



Pretreatment of sugarcane bagasse by acid-catalysed process in aqueous ionic liquid solutions

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HIGHLIGHTS

- ▶ 10–30% water was used in an ionic liquid (IL) for pretreating sugarcane bagasse.
- ▶ Pretreatment required only 130 °C and 15–30 min with an acid catalyst.
- ▶ Glucan digestibility of the solid residues reached 93–100%.
- ▶ High glucan digestibility was attributed to delignification and removal of xylan.
- ▶ Recycling IL without replenishing acid catalyst didn't decrease the digestibility.

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ABSTRACT

A biomass pretreatment process was developed using acidified ionic liquid (IL) solutions containing 10–30% water. Pretreatment of sugarcane bagasse at 130 °C for 30 min by aqueous 1-butyl-3-methylimidazolium chloride (BMIMCl) solution containing 1.2% HCl resulted in a glucan digestibility of 94–100% after 72 h of enzymatic hydrolysis. HCl was found to be a more effective catalyst than H₂SO₄ or FeCl₃. Increasing acid concentration (from 0.4% to 1.2%) and reaction temperature (from 90 to 130 °C) increased glucan digestibility. The glucan digestibility of solid residue obtained with the acidified BMIMCl solution that was re-used for three times was >97%. The addition of water to ILs for pretreatment could significantly reduce IL solvent costs and allow for increased biomass loadings, making the pretreatment by ILs a more economic proposition.

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1. Introduction

Pretreatment of lignocellulosic biomass prior to use as feedstock for biofuel and chemical production is required to either disrupt the crystalline structure of cellulose, remove hemicellulose, or remove or modify the lignin, to increase the exposure of the cellulosic substrate to hydrolytic enzymes, decrease cellulosic substrate recalcitrance for enzyme attack and thus increase glucose yield (Mosier et al., 2005; Zheng et al., 1998).

The use of ionic liquids (ILs) as solvents for pretreatment of lignocellulosic biomass has received attention (Alvira et al., 2010; Zhu et al., 2006) because of the ability of some ILs to dissolve cellulose under moderate conditions and the possibility of recovering nearly 100% of the IL in its initial purity (Heinze et al., 2005). ILs are salts, typically composed of large organic cations and small inorganic anions, which exist as liquids at relatively low temperatures

(typically <100 °C) (Alvira et al., 2010). Some of ILs exhibit chemical and thermal stability, non-flammability and immeasurably low vapour pressure (Zhu et al., 2006). However, ILs are expensive, generally viscous and to-date their commercial application for lignocellulosic processing is limited. Depending upon the ILs used, lignocellulosic biomass may be completely dissolved by the ILs and subsequently regenerated by adding anti solvents such as water (Zhu et al., 2006). Such a process allows ILs to be recovered and recycled. Water is the most commonly used antisolvent in IL systems, though it is generally considered that its presence in contents above 1% could significantly impair the ability of the IL to solubilise lignocellulosic biomass (Swatloski et al., 2002). Recycling ILs to a very low water content is expensive, but essential to ensure that the water does not negatively affect biomass dissolution. In addition, the viscosities of IL and IL-containing dissolved biomass are high, which make pretreatment with high biomass loadings difficult. As a consequence, many studies use biomass loadings of ≤5% in hydrolysis, dissolution and pretreatment with IL solutions (Binder and Raines, 2010; Kimon et al., 2011; Kuo and Lee, 2009; Li and Zhao, 2007).

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