Public Abstract

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Title:NANOCELLULOSE EXTRACTION AND SURFACE MODIFICATION TOWARD ACTIVE PACKAGING APPLICATIONS

Cellulose nanocrystals (CNCs) have attracted growing interest as a renewable nanomaterial. The main objective of this study was to explore the extraction of CNCs from switchgrass and surface modification of CNCs into antimicrobially active nanomaterials for active packaging application. Switchgrass was first fractionated via different pretreatment/pulping methods (i.e., acid-chlorite pretreatment, organosolv pretreatment, and deep eutectic solvent (DES) pretreatment), yielding high cellulose-enriched pulp (> 75.53% cellulose). Acid-chlorite pretreatment was the most effective for delignification, removing 97.80% lignin from switchgrass. In contrast, DES pretreatment was more effective for hemicellulose removal (> 79.55% xylan). Fourier transform infrared (FTIR) spectra also showed significant lignin and hemicellulose removal and enrichment of cellulose after pretreatment. Post-treatment with NaOH and H2O2 bleached organosolv and DES pulp, making them more suitable for CNCs extraction via sulfuric acid hydrolysis. The yields of CNCs extracted from the resulting pulps ranged from 30.52 to 35.82% (based on the dry mass of pulp loaded) via sulfuric acid hydrolysis with the highest yield observed with mildly post-treated ChCl: FA pulp. The surface charge of the prepared CNCs ranged from -20.30 to -26.70 mV. And the average particle size ranged from 63.55 to 222.20 nm.

Surface modification by grafting polyethyleneimine (PEI) onto the surface of CNCs with carboxylic groups endowed CNCs with antimicrobial activity, especially toward Gram-positive bacteria Bacillus megaterium. The modified CNCs (CNCs-PEI) showed positive surface charge, indicating successful cationization. FTIR also confirmed the presence of PEI on surface modified CNCs. Incorporation of CNCs-PEI by 5% into PVA film improved its mechanical strength remarkably. This study demonstrated successful extraction of CNCs from switchgrass and development of antimicrobially active CNCs via surface modification toward active packaging applications. Antimicrobially active CNCs have great potential to be used as a multifunctional nanomaterial for advanced applications.