C-O vibrations. The preliminary run showed a lower optical signal after filtration and supports further evaluation of the coated-paper system. The percentage describes absorbance change rather than calibrated drug removal. Follow-up work will include independent repeats, an uncoated-paper control, a coated-paper water blank, concentration calibration and variation of feed concentration and coating amount. Tests with Benadon, Citzen and other pharmaceutical preparations are underway; their results are pending.

6. Acknowledgement and References

The project mentor and laboratory team are acknowledged for supervision, facilities and technical guidance. Published carbon preparation and background research are credited below.

[1] Yadav et al. (2020). Biomass-derived carbon helices induced phase transition in poly(N-isopropylacrylamide). https://doi.org/10.1016/j.colsurfb.2019.110637

[2] Pharmaceutical pollution of the world's rivers (2022). https://doi.org/10.1073/pnas.2113947119

[3] Seasonal Variation in Contact Hypersensitivity to Parthenium in Patients of Parthenium Dermatitis (2016). https://doi.org/10.4103/0019-5154.174026