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Fungal pretreatment of cornstalk with *Phanerochaete chrysosporium* for enhancing enzymatic saccharification and hydrogen production

Lei Zhao [a], Guang-Li Cao [a,b,*], Ai-Jie Wang [a], Hong-Yu Ren [a], De Dong [b], Zi-Nan Liu [b], Xiao-Yu Guan [b], Cheng-Jiao Xu [a], Nan-Qi Ren [a,*]

[a] State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, Harbin 150090, China
[b] School of Life Science and Technology, Harbin Institute of Technology, Harbin 150090, China

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ABSTRACT

The feasibility of fungal pretreatment of cornstalk with *Phanerochaete chrysosporium* for enzymatic saccharification and H_2 production was investigated in this study. Firstly, cornstalk was pretreated with *P. chrysosporium* at 29 °C under static condition for 15 d, lignin reduction was up to 34.3% with holocellulose loss less than 10%. Microscopic structure observation combined FTIR analysis further demonstrated that the lignin and crystallinity were decreased. Subsequently, the fungal-pretreated cornstalk was subjected to enzymatic hydrolysis by the crude cellulase from *Trichoderma viride* to produce fermentable sugars which were then fermented to bio-H_2 using *Thermoanaerobacterium thermosaccharolyticum* W16. The maximum enzymatic saccharification was found to be 47.3% which was 20.3% higher than the control without pretreatment. Upon fermentation of enzymatic hydrolysate, the yield of H_2 was calculated to be 80.3 ml/g-pretreated cornstalk. The present results suggested the potential of using hydrogen-producing bacteria for high-yield conversion of cornstalk into bio-H_2 integrate with biological pretreatment and enzymatic saccharification.

1. Introduction

Increased concerns over the excessive utilization of limited energy resources and environmental impacts of fossil fuel use have inspired worldwide research and development of hydrogen gas (H_2) as an alternative. Anaerobic hydrogen fermentation seems to be favorable among various hydrogen production methods, since hydrogen can be yielded at a high rate in an environmental benign and energy-saving process (Kumar and Das, 2000; Ren et al., 2009; Zhao et al., 2012). Currently, fermentative hydrogen production is primarily from simple carbohydrates, such as glucose, sucrose, starch and waste water contain these compounds (Akutsu et al., 2009; Davila-Vazquez et al., 2009; Yuan et al., 2009), which greatly increase the hydrogen production cost. Lignocellulosic biomass, mainly from agricultural residues, municipal wastes and forestry sources (Wan and Li, 2010), is particularly well-suited for hydrogen application because of its large-scale availability, low cost, and environmentally friendly production. Cornstalk, as the most abundant agricultural residue in China, has the greatest potential to be used for hydrogen production.

However, lignocellulose has a relatively complex structure, resulting in highly resistant to enzymatic hydrolysis and low cellulose conversion. Many researchers have reported that without appropriate pretreatment, only 20% theoretical maximum sugar yield of cornstalk can be obtained from enzymatic hydrolysis (Kim et al., 2006; Mosier et al., 2005). Therefore, the development of a pretreatment process to separate lignin and hemicellulose from cellulose, deconstruct the cellulosic polymers and disrupt the crystalline structure of lignocellulose for improving enzymatic hydrolysis efficiency is urgent. The current leading pretreatment processes (e.g. diluted acid, steam explosion, alkali extraction, hydrothermolysis, etc.) constantly require high energy (steam and electricity), corrosion resistant, and high-pressure reactors. During the pretreatment procedures, great amount of inhibitors are produced (Bak et al., 2009), as well as lose in holocellulose (cellulose and hemicelluloses), which would hinder the enzymatic saccharification and hydrogen fermentation. Biological pretreatment using white rot fungus is increasingly being advocated as a process which not only does not have the disadvantages mentioned above, but also requires less energy contribution for lignin removal from lignocellulosic biomass. This process has been receiving extensive attention for biodelignification of lignocellulosic biomass. Dias et al. (2010) found that the initial ratio of cellulose/lignin in the wheat straw of 2.7 was increased to 5.9 and 4.6 after fungal pretreatment by *Basidiomycetes* Euc-1 and *Irpex lacteus*, respectively.

* Corresponding authors. Fax: +86 451 86402695 (G-L. Cao), +86 451 86282008 (N.-Q. Ren)
E-mail addresses: glcao1980@yahoo.com.cn (G.-L. Cao), rnq@hit.edu.cn (N.-Q. Ren).

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