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Fermentation of liquefacted hydrothermally pretreated sweet sorghum bagasse to ethanol at high-solids content

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HIGHLIGHTS

- Optimization of hydrothermal pretreatment lead to high cellulose hydrolysis yields.
- Liquefaction of SB at high DM content was enabled at these conditions.
- Liquefacted SB permitted submerged fermentation.
- High ethanol concentration was achieved.

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ABSTRACT

The ability of sweet sorghum bagasse to be utilized as feedstock for ethanol production at high initial dry matter concentration was investigated. In order to achieve high enzymatic hydrolysis yield, a hydrothermal pretreatment prior to liquefaction and saccharification was applied. Response surface methodology had been employed in order to optimize the pretreatment step, taking into account the yield of cellulose hydrolysis. Liquefaction of the pretreated bagasse was performed at a specially designed liquefaction chamber at 50 °C for either 12 or 24 h using an enzyme loading of 10 FPU/g·DM and 18% DM. Fermentation of liquefacted bagasse was not affected by liquefaction duration and leaded to an ethanol production of 41.43 g/L and a volumetric productivity of 1.88 g/L h. The addition of extra enzymes at the start up of SSF enhanced both ethanol concentration and volumetric productivity by 16% and 17% after 12 and 24 h saccharification, respectively.

1. Introduction

With decreasing crude oil reserves, which represent the primary source of transport fuel in the world, and environmental deterioration resulting from the overconsumption of petroleum-derived products, developing renewable energy alternatives to petroleum as soon as possible stands to be crucial (Shen et al., 2011; Wang et al., 2011; Shen and Liu, 2008). The growing interest in energy alternatives for fossil fuels has boosted ethanol production worldwide from 12 to 19.5 billion gallons in the period of 2005–2009, with the United States of America and Brazil being the two largest producers representing 54% and 34% of total production, respectively (RFA, 2010). In the past more than 30 years, ethanol derived from corn and sugarcane (first generation ethanol) has been developed energetically all over the world. Utilization of corn and sugarcane for ethanol production is considered to face increasing competition with direct use as food and animal feed, impacting both availability and price (Wu et al., 2011; Wang et al., 2011). Presently, the production of the second generation cellulosic ethanol from abundant and inexpensive non food lignocellulosic biomass materials, such as agricultural residues and herbaceous energy crops, has become the focus of research due to its potential advantages (Sánchez and Cardona, 2008; Sims et al., 2010).

Sweet sorghum (*Sorghum bicolor* (L.) Moench) is a promising C4 energy plant due to its high photosynthetic efficiency, high biomass yield per hectare, increased drought resistance and low fertilizing rates (Li et al., 2010; Martinez et al., 2000; Xu et al., 2011). Other characteristics that make sweet sorghum suitable raw material for ethanol production are its high efficiency in water usage, short growth period (3–5 months) and wide adaptability to diverse climate and soil condition (Davila-Gomez et al., 2011; Ratnavathi et al., 2010). Based on these characteristics, the marginal lands could be utilized to grow sweet sorghum for ethanol production, which might give a potential solution to the completion between foods and fuels (Shen et al., 2011).

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