Simultaneous co-saccharification and fermentation of sago hampas for bioethanol production

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Abstract: Abundance of lignocellulosic biomass provides a good solution to the demands of energy crops in producing biofuel like biodiesel and bioethanol. In this study, bioethanol was produced from sago hampas via the Simultaneous co-Saccharification and Fermentation (Sc-SF) process, at 2.5% and 5.0% (w/v) solid loadings. The processing step in Sc-SF is virtually similar to that of Simultaneous Saccharification and Fermentation (SSF). However, during Sc-SF, two enzymes, amylase and cellulose, were added for the co-saccharification of sago starch and fiber. In addition, Saccharomyces cerevisiae was used to ferment the sugars in the hydrolysates. The Sc-SF samples were analyzed for carbohydrate residues, ethanol and acetic acid using the dinitrosalicylic (DNS) acid assay and High Performance Liquid Chromatography (HPLC).Results showed that the Sc-SF of the sago hampas showed high efficiencies of hydrolysis and ethanol production within the first six hours of fermentation. Highest glucose production was at 37.86 g/l for the 5.0% sago hampas load and 17.47 g/l for 2.5% sago hampas load. The highest ethanol production was observed in the broth with 5.0% sago hampas, with a theoretical yield of 80.50%. Meanwhile, the highest bioethanol yield in the sample with 2.5% sago hampas was 73.19%. This study indicated that bioethanol production via Sc-SF from starch rich agricultural residues such as sago hampas is feasible.

Keywords:bioethanol, sago hampas, simultaneous co-Saccharification and Fermentation (Sc-SF), amylase, cellulase, Saccharomyces cerevisiae, HPLC

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1 Introduction

The demand on fossil fuels for energy has increased exponentially since the explosion of industries in the first world and developing countries and the increase is predicted to continue (Sun and Cheng, 2002; Karki et al., 2012; Vincent et al., 2014). On the other hand, global oil production is expected to decline from 25 billion barrels to 5 billion barrels by 2050 (Campbell and Laherree, 1998). Together with the continual fluctuation in oil prices, this phenomenon has sparked a renewed interest in the potential use of renewable sources such as lignocellulose to produce a variety of liquid biofuels such as biodiesel and bioethanol (Vincent et al., 2014). The current leading nations in bioethanol production are USA and Brazil whereas Asian countries altogether account for about 14% of world's bioethanol production (Carere et al., 2008; Vincent, 2010).

Historically, biofuel productions are basically categorized into two phases, first and second generation. First generation biofuels are produced primarily from food crops. In Brazil, about 70% of ethanol is produced from fresh sugarcane and the remaining percentage is from cane molasses (Wilkie et al., 2000). Meanwhile, bioethanol in USA is produced almost exclusively from corn (Vincent et al., 2011b). The main concern regarding first generation biofuels is the impact biofuel production may have on land biodiversity and the competition with food crops (Pimentel and Patzek, 2005; Mitchell, 2008).

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