OFFICIAL ABSTRACT and CERTIFICATION

Dialdehyde Cellulose Nanocrystal Hydrogel Synthesis for Antibiotic Remediation

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The release of hospital, municipal, and industrial wastewater effluent contaminated with antibiotics is a rising global health concern. Herein, a dialdehyde cellulose nanocrystal (DCNC)-sodium alginate (SA) hydrogel was synthesized for the adsorption of Doxycycline Hydrochloride (Doxy), a broad-spectrum Tetracycline antibiotic.

FTIR and XRD analyses confirmed the successful periodate oxidation of cellulose nanocrystals into DCNC to target Doxy through the Schiff-base reaction. The 1.25:1.25 DCNC:SA ratio displayed optimal Doxy removal (48%, 1 hr) and was used for the rest of the study. SEM and zeta potential analyses of DCNC-SA confirmed its porous structure with abundant adsorption sites and negative surface charge that allow for electrostatic attractions as additional promising mechanisms to facilitate Doxy remediation.

Adsorption isotherms and kinetics of DCNC-SA showed a Freundlich isotherm model (R^2 = 0.998) and pseudo-second order model (R^2 = 0.948), respectively. DCNC-SA exhibited an adsorption maximum of 1500 mg/g in 4000 ppm Doxy solution. From pHs 3 to 11, DCNC-SA remained an effective adsorbent with adsorption increasing as pH increased and optimal conditions at pH 11 (82% Doxy removal, pH 11). Next, an increase in hydrogel dosage also optimized Doxy removal (0.5g, 67% Doxy removal). DCNC-SA demonstrated is a cost-effective adsorbent with excellent reusability properties (regeneration efficiency = 93%, 2 cycles).

DCNC-SA shows excellent potential as a sustainable and cost-effective candidate to remediate antibiotics from water. Future investigations include elucidating DCNC-SA remediation in municipal wastewater and extending applications into the biomedical field via in-vitro drug release experiments.

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