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Increase in ethanol production from sugarcane bagasse based on combined pretreatments and fed-batch enzymatic hydrolysis

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HIGHLIGHTS

- Enzymatic hydrolysis in fed-batch with pretreated sugarcane bagasse.
- Glucose concentration remained constant after 30 h due to higher lignin content.
- Fed-batch addition of both material led to higher glucose concentration with 12-h.
- The delignification and fed-batch hydrolysis led to an increase ethanol production.

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ABSTRACT

Enzymatic hydrolysis of pretreated sugarcane bagasse was performed to investigate the production of ethanol. The sugarcane bagasse was pretreated in a process combining steam explosion and alkaline delignification. The lignin content decreased to 83%. Fed-batch enzymatic hydrolyses was initiated with 8% (w/v) solids loading, and 10 FPU/g cellulose. Then, 1% solids were fed at 12, 24 or 48 h intervals. After 120 h, the hydrolysates were fermented with *Saccharomyces cerevisiae* UFPEDA 1238, and a fourfold increase in ethanol production was reached when fed-batch hydrolysis with a 12-h addition period was used for the steam pretreated and delignified bagasse.

1. Introduction

Lignocellulosic biomass, such as agricultural residues, potentially can be used for the biofuel production. Sugarcane bagasse, the major by-product of the sugarcane industry, is an economically viable and very promising raw bagasse for bioethanol and biomethane production (Rabelo et al., 2011; Badshah et al., 2012).

Bioethanol production from lignocellulosic biomass, by using *Saccharomyces cerevisiae*, comprises the hydrolysis of cellulose and sugar fermentation. In order to obtain fermentable sugars from sugarcane bagasse, the cellulose can be saccharified using either acids or enzymes. However, somewhat acid enzymes are preferred rather acid because enzymatic hydrolysis is free from fermentation inhibitory products (Rivera et al., 2010; Galbe and Zacchi, 2002; Sun and Cheng, 2002).

The task of hydrolyzing lignocellulose to fermentable monosaccharides is still technically problematic because the digestibility of cellulose is hindered by many physico-chemical, structural and compositional factors. Therefore, pretreatments, such as with steam explosion, alkaline, diluted acid, ammonia, organosolv water/ethanol, oxidation with Fenton's reagent and pelleting, among other methods, are required prior of enzymatic hydrolysis in order to make the cellulose more accessible to attack by enzymes (Galbe and Zacchi, 2002; Beukes and Pletschke, 2010; Michalska et al., 2012; Rijal et al., 2012).

Steam explosion is the most widely employed physico-chemical pretreatment for lignocellulosic biomass. In combination with the partial hemicellulose hydrolysis and solubilization, the lignin is redistributed and to some extent removed from the bagasse (Pan et al., 2005). On the other hand, alkaline pre-treatments solubilize

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