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生物化学工程与技术

基于动力学模型的丙酮酸分批发酵温度控制策略

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摘要

在对不同温度下*Torulopsis glabrata*分批发酵生产丙酮酸过程进行详尽分析的基础上，建立丙酮酸分批发酵动力学模型，并分析了温度与动力学参数之间的函数关系，提出*T.glabrata*高产量、高产率和高强度发酵生产丙酮酸的温度控制轨迹：在发酵初始阶段(0～8 h) 控制发酵温度为34℃以维持较高的菌体生长速率和丙酮酸合成速率；发酵中期(8～42 h)，逐步将发酵温度降到27℃以获取代谢流强化和细胞衰亡之间的最佳平衡；然后维持27℃至发酵结束以提高细胞后续产酸能力。采用这一最佳温度控制轨迹，丙酮酸产量(89.4 g •L^{-1})、对葡萄糖产率(0.76 g •g^{-1})和生产强度(1.32 g •L^{-1} •h^{-1})比30℃恒温发酵分别提高了25.7%、16.9%和48.3%。

关键词

光滑球拟酵母 动力学模型 温度 控制策略

分类号

Maximized pyruvate production through temperature shifting strategy based on kinetics model

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Abstract

In the batch fermentation of pyruvate, temperature is one of the most important environmental factors that affect pyruvate productivity.The effect of temperature, varying from 26℃ to 34℃, on production of pyruvate in a 7 L stirred fermenter by *T.glabrata* CCTCC M202019 was investigated.A modified Logistic equation and Luedeking-Piret equation were used to estimate kinetics of cell growth and pyruvate production.The effect of temperature on the estimated kinetic parameters was further studied by regression analysis.Based on kinetic parameters analysis, a temperature-shifting strategy was proposed, in which, at 0—8 h, culturing was performed at 34℃ to obtain a high specific cell growth rate, and at 8—42 h, the temperature was decreased step by step from 34℃ to 27℃ to keep a high pyruvate production rate.After 42 h, the temperature was maintained at 27℃ to weaken inhibition of pyruvate and offer constant production capacity of pyruvate in the anaphase of fermentation.A high concentration (89.4 g•L^{-1}), yield (0.76 g•g^{-1}) and productivity (1.32 g•L^{-1}•h^{-1}) of pyruvate were achieved by applying this strategy, which were 25.7%, 16.9% and 48.3% higher than batch fermentation at a constant temperature 30℃, respectively.

Key words

Torulopsis glabrata kinetics model temperature shifting strategy

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