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Enhancement of very high gravity bioethanol production via fed-batch fermentation using sago hampas as a substrate

Nur Adila Muradi, Dayang Salwani Awang Adeni*, Nurashikin Suhaili

Resource Biotechnology Programme, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

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Abstract. Very high gravity (VHG) ethanolic fermentation is a promising technology used for producing bioethanol. However, the technology is often associated with the excessive amount of glucose that is entirely supplied in the beginning of the culture causing the fermentation process to be sluggish and therefore inhibits complete utilisation of glucose. The high concentration of glucose in the fermentation medium also elevates the osmotic pressure, which has a destructive effect on yeast cells. This study aims to enhance the production of VHG bioethanol from sago hampas hydrolysate (SHH) via fed-batch fermentation. The fermentations were performed in a 2-L stirred tank bioreactor. Batch fermentation was conducted as a control. Our results showed that the maximum yeast cell concentration achieved was significantly improved by 1.5-fold when the fermentation was carried out in fed-batch mode. The ethanol yield attained in the fed-batch culture represents an enhancement of 22% over that achieved in the batch culture. Moreover, the ethanol productivity achieved in the fed-batch culture was found to be increased by 1.8 times in comparison to the productivity attained in the batch culture. In general, this work provides useful insights into promising techniques for enhancing VHG fermentations in the stirred tank bioreactor employing agricultural residues as feedstocks.

Keywords: Ethanol, fed-batch system, osmotic pressure, substrate inhibition, very high gravity (VHG) fermentation, yeast

INTRODUCTION

Bioethanol has emerged as a sustainable and eco-friendly alternative to the conventional fossil fuel that poses major environmental problems. Currently, there is an increasing interest to exploit lignocellulosic waste as feedstocks for producing bioethanol. Apart from being cheap feedstocks, the use of lignocellulosic waste for bioproduction may also overcome the disposal problem that may otherwise be caused by the bulk dumping of the waste to the environment (Gutierrez-Rivera *et al.*, 2012; Ishola & Taherzadeh, 2014; Vincent *et al.*, 2014). Lignocellulosic waste generally has high content of starch and cellulosic components, which can be utilised to produce fermentable sugars and bioethanol (Janggu & Bujang, 2009; Linggang *et al.*, 2012; Awg-Adeni *et al.*, 2013; Jenol *et al.*, 2014).

One of the potential lignocellulosic waste is sago hampas, which is a side product of the sago extraction process. Every year, Sarawak exports about 44,000 tonnes of sago starch mainly to Peninsular Malaysia, Japan and other countries (Awang-Adeni *et al.*, 2010). For every tonne of starch produced, one tonne of sago hampas are

*Author for correspondence: Dayang Salwani Awang Adeni, Resource Biotechnology Programme, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia. Email – adsalwa@unimas.my