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Integrated hydrothermal and deep eutectic solvent-mediated fractionation of lignocellulosic biocomponents for enhanced accessibility and efficient conversion in anaerobic digestion

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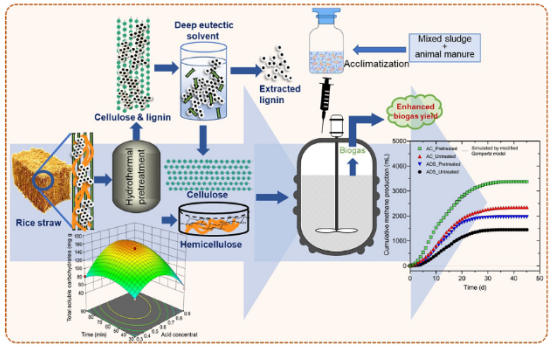
HIGHLIGHTS

- Hydrothermal and deep eutectic solvent fractionate lignocellulosic (LC) components.
- Optimized hydrothermal process recovered 96% hemicellulose at a severity of 2.26.
- Deep eutectic solvent removed 81.3% of lignin after hemicellulose solubilization.
- Integrated process remarkably improved the digestion of fractionated LC-components.
- Acclimatized consortium rapidly removed LC-inhibitors, yielding 33.4% more methane.

GRAPHICAL ABSTRACT



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ABSTRACT

Effective fractionation of lignocellulosic biocomponents of lignocellulosic biomass can increase its utilization in anaerobic digestion for high yield biomethane production. A hydrothermal process was optimized and integrated with a deep eutectic solvent (DES) pretreatment to preferentially fractionate hemicellulose, cellulose, and lignin in rice straw. The optimized hydrothermal process resulted in 96% hemicellulose solubilization at moderately low combined pretreatment severity (log S = 2.26), allowing increased hemicellulosic sugar recovery with minimal formation of inhibitory byproducts. Subsequent DES pretreatment resulted in highly bioaccessible cellulosic pulp, removing 81.3% of lignin that can be recovered and converted into value-added products. Anaerobic digestion of hemicellulosic fraction and cellulosic pulp using a microbial methanogenic consortium seed acclimatized to the lignocellulosic inhibitors resulted in a 33.4% higher yield of methane (467.84 mL g^{-1}

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