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Enhanced Copper Ion and Methylene Blue Adsorption by Green Biobased Hydrogels Reinforced with *Huangshui* Polysaccharides

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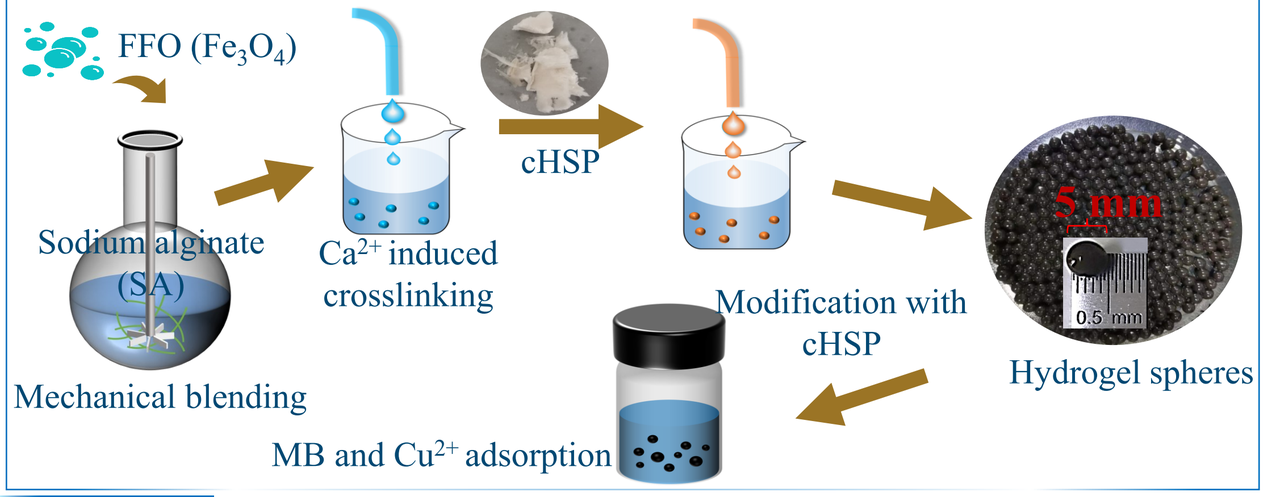
Abstract

To address methylene blue and Cu^{2+} pollution, this study developed enhanced biobased hydrogels by incorporating a polysaccharide (cHSP) extracted from *Huangshui* (HS)—a waste from Baijiu production. The cHSP-composite showed improved physicochemical properties, high adsorption capacities (87.43 mg/g for MB; 67.89 mg/g for Cu^{2+}), and excellent reusability, demonstrating a sustainable "waste-treats-waste" approach to water purification.

Experimental Design



Results

1. Structure Analysis: The incorporation of cHSP into the superparamagnetic SA/FFO matrix via hydrogen bonding improved its thermal stability.

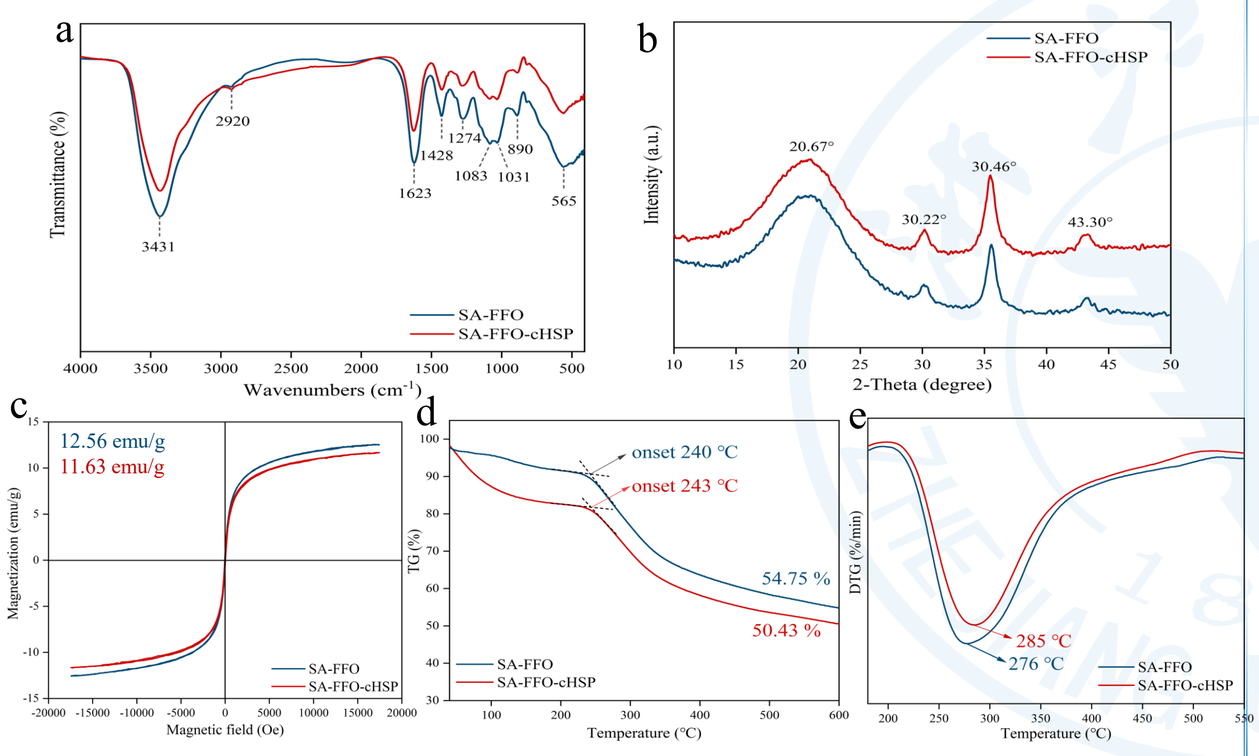


Fig. 1. FTIR (a), XRD (b), VSM (c), TG (d) , and DTG (e) .

2. Hydrogel Morphology: The incorporation of cHSP was responsible for constructing a stable 3D network with enhanced porosity.

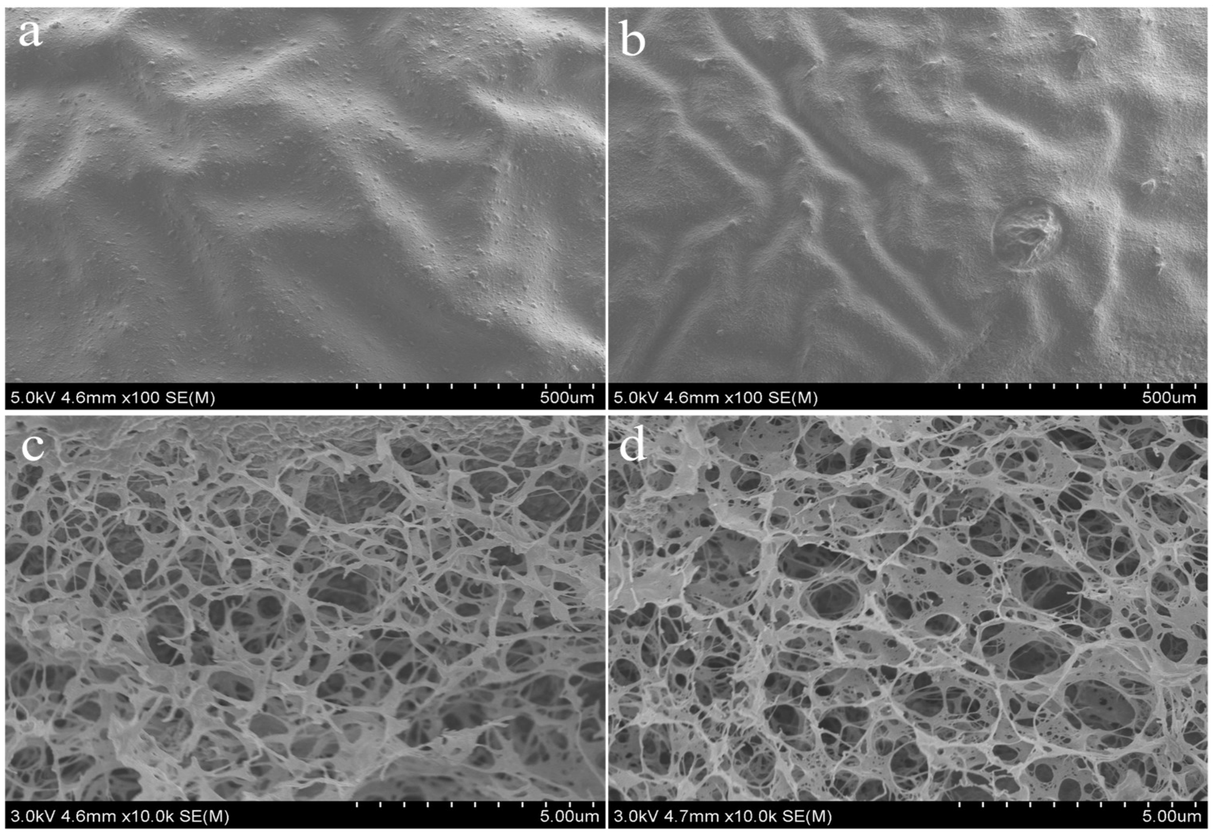


Fig. 2 . SEM images of SA-FFO and SA-FFO-cHSP for surface (a, b) and cross-section (c, d).

3. Capacity Enhancement: cHSP enhanced the hydrogel's adsorption capacity for MB (78.73 → 87.43 mg/g) and for Cu^{2+} (59.10 → 67.89 mg/g).

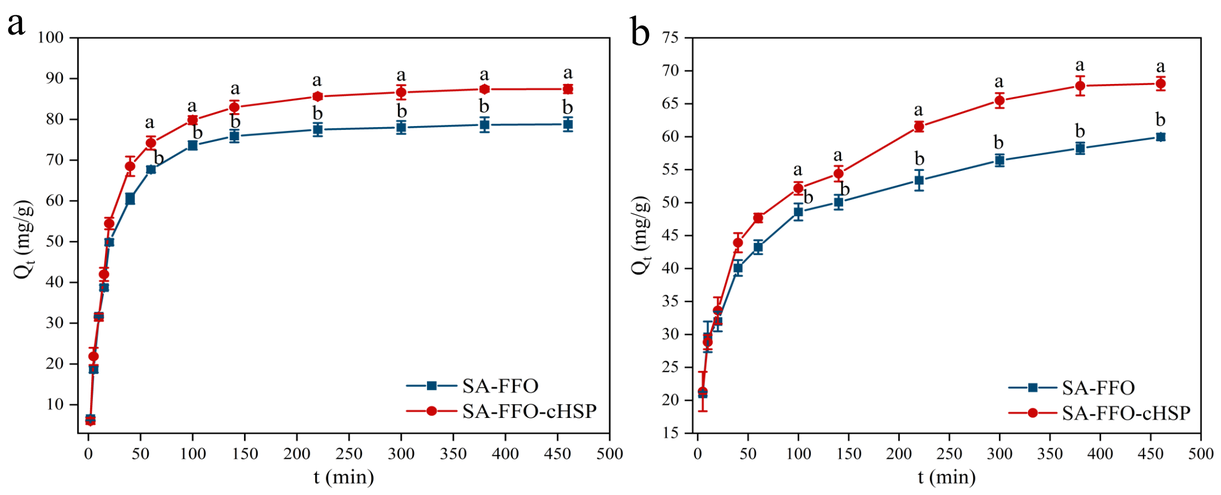


Fig. 3 Adsorption kinetics of the hydrogels for MB (a) and Cu^{2+} (b).

4. Adsorption Mechanisms: MB and Cu^{2+} adsorption on the hydrogels via chemisorption.

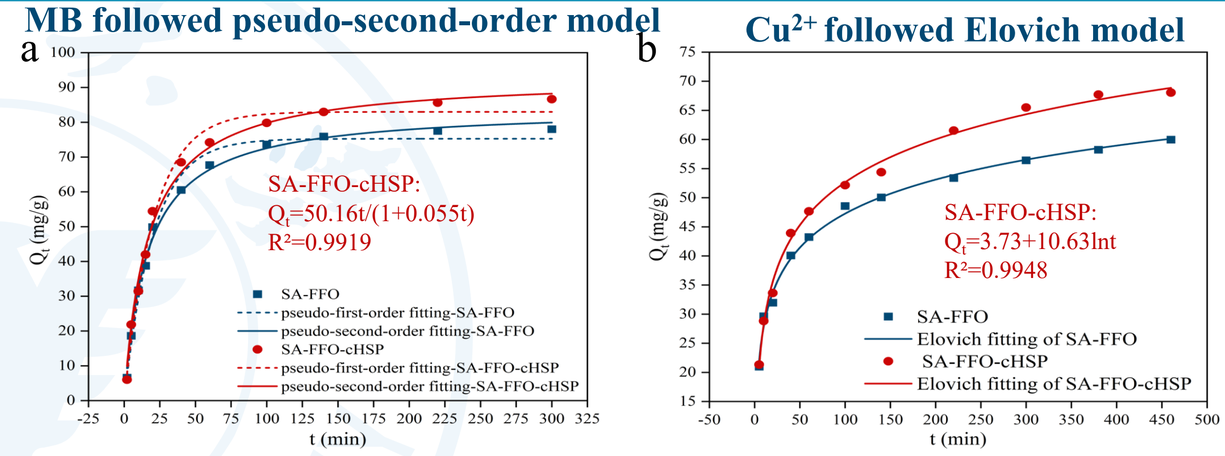


Fig. 4 Kinetic models fitting for the adsorption of MB (a) and Cu^{2+} (b).

5. Cycling Stability: The hydrogel showed superior cycling stability for MB (87–95% capacity retention) over that for Cu^{2+} (66–77%).

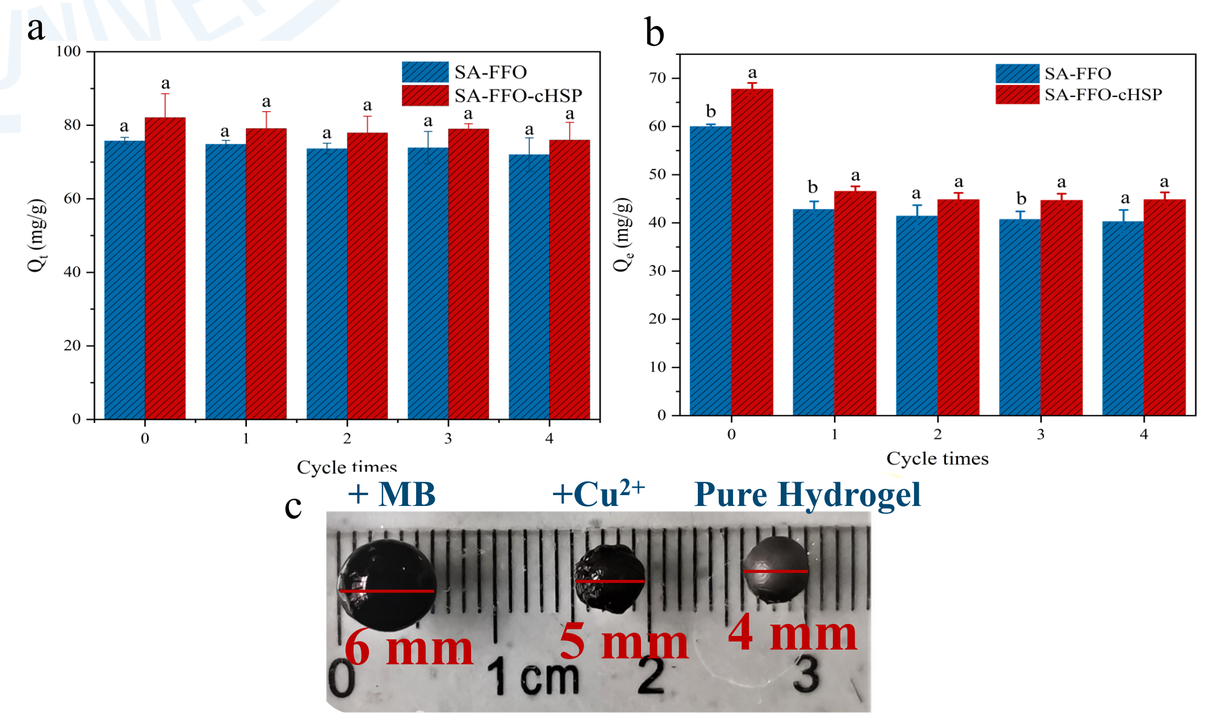


Fig. 5 Reusability for (a) MB and Cu^{2+} (b); hydrogel before vs. after adsorption (c) .

Conclusion

This study demonstrated that cHSP enhanced the SA-FFO network via hydrogen bonding, improving its co-adsorption of MB and Cu^{2+} and offering a novel adsorbent for the high-value utilization of HS in wastewater treatment.