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Sequential Saccharification and Simultaneous Fermentation (SSSF) of Sago Hampas for the Production of Bioethanol

(Sakarifikasi dan Fermentasi Serentak Berperingkat (SSSF) Hampas Sago untuk Penghasilan Bioetanol)

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ABSTRACT

Bioethanol is a very environmentally friendly liquid biofuel that is not only renewable, but also sustainable. It is currently deemed as a highly suitable additive and substitute energy source to replace fossil based fuel. In this study, bioethanol was produced from sago hampas by using commercial amylase, cellulase and Saccharomyces cerevisiae *via sequential saccharification and simultaneous fermentation (SSSF), a modified version of the simultaneous saccharification and fermentation (SSF) process. SSSF was performed on sago hampas at 2.5 and 5.0% (w/v) feedstock load for five days. The samples taken from the SSSF broths were analysed via high performance liquid chromatography (HPLC) for ethanol, glucose and acetic acid production. From the results obtained, SSSF with 5.0% sago hampas loading exhibited the highest ethanol production at 14.13 g/L (77.43% of theoretical ethanol yield), while SSSF using 2.5% sago hampas loading produced ethanol at 6.45 g/L (69.24% of theoretical ethanol yield). This study has shown that ethanol not only can be produced from sago hampas using different enzyme mixtures and* S. cerevisiae *via SSSF, but yields were also high, making this process highly promising for the production of cheap and sustainable ethanol as fuel.*

Keywords: Amylase; bioethanol; cellulase sago hampas; sequential saccharification and simultaneous fermentation (SSSF)

ABSTRAK

Bioetanol adalah bahan api mesra alam yang bukan sahaja boleh diperbaharui, tetapi juga mapan. Ia kini dianggap sebagai bahan api tambahan dan tenaga pengganti yang sangat sesuai untuk menggantikan bahan api berasaskan fosil. Dalam kajian ini, bioetanol dihasilkan daripada hampas sagu dengan menggunakan enzim amilase komersial, selulase dan Saccharomyces cerevisiae *melalui proses sakarifikasi dan fermentasi serentak berperingkat (SSSF), iaitu proses sakarifikasi dan fermentasi serentak (SSF) yang telah diubah suai. SSSF telah dijalankan ke atas 2.5 dan 5.0% (w/v) selama lima hari. Sampel yang diambil daripada kaldu SSSF dianalisis melalui kromatografi cecair prestasi tinggi (HPLC) untuk menentukan kepekatan etanol, glukosa dan asid asetik. Daripada keputusan yang diperoleh, SSSF dengan 5.0% hampas sagu didapati menghasilkan etanol yang tertinggi iaitu 14.13 g/L (77.43% daripada hasilan teori etanol), manakala SSSF menggunakan 2.5% hampas sagu menghasilkan etanol pada 6.45 g/L (69.24 % daripada hasilan teori etanol). Kajian ini telah menunjukkan etanol bukan sahaja boleh dihasilkan daripada hampas sagu menggunakan campuran enzim yang berbeza dan* S. cerevisiae *melalui SSSF, tetapi penghasilannya juga adalah tinggi, menjadikan proses ini sangat berpotensi untuk menghasilkan etanol dengan kos rendah.*

Kata kunci: Amilase; bioetanol; hampas sagu; sakarifikasi dan fermentasi serentak berperingkat (SSSF); selulase

INTRODUCTION

Bioethanol is a promising substitute to conventional fossil fuels due to its carbon dioxide neutrality and sustainability (Vincent 2010; Vincent et al. 2014). When compared to fossil fuels, bioethanol burns completely and cleanly, producing only water and carbon dioxide, while at the same time enhancing petrol performances (Altintas et al. 2002; Yamashita et al. 2010). Most bioethanol is produced by the fermentation of carbohydrate from sugar cane, cane juice, corn starch, grains and potato starch using fermenting organisms such as *Saccharomyces cerevisiae* and *Zymomonas mobilis* (Cervero et al. 2010; Vincent et al. 2011a). This is known as first generation bioethanol and its production uses crop-based raw materials.

The drawback to first generation bioethanol production is its production cost that is very uneconomical (Vincent et al. 2011b). In addition, the usage of food crops as feedstock for ethanol production is also very controversial as this practice disrupts the food supply chain. Thus, second generation bioethanol was introduced by utilizing lignocellulosic biomass to save cost and to meet the increasing world-wide demand for bioethanol (Vincent et al. 2014). Lignocellulosic biomass is an abundant source of carbohydrate such as cellulose, hemicellulose and can be found in agricultural waste, forest waste and food-based industrial waste as such palm oil empty fruit bunch (EFB) and sago hampas (Adeni et al. 2010; Cervero et al. 2010; Zakaria et al. 2014, 2013).