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# Continuous butanol fermentation from xylose with high cell density by cell recycling system

Jin Zheng [a], Yukihiro Tashiro [b], Tsuyoshi Yoshida [a], Ming Gao [a], Qunhui Wang [c], Kenji Sonomoto [a,d,*]

[a] Laboratory of Microbial Technology, Division of Applied Molecular Microbiology and Biomass Chemistry, Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School, Kyushu University, 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, Japan
[b] Laboratory of Soil Microbiology, Division of Applied Molecular Microbiology and Biomass Chemistry, Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School, Kyushu University, 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, Japan
[c] Department of Environmental Engineering, University of Science and Technology Beijing, Beijing 100083, China
[d] Laboratory of Functional Food Design, Department of Functional Metabolic Design, Bio-Architecture Center, Kyushu University, 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, Japan

## HIGHLIGHTS

- pH was a significant factor in continuous fermentation of butanol.
- Butanol productivity were increased dramatically by cell recycling.
- Maximum butanol productivity was obtained at a dilution rate of 0.78 $h^{-1}$.

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## ABSTRACT

A continuous butanol production system with high-density *Clostridium saccharoperbutylacetonicum* N1-4 generated by cell recycling was established to examine the characteristics of butanol fermentation from xylose. In continuous culture without cell recycling, cell washout was avoided by maintaining pH > 5.6 at a dilution rate of 0.26 $h^{-1}$, indicating pH control was critical to this experiment. Subsequently, continuous culture with cell recycling increased cell concentration to 17.4 g $L^{-1}$, which increased butanol productivity to 1.20 g $L^{-1}$ $h^{-1}$ at a dilution rate of 0.26 $h^{-1}$ from 0.529 g $L^{-1}$ $h^{-1}$ without cell recycling. The effect of dilution rates on butanol production was also investigated in continuous culture with cell recycling. Maximum butanol productivity (3.32 g $L^{-1}$ $h^{-1}$) was observed at a dilution rate of 0.78 $h^{-1}$, approximately 6-fold higher than observed in continuous culture without cell recycling (0.529 g $L^{-1}$ $h^{-1}$).



## 1. Introduction

The world's rapidly diminishing petroleum reserves and increasing environmental concerns over the impact of petroleum fuel emissions, has made the search for alternative biofuel sources more important (Van Hecke et al., 2012). Butanol is a valuable biofuel, as it possesses many favourable physical properties, including higher energy content, higher boiling points, and a reduced need to modify combustion engines as compared to ethanol (Tran et al., 2010).

Acetone–butanol–ethanol (ABE) fermentation from renewable resources has been paid much attention. Agricultural residues, which consist mainly of cellulose and hemicellulose, are the most abundant renewable resource, and have great potential for butanol fermentation (Jang et al., 2012). Various carbohydrates such as glucose, fructose, mannose, sucrose, lactose, and starch can be consumed by butanol-producing strains (Kumar and Gayen, 2011). However, few studies have focused on butanol fermentation with xylose as the sole carbon source. In previous study (Shinto et al., 2008), *Clostridium saccharoperbutylacetonicum* N1-4 gave a higher yield of butanol from xylose (0.62 C-mol/C-mol) than from glucose (0.53 C-mol/C-mol) in batch culture, suggesting xylose is a useful substrate for ABE fermentation, although a detailed mechanism

* Corresponding author at: Laboratory of Microbial Technology, Division of Applied Molecular Microbiology and Biomass Chemistry, Department of Bioscience and Biotechnology, Faculty of Agriculture, Graduate School, Kyushu University, 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, Japan. Tel./fax: +81 92 642 3019.
*E-mail addresses:* zhengjin2811@gmail.com (J. Zheng), tashiro@agr.kyushu-u.ac.jp (Y. Tashiro), jubeat.knit.tsuyoshi@gmail.com (T. Yoshida), gaoming402@gmail.com (M. Gao), wangqh59@163.com (Q. Wang), sonomoto@agr.kyushu-u.ac.jp (K. Sonomoto).

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