

Optimization of Nano-Crystalline Cellulose Formation from Cellulose

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This research work is based on the process optimization of nanocellulose extraction from chemically purified cellulose. Cellulose was extracted from rice straws of BG 352 which contains the highest cellulose percentage among other rice species in Sri Lanka. This process included dewaxing, delignification, bleaching, acid hydrolysis, centrifugation, dialysis, sonication and freeze drying. X-ray diffractometer, FTIR, Laser particle size analyzer, SEM, EDX were used to examine & investigate the effect of each chemical treatment on the chemical structure of the extracted cellulose fibers.

FTIR was used to compare the chemical structure of untreated and treated fibers. The chemical compositions of fibers including cellulose, hemicelluloses, lignin, and silica were determined by different techniques. The results showed that the cellulose content of the bleached fibers was increased by around 71% compared to the raw materials. XRD analysis concluded the decrement of crystallinity with an increment of the temperature and time of the centrifugation process. The optimum centrifugation conditions were found at 8000 rpm, 10 min 4 times at room temperature for the centrifugation speed and centrifugation time respectively. The optimum dialysis conditions were determined for regenerated cellulose membranes with 12-14 kDa molecular weight cut off (Fisher brand, Pittsburgh, PA) against distilled water for 4 days using a cellulose membrane in distilled water until a constant pH was achieved. The sonication process parameters were optimized as for 3 hours sonication time, 25W 20kHz and amplitude of 50% in an ice bath to avoid overheating, to disperse the nanocrystals for the sonication frequency and sonication time. Finally, the aqueous suspension was freeze-dried in liquid nitrogen to obtain Nano Crystalline Cellulose powder. The dimensions and morphology of the chemically and mechanically extracted nanofibers were investigated by Scanning Electron Microscopy and Laser Particle Size Analyzer. The results of the image analyzer showed that almost 50% of extracted materials are within the range of 64-98 nm and length of several micrometers.

Keywords: Rice straw, Cellulose, Nanocrystalline cellulose, Acid Hydrolysis, Sonication, Centrifugation, Freeze Drying, Particle size analysis