A tandem process for the production of levan and bioethanol by microbes

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ABSTRACT

The purpose of the present study is to investigate the feasibility of a tandem production of levan and ethanol by microbial fermentation using sucrose substrate. The tandem process involves fermentation of Bacillus subtilis (natto) Takahashi in sucrose medium to produce levan, separation of levan product from glucose by-product by ultrafiltration and fermentation of the glucose remnant from levan production by Z. mobilis to produce ethanol. In the production of levan, the levan production was carried out in a 5-l fermenter using the optimal conditions developed previously in the shake-flask experiments. After cultivation of B. subtilis (natto) Takahashi for 48 h, 60-70 g l-1 of levan was produced in medium containing 250g l-1 sucrose, which was about 50 % yield on available fructose. After removing the cells, the fermentation broth was concentrated by ultrafiltration. The concentrated retentate, which was very viscous, required addition of 95 vol.% cold ethanol to give high yield with the total recovery of levan. The product thus obtained is consisted of high and low molecular weight levans. The filtrate containing glucose, fructose and unreacted sucrose was used for ethanol fermentation. Fractionation of levans of low and high molecular weight is necessary, because levans with different molecular weights are needed for different purposes. Attempts were made to carry out the fractionation of levans in the concentrated retentate by ultrafiltration through a membrane of 300, 000 MWCO, before their precipitation by alcohol. The cell-free solution was first cycled though the Tami system with the membrane of 300,000 MWCO. The first concentrated retentate, required addition of 95 vol.% cold ethanol to give high yield with the total recovery of high molecular weight levan. The first filtrate was further cycled through the membrane of 5,000 MWCO. The second concentrated retentate was harvested with the total recovery of low molecular weight levan by the addition of 95 vol.% cold ethanol. The second filtrate containing glucose, fructose and unreacted sucrose was used for ethanol fermentation. The filtrate which contained roughly 150 g l-1 of hexose was diluted, supplemented with yeast extract, (NH4)2SO4, MgSO4 · 7H2O, KH2PO4and used for alcohol fermentation by Z. mobilis. Nutritional and operational factors were investigated for optimal ethanol production; the results showed that incubation of Z. mobilis in the medium containing glucose remnant diluted two-fold, supplemented with Yeast extract 1%、KH2PO4 0.1%、(NH4)2SO4 0.1%、MgSO4．7H2O 0.05%, at 30°C, pH 6.5, standing for 48 h gave the highest 31.84 g l-1 (Ey 93.78%、YP/S 0.49 g/g) of bio-ethanol. The tandem process developed in this study is an eco-friendly process in that the sucrose substrate was fully utilized without any waste of by-produdcts in the process; in addition, two invaluable environmental-friendly biomaterials (levan and ethanol) were produced. Furthermore, the amount of alcohol required for levan recovery could be reduced to a fourth of that generally used in the conventional precipitation.

Keywords : Bacillus subtilis、Zymomonas mobilis、ultrafiltration、levan、ethanol

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