Continuous Production of Poly(hydroxybutyrate-co-hydroxyvalerate)-Effect of Propionate and Valerate on the Microbial Gro

林逸群、?瑞澤

E-mail: 9300181@mail.dyu.edu.tw

ABSTRACT

PHA is a kind of polyesters produced by microorganisms. Ralstonia eutropha can produce PHA when the carbon source is still sufficient, but one of necessary nutrient sources (e.g., nitrogen) is lacking. R. eutropha can produce PHBV (poly-hydroxybutyrate-co-hydroxyvalerate) if organic acidic substrates such as sodium propionate and valerate are fed during the second stage of microbial growth. However, excessive sodium propionate and valerate may be toxic to R. eutropha and hinder microbial growth and PHBV accumulation. Therefore, the feeding rate of acidic substrate must be properly controlled. When acid substrates are fed, bacteria can take them into the pathway of synthesizing PHBV. A continuous stirred tank bioreactor is used to enhance the effect of limiting nutrients on the PHBV accumulation. The production rates of PHBV in bacteria intracellular for different acidic substrates and C/N ratios are compared. In this study, R. eutropha was cultivated in a continuous stirred tank bioreactor with various dilution rates, C/N ratio (20, 30, and 40) and acid substrates (sodium propionate or sodium valerate) in order to explore the microbial growth, the PHBV accumulation, the consumption of glucose, nitrogen, and sodium propionate or valerate during fermentation. Results show that PHBV was about 37% of the dry biomass and PHBV production rate 0.094 g/L・h, the highest peak occurring at the dilution rate of 0.060 h-1. In the case of feeding sodium propionate, the biomass contains about 14%(w/w) PHBV at a dilution rate of 0.060 h-1, the average molar ratio of HB/HV approximately maintained at 90:10, and the yield of HV is 0.040 g per gram of propionate. In the case of feeding sodium valerate, the biomass contains about 37%(w/w) PHBV at the dilution rate of 0.060 h-1, the average molar ratio of HB/HV approximately maintained at 60:40, and the yield of HV is 0.131 g per gram of valerate. It has been shown that feeding sodium valerate can promote the accumulation of HV better than sodium propionate. In this study, the dilution rate, C/N ratio, and acid substrate were selected as manipulating factors. Main effects as well as their interactions were taken into consideration. The results were analyzed through statistical software called Statistica. The effect of manipulating factors on the microbial growth, the PHBV accumulation, the consumption of glucose, nitrogen, sodium propionate, and sodium valerate during fermentation could be obtained through the ANOVA (analysis of variances). Experimental results show that the higher the dilution rate is during the high rate, the higher the HB productivity will be. Feeding sodium valerate seems better to the HV production than feeding sodium propionate. Experimental results also show that the production of HB decreases, if the C/N ratio increases. The effect of manipulating factors on the production of PHBV is not that substantial.

Keywords : PHBV, continuous stirred tank reactor, dilution rate, Ralstonia eutropha, C/N ratio, analysis of variance

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