NUSANTARA BIOSCIENCE
Vol. 10, No. 4, pp. 240-245
November 2018

ISSN: 2087-3948
E-ISSN: 2087-3956
DOI: 10.13057/nusbiosci/n100407

Production of bioethanol from sago hampas via Simultaneous Saccharification and Fermentation (SSF)

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Manuscript received: 14 September 2018. Revision accepted: 21 October 2018.

Abstract. *Huang CH, Adeni DSA, Johnny Q, Vincent M. 2018. Production of bioethanol from sago hampas via Simultaneous Saccharification and Fermentation (SSF). Nusantara Bioscience 10: 240-245.* Sago hampas is an inexpensive, renewable and abundant agro-industrial residue that can be exploited to produce bioethanol. In this study, ethanol production was performed via simultaneous saccharification and fermentation (SSF) on fresh sago hampas at 2.5%, 5.0% and 7.5% (w/v) feedstock loadings with the aid of amylolytic enzymes, cellulolytic enzymes and *Saccharomyces cerevisiae*, under anaerobic condition for five days with a constant agitation of 150 rpm and ambient temperature. Results obtained indicated that SSF with 5.0% (w/v) sago hampas loading produced the highest ethanol yield at 17.79 g/L (79.65% Theoretical Ethanol Yield, TEY), while SSF using 2.5% and 7.5% (w/v) sago hampas produced ethanol at only 8.38 g/L (75.00% TEY) and 23.28 g/L (69.48% TEY), respectively. Total biomass reduction was recorded between 66.3% to 71.3% by the end of the SSF period. This study demonstrated that fresh sago hampas is a promising feedstock for bioethanol production as yields are generally high for all the substrate loadings tested. Moreover, bioethanol production using fresh sago hampas may assist in reducing pollution caused by sago waste accumulation.

Keywords: Bioethanol, cellulose, enzymatic hydrolysis, sago hampas, simultaneous saccharification and fermentation, SSF

INTRODUCTION

Fuel demands from the transportation sector, which is the biggest user of diesel and gasoline, has increased tremendously in a worrying trend (Aditiya et al. 2016). These fossil-based fuels are not only non-renewable, but they are also not environmentally, ecologically or economically sustainable in a long term (Vincent et al. 2015a; Adekunle et al. 2016; Zabed et al. 2014). Therefore, alternative liquid biofuel, such as bioethanol, is currently being mass produced to substitute and supplement petroleum-based fuel due to its sustainability and carbon dioxide neutrality (Vincent et al. 2014). However, the current practices of using food and feed based feedstock, such as corn and sugar cane, are undesirable and controversial due to the concerns on food security (Daylan and Ciliz 2016). Therefore, the utilization of non-edible lignocellulosic materials for second-generation bioethanol production is capturing the attention of many researchers due to the restrictions in the use of food crops for first-generation bioethanol production as well as the high costs involved (Aditiya et al. 2016; Daylan et al. 2016).

Non-edible lignocellulosic materials are composed of cellulose, hemicellulose and lignin. These materials include waste streams from various sources such as food processing industries, forestry, agriculture, domestic and municipality origins. Additionally, starch is also found in several starchy-lignocellulosic biomasses such as cassava pulp, food waste and sago hampas (Behera et al. 2014; Thangavelu et al. 2016; Wan et al. 2016). These resources do not entirely compete with agricultural crops, and, are excellent candidates to be used as raw materials for bioethanol production (Tye et al. 2016).

Sarawak is the largest sago-growing region in Malaysia and has been recognized as the biggest sago starch exporter in the world. Sarawak exports approximately 44,000 tonnes of starch annually, mainly to Peninsular Malaysia, Japan and Singapore (Awg-Adeni et al. 2013). However, the production of this precious commodity also generates wastes, in the forms of organic rich effluent and solid residues called sago hampas, that are discarded into nearby streams, as well as deposited in the factory compound (Awg-Adeni et al. 2010). These practices have led to several environmental issues, such as water pollution and wastage of valuable resources (Wan et al. 2016). Sago hampas is made of 58% starch, making it relatively easier and less expensive to process compared to another lignocellulosic biomass (Vincent et al. 2015b). It can be found in abundance in a typical sago starch processing plant where an estimated 7 tonnes of sago pith waste are generated daily (Awg-Adeni et al. 2010).

Therefore, in order to find a possible use for this misplaced solid residue, this study was performed to investigate bioethanol production from sago hampas at several loadings via simultaneous saccharification and fermentation (SSF) with the aid of commercial amylolytic and cellulolytic enzymes, in the presence of *Saccharomyces cerevisiae.* According to Vincent et al. (2015a), it is a preferred method for the production of second-generation bioethanol from lignocellulosic biomaterials. During SSF, resultant sugars liberated by the hydrolyzing enzymes are simultaneously metabolized by fermenting microorganisms