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Lactic acid production by *Enteroccocus faecium* in liquefied sago starch

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Abstract

Enterococcus faecium No. 78 (PNCM-BIOTECH 10375) isolated from *puto,* a type of fermented rice in the Philippines was used to produce lactic acid in repeated batch fermentation mode. Enzymatically liquefied sago starch was used as the sole carbon source, since sago (*Metroxylon spp)* is a sustainable crop for industrial exploitation. Liquefied sago starch was inoculated with *E. faecium* to perform the saccharification and fermentation processes simultaneously. Results demonstrated that *E. faecium* was reused for 11 fermentation cycles with an average lactic acid yield of 36.3 ± 4.71 g/l. The lactic acid production was superior to that of simple batch mode and continuous fermentation in terms of lactic acid concentration. An un-dissociated lactic acid concentration of 1.15 mM affected the productivity of the cells. Work is in progress to maintain and increase the usability of the cells over higher fermentation cycles.

Keywords: *Enteroccus faecium*, Lactic acid, Repeated batch fermentation, Liquefied sago starch, Cell reuse

Introduction

Lactic acid is an important commodity because it is a multi-functional versatile organic acid having a wide range of applications. One of the most important factors that affect the overall production cost in Lactic Acid Fermentation (LAF) is the raw material. The consortium CSM (2010) reported that the raw material costs for lactic acid (LA) production, as a percentage of sales, increased from 52.9% in 2009 to 53.2% in 2010. For a long time, it has been stated that lignocellulosic materials are very promising for bio-refinery applications, but this technology is still problematic (Zhou et al. 2011). Recently Ou et al. (2011), reported a process using *Bacillus coagullans* to produce LA from non food carbohydrates, and interestingly, an indigenous *Clostridium phytofermentans* was found as a potential microorganism for the efficient use of lignocellulosic materials to produce ethanol, hydrogen and organic acids (Leschine and Warnick 2010). Among starchy materials, sago starch is being considered as an attractive raw material for food and industrial exploitation due to the fact that it is produced abundantly in the agricultural plant *Metroxylon spp* (Karim et al. 2008). In 2008, Malaysia exported 37,365.3 metric tons of sago flour, thereby earning RM44, 091.0 million (Malaysia Dept Statistics 2011). The sago palm efficiently fixes carbon dioxide to synthesize starch in large quantities in its trunk. Sago starch granules are generally bigger than those of rice, (3–10 μm), corn (5–20 μm), wheat (22–36 μm), or cassava (5–25 μm), but smaller than those of potato (15–85 μm) (Nor-Nadiha 2010). Sago starch contains approximately 74-80% of amylopectine and 24-31% of amylose (Karim et al. 2008) and has a crystalline structure (Yetti et al. 2007). These properties of sago starch make difficult its hydrolysis. Uthumporn et al. (2010) reported that the relative order in the hydrolysis of the starchy materials studied was as follows: corn starch > mung bean starch > cassava starch > sago starch. These findings demonstrated that sago is a difficult substrate for raw starch degrading enzymes (Yetti et al. 2007). On the other hand, an improvement in the industrial production and efficiency of enzymes has decreased their cost in the market (Novozymes and BBI International 2005). Nevertheless, to improve the economics of LAF, the use of microorganisms with amylolytic activity could be preferred because it saves

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