Biohydrogen Production from Rice Noodle Processing Wastewater by Immobilizing Hydrophobic Media

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ABSTRACT
Maximum cumulative hydrogen production of the rice noodle processing wastewater (552.29 mL H\textsubscript{2}/L wastewater) was observed at initial pH 6.0 under thermophilic condition (55±1°C). Regarding 5% (v/v) addition of Hydrophobic Media (HB), the maximum cumulative hydrogen production using immobilizing ball-shaped HB (1,256.50 mL H\textsubscript{2}/L wastewater) was a three-fold increase of cumulative hydrogen production when compared to its production using immobilizing wheel-shaped HB (424.31 mL H\textsubscript{2}/L wastewater). The SEM observation of immobilized biofilm on a ball-shaped HB was the rod shape and gathered into groups.

Key words: Biohydrogen production, rice noodle processing wastewater, pH, temperature, immobilizing hydrophobic media

INTRODUCTION
Biohydrogen production by fermentative process is desirable because such methods generate high yields of hydrogen and high rates of bacterial growth with relatively low energy inputs, compared to photobiological methods (Hasyim et al., 2011). Hydrogen is a clean fuel with Carbon Dioxide (CO\textsubscript{2}) emission and can be sustainably produced (Argun et al., 2009). The fermentative processes that utilize free carbon available in large-volume discharges of agro-industrial wastewater containing carbohydrates can recover available energy and purify the effluent (Wei et al., 2010; Wongthanate et al., 2014). The high-carbohydrate wastewaters will be the most useful for industrial hydrogen production (Van Ginkel et al., 2005). In addition, biohydrogen production would be accompanied by the acidic metabolites (e.g., acetic acid, butyric acid, etc). A proper control of the culture pH is a critical factor affecting the efficiency of the fermentation (Wang et al., 2007). Moreover, temperature is one of important factors on biohydrogen production, in which mesophilic and thermophilic hydrogen production conditions were compared and in which the thermophilic condition was shown to be superior to the mesophilic condition (Akutsu et al., 2009). Thermophilic bacteria can utilize a variety of carbon sources and generate high yields of hydrogen as well as tolerate acidic fermentative conditions (Hasyim et al., 2011). Immobilized cell systems have been successfully applied for biohydrogen production in various bioreactors because they are resistant to cell wash-out during operation and can maintain a higher cell density (Singh et al., 2013). In general, three types of immobilized cell systems have been applied in biohydrogen production, including surface attachment, self-flocculation and gel entrapment approaches, among which the surface attachment approach was most frequently used for dark hydrogen fermentation (Lin et al., 2009). However, many previous studies have reported