Bioethanol production from non-acid pretreated woody biomass

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Fuel ethanol produced from biomass is a promising approach to reduce the fossil fuel use and alleviate the global warming. Lignocellulosic biomass, such as wood and agricultural residues, is attractive materials for the ethanol production since it is the most abundant reproducible resources on earth. In general, the conversion of lignocellulosic biomass to ethanol includes two main processes: acid hydrolysis of the lignocellulosic feedstock to fermentable reducing sugars, and fermentation of the sugars to ethanol. However, the cost of ethanol production from lignocellulosic biomass is relatively high based on current technologies. The present hydrolysis processes including pretreatment for enzymatic hydrolysis still leave room for improvement of efficiency and cost reduction, because those processes usually require the use of chemicals such as sulfuric acid and ammonia those add costs to the processes. These chemicals must also be neutralized or recovered to reduce the loads on the environment.

Our goal is to develop an efficient and economical ethanol-production technology from woody biomass using a new non-sulfuric pretreatment based on mechanical milling (MM). In this study, we discuss the effects of MM pretreatment of woody biomass on enzymatic hydrolysis and fermentation.

MM pretreatment by a planetary ball-mill reactor decreased the cellulose crystallinity of woody meal. This treatment was very effective in improving the enzymatic digestibility of softwood as well as hardwood. An enzymatic hydrolysis for cellulose with a milling-treated eucalyptus wood was achieved with relatively low enzymatic loading (2FPU cellulase/g - substrate). Under the optimal conditions, approximately 38 g of glucose and 10g of xylose from 100 g of dry eucalyptus wood were produced through MM pretreatment and enzymatic hydrolysis. The glucose in this hydrolysate was fermented by baker’s yeast to ethanol with 90% value of theoretical yield. The enzymatic saccharification ratio of the milled eucalyptus wood depended on a milling time, which involves significant energy consumption. However, we found that the milling time required for the sufficient saccharification ratio was shortened by combining MM pretreatment with a low cost pretreatment such as hydrothermal hydrolysis.