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Enhancement of lipopeptides production in a two-temperature-stage process under SSF conditions and its bioprocess in the fermenter

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HIGHLIGHTS

- Effects of various temperatures on lipopeptides production was studied in SSF.
- A two temperature stage process was developed.
- The lipopeptides yields were enhancced by 8.40% in flask and 13.11% in fermenter.
- 1000-Fold scale-up fermentation in fermenter was successfully achieved.

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ABSTRACT

A two-temperature-stage process was developed for the production of lipopeptides under SSF conditions. The effects of various temperatures, ranging from 25 to 40 °C, on the bacterial growth during the growth stage and on the production of lipopeptides during the productive stage were investigated. The optimum temperatures were found to be 30 °C for the growth of the strain and 37 °C for the biosynthesis of lipopeptides. The two-stage fermentation temperatures should be 30 °C in the initial 24 h and then 37 °C for the enhanced production of lipopeptides. The bioprocess results obtained in a 50 L fermenter verified the efficacy of this technique, which increased the yield of lipopeptides by 8.40% in flasks and by 13.11% in the fermenter, with a 4 h decrease of fermentation time in the fermenter. The 1000-fold scale-up of fermentation in a fermenter was successfully achieved.

1. Introduction

It was reported recently that soybean flour and rice straw can be utilized for the production of lipopeptides using solid-state fermentation (SSF) (Zhu et al., 2012). In that paper, the researchers evaluated the possibility of using agro-industrial byproducts as substrates for the production of lipopeptides, and optimized the culture conditions to maximize the productivity from SSF. Under the optimized conditions, the yield of lipopeptides reached 50.01 mg/gds. However, these results were obtained in flasks. The conditions in a scale-up bioreactor may be different from those in flasks (Banerjee et al., 2012; Kanda et al., 2010) and require investigation for industrial production.

The fermentation process can be significantly influenced by various physical and chemical parameters (Sharma and Arora, 2010), temperature is one of the most important factors because it can affect the kinetics of the process, which affects the duration and the rate of fermentation as well as the production of fermentative metabolites (Beltran et al., 2008). A higher fermentation temperature might be advisable for faster fermentation, but it might not be beneficial for the yield and quality of the fermentation products (Xu et al., 2010). Generally, a complete fermentation period for lipopeptide production consists of three major stages, i.e., the growth stage, in which microorganisms begin to use the substrates for growth; the productive stationary stage, in which the lipopeptides begin to accumulate rapidly (Wang et al., 2008), and the decline stage, in which both the cell numbers and secondary metabolites yields begin to decline. The optimal temperature for metabolite production may be different than that for cell growth (Raninger and Steiner, 2003; Wei et al., 2003). It has been suggested that changing the temperature may play an important role in the induction of cell synchrony thereby increasing productivity and decreasing the production time (Storms et al., 2012). Whereas previous studies on the fermentation of lipopeptides under SSF conditions have focused mainly on the use of different substrates and the optimization of the media compositions (Al-Ajlani et al., 2007; Mizumoto and Shoda, 2007), the effect of temperature on

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