GENETICALLY MODIFIED LIGNOCELLULOSIC BIOMASS FOR IMPROVEMENT OF ETHANOL PRODUCTION

Qijun Wang[a,b] and Shengdong Zhu[b,*]

Production of ethanol from lignocellulosic feed-stocks is of growing interest worldwide in recent years. However, we are currently still facing significant technical challenges to make it economically feasible on an industrial scale. Genetically modified lignocellulosic biomass has provided a potential alternative to address such challenges. Some studies have shown that genetically modified lignocellulosic biomass can increase its yield, decreasing its enzymatic hydrolysis cost and altering its composition and structure for ethanol production. Moreover, the modified lignocellulosic biomass also makes it possible to simplify the ethanol production procedures from lignocellulosic feed-stocks.

Keywords: Lignocellulosic biomass; Genetic modification; Ethanol production

*Contact information: a: College of Horticulture and Landscape Architecture, Engineering Research Center of Konjac Resource Utilization of Chongqing Colleges and Universities , Southwest University, Chongqing 400716, PR China; b: Key Laboratory for Green Chemical Process of Ministry of Education, Hubei Key Laboratory of Novel Chemical Reactor and Green Chemical Technology, School of Chemical Engineering and Pharmacy, Wuhan Institute of Technology, Wuhan 430073, PR China, *Corresponding author: zhusd2003@21cn.com*

Why are we interesting in production of ethanol from lignocellulosic feed-stocks?

Consumption of energy and natural resources has increased steadily with population growth and industrial development. The traditional chemical and energy industry has played an important role in establishment of modern civilization. As we all know, the prosperity of our traditional chemical and energy industry has been based on the steady availability of a cheap raw material supply, especially such non-renewable fossil resources as crude oil, coal, and natural gas. However, its raw material supply is facing great challenges because of the limited reservoir of fossil resources and their non-renewable nature. Moreover, the use of the fossil resources has also caused severe environmental and ecological problems. To maintain the sustainable development of industry, the obvious choice is to shift its feedstock from non-renewable fossil resources to renewable bio-resources, especially lignocellulosic materials, which are the most abundant renewable resources in the world. Therefore, our interest in production of ethanol from lignocellulosic feed-stocks is based on the following three facts: First, ethanol itself is not only a clean energy resource but also a widely-used solvent or chemical feed-stock, which is an important platform compound for modern chemical and energy industry. Second, technical breakthroughs in lignocellulosic ethanol production provide a powerful tool to reform the traditional chemical and energy industry. Finally, the lignocellulosic ethanol production itself is a typical process for the modern chemical and energy industries.

What are the main technical obstacles for the lignocellulosic ethanol production?

The main chemical components in lignocellulosic biomass are cellulose, hemicellulose, and lignin. Because of the strong crystalline structure of cellulose and the presence of the complex structure of lignin and hemicellulose with cellulose in lignocellulosic biomass, some pretreatment procedures are carried out before the enzymatic hydrolysis of lignocellulosic biomass to sugars, which can subsequently fermented to ethanol. A simplified scheme for lignocellulosic ethanol production process is shown in **Fig. 1**.

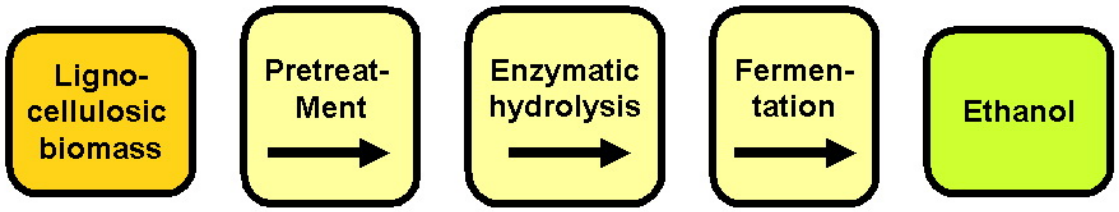

Fig. 1. Simplified scheme for a lignocellulosic ethanol production process

Although extensive research work has been carried out, there are still some technical obstacles facing lignocellulosic ethanol production on an industrial scale. The main technical obstacles are lack of efficient pretreatment methods, the high cost of enzymatic hydrolysis, and lack of suitable microorganisms for lignocellulosic biomass fermentation.

How can genetically modified biomass improve the lignocellulosic ethanol production?

The term "genetically modified lignocellulosic biomass" refers to biomass whose genetic material has been altered using genetic engineering techniques. These techniques, generally known as recombinant DNA technology, use DNA molecules from different sources, which are combined into one molecule to create a new set of genes. Growth of plants having these new genes provides biomass having an altered composition. Recent research on lignocellulosic biomass physiology has shown that its biosynthesis is controlled by some key genes. For example, the CesA gene plays an important role in cellulose biosynthesis within the lignocellulosic biomass. Based on the recombinant DNA technology and knowledge on the biosynthesis of lignocellulosic biomass, it is possible to change the composition and structure of lignocellulosic biomass and increase the yield of ethanol production. Accordingly, its pretreatment procedures can be simplified and its enzymatic hydrolysis cost can be greatly decreased, because the genetically modified lignocellulosic biomass has its composition and structure more favorable for its enzymatic hydrolysis. In this way, genetically modified lignocellulosic biomass provides a potential alternative to improve lignocellulosic ethanol production.