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Solvent extraction of antioxidants from steam exploded sugarcane bagasse and enzymatic convertibility of the solid fraction

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HIGHLIGHTS

- Antioxidants were solvent-extracted from steam exploded sugarcane bagasse (SESB).
- Solid, phenolic and total sugar yields of different extractions were different.
- The extracts showed potent antioxidant activities.
- Enzymatic convertibility of solid fraction after extraction was enhanced.

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ABSTRACT

Solvent extraction of steam exploded lignocellulosic biomass may be a potential way to obtain antioxidative extracts and to enhance the enzymatic convertibility of the solid residue. Boiling solvent extraction (BSE) showed higher solid and phenolic yields than room temperature extraction. Solubilities of phenolics and sugars were higher in anhydrous ethanol (AE) and deionized water (DW) than in ethyl acetate under each individual extraction condition. The antioxidant activities of the AE and DW extract obtained under BSE were better than those of 10 mM vitamin C. Conversion of the solid fractions into reducing sugar using Celluclast 1.5 L and Novozym 188 after AE and DW extraction was 95.13% and 92.97%, respectively, higher than that obtained with SESB (88.95%).

1. Introduction

Sugarcane bagasse (SCB) is a waste from sugar production. SCB has been a feedstock to produce bio-alcohol (Dekker and Wallis, 1983) after conversion of the cellulose and hemicellulose into fermentable sugars by acidic or enzymatic catalysis. Certain pretreatments to reduce crystallinity and degree of polymerization or remove part of the lignin and hemicellulose need to be employed in order to enhance enzymatic hydrolysis (Sun and Cheng, 2002).

Steam explosion is the most commonly used method to pretreat lignocellulose (Sun and Cheng, 2002) and the typical effects of such pretreatment are substantial breakdown of the lignocellulosic structure, degradation of hemicellulose and delignification (Castro et al., 2008); however, some degradation products such as furfural, 5-hydroxymethylfurfural, acetate acid and lignin-derived phenolics inhibit microbial conversion of steam exploded lignocellulose (Cruz et al., 2001). These inhibitors can be removed either by physico-chemical procedures such as adsorption, neutralization and overliming (Cruz et al., 1999) or by solvent extraction (Conde et al., 2011; Cruz et al., 1999, 2001). Solvent-detoxified media display good fermentation performance. Low boiling point solvents and lignin-derived antioxidants are easily recovered, and these antioxidants might be used as a cheap, renewable source of food additives.

Phenolic compounds, since they have antimicrobial activity (Garrote et al., 2004), are undesirable in microbial fermentation media (Cruz et al., 2001). Additionally, cellulase can be inhibited by phenolics (Ximenes et al., 2010). Therefore, simultaneous antioxidant extraction and detoxification of steam exploded or autohydrolyzed lignocellulosic materials is a reasonable way to solve the antimicrobial problem prior to further conversion of pretreated lignocellulose into alcohol. Although several authors have studied extraction of antioxidants from steam exploded or hydrolyzed lignocellulosic materials (Castro et al., 2008; Conde et al., 2009; Cruz et al., 2001; Hongzhang and Liying, 2007), the effects of different solvents on the extraction and the subsequent enzymatic convertibility of the solid fractions after solvent extraction have not been explored.

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