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Effect of ionic liquid weight ratio on pretreatment of bamboo powder prior to enzymatic saccharification

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HIGHLIGHTS

- ▶ Biomass was pretreated with different ionic liquid (IL)/biomass ratios (0–10 g/g).
- ▶ Cholinium IL (less expensive and less toxic than conventional IL) was used.
- ▶ An IL/biomass ratio of 3 g/g was critical for sufficient biomass pretreatment.
- ▶ At an IL/biomass ratio of 3 g/g, biomass was not liquid but solid.
- ▶ The solid-state biomass pretreatment using IL can reduce cost and waste water.

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ABSTRACT

The pretreatment efficiency of weight ratios ranging from 0 to 10 of the ionic liquid, cholinum IL, to bamboo powder was investigated. An IL/biomass ratio of 3 g/g was critical to obtain a cellulose saccharification ratio of 80%. At this ratio, the treated bamboo powder remained as a solid. The solid-state pretreatment required a minimum amount of cholinium IL, which could reduce the cost of IL-assisted pretreatment and reduce the amount of wastewater generated in the process.

1. Introduction

The biorefinery of lignocellulosic materials, such as waste woods and agricultural residues, into ethanol and other valuable metabolites generally consists pretreatment to enhance the subsequent enzymatic saccharification of cellulose and hemicellulose; enzymatic hydrolysis of cellulose and hemicellulose to fermentable sugars, and microbial fermentation of these sugars to ethanol or other metabolites (Adsul et al., 2011). Among these steps, pretreatment is an important unit operation because it greatly affects the efficiency and methodology used during the subsequent saccharification and fermentation processes.

Ionic liquids (ILs) are generally defined as organic salts that melt below 100 °C. They are thermally stable, non-volatile, and can dissolve polar and non-polar organic, inorganic, and polymeric compounds such as cellulose under mild conditions (Olivier-Bourbigou et al., 2010; Swatloski et al., 2002). Precipitation of dissolved cellulose produces a polymer with much higher enzymatic hydrolysis efficiency owing to its decreased crystallinity (Dadi et al., 2006). ILs can also dissolve lignocellulosic biomass (Fort et al., 2007; Kilpeläinen et al., 2007; Lee et al., 2009; Li et al., 2009).

Almost all of the ILs used for lignocellulose pretreatment contained imidazolium cations (Sun et al., 2010); however, these ILs are quite expensive. To reduce the cost of IL-assisted pretreatment of lignocellulosic materials, studies have investigated the reusability of ILs (Lee et al., 2009; Li et al., 2009; Nguyen et al., 2010; Shill et al., 2011; Wu et al., 2011) and the minimum IL amount required for lignocellulosic pretreatment (Wu et al., 2011).

A new-generation ILs has been synthesized by combining cholinium cations with amino acid-based ([Ch][AA] ILs) (Hu et al., 2007) or carboxylic acid-based anions ([Ch][CA] ILs) (Fukaya et al., 2007). These completely bio-derived cholinium ILs are less expensive than imidazolium ILs (Plechkova and Seddon, 2008).

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