



Advancing biorefineries with ultrasonically assisted ionic liquid-based delignification: Optimizing biomass processing for enhanced bio-based product yields

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ABSTRACT

Encouraging sustainable business needs utilization of bio-based substrate for green manufacturing of chemicals and fuels to achieve sustainable development goals set by the United Nations. One of the abundantly available bio-based substrates is lignocellulosic (LC) biomass, which requires effective pretreatment to fractionate into its structural biocomponents to maximize biorefinery potential. This study addresses the use of an inexpensive ionic liquid (triethylammonium hydrogen sulfate) [T2220][HSO₄] in an ultrasound-assisted process as an environmentally acceptable pretreatment method for the delignification of LC biomass, specifically rice straw (RS). Using ionic liquid (IL)-assisted (IL, acid-IL, and alkali-IL) pretreatment procedures, the effects of IL volume, sonication time, and temperature were methodically examined for RS delignification. To evaluate the compositional changes in pretreated and raw RS, instrumental analyses were carried out. The maximum rates of 47 %, 55 %, and 64 % for the only IL, acid-IL, and alkali-IL treatments demonstrated the effect of temperature, operating time, and IL concentration on the delignification efficiency. The alkali-IL pretreatment was noteworthy for achieving a 64 % delignification rate under optimum values of IL volume (8.65 mL), sonication time (123 min), and temperature (82 °C). Artificial neural networks (ANN) and response surface methodology (RSM) were used for process modeling and optimization. With an accuracy of 0.989 in correlation coefficient, the ANN model outperformed the RSM regression model regarding forecasting delignification performance. Biorefinery of renewable biomass resources ensures the sustainable supply of materials, chemicals, and fuels. The delignification and downstream product recovery technologies are major limiting factors in the commercialization of biomass processing. The suggested [T2220][HSO₄]-based ultrasonic approach provides a viable way to boost biomass valorization efficiency, which in turn improves economical and sustainable biorefinery and aids in the shift to green bio-based production.

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