

## ABSTRACT

Zeng, Meijuan. Ph.D. Purdue University, August 2007. Characterization of Cell Wall Deconstruction Induced by Aqueous Pretreatment and Enzyme Hydrolysis. Major Professor: Michael R. Ladisch.

Enzyme saccharification still constitutes a significant portion of the overall cost in biomass to ethanol production. The goals of this research are to study the impact of different particle size and different fractions (leaves and stalks) of corn stover on the efficiency of hot water pretreatment and enzymatic hydrolysis. This work presents methods for probing the effect of pretreatments and/or direct changes in plant cell tissue, measured and observed at a plant cell level by use of scanning electronic microscopic observations (SEM) combined with carbohydrate analyses by HPLC, to achieve understanding of mechanisms that could help to accelerate research on pretreatment and hydrolysis of lignocellulosic biomass.

Small particles (53-75  $\mu\text{m}$ ) are more susceptible to enzymatic hydrolysis than large particles (425-710  $\mu\text{m}$ ). This difference between the two particle size ranges is eliminated when the stover is pretreated with liquid hot water at 190°C for 15 min, pH between 4 and 7. A mathematical model is developed to describe the process incorporating adsorption of cellulase as well as end-product inhibition of enzymatic hydrolysis. The model distinguishes heterogeneous and homogeneous reaction types.

Exposed cellulose is related to accessible surface area, and thereby represents the cellulose that is accessible to enzyme molecules. The higher predicted initially exposed cellulose before pretreatment for 53-75  $\mu\text{m}$  particles corresponds to higher estimated outer surface area. During pretreatment, the cell wall is observed to be deconstructed; more inner cell structures are exposed. This enlarges the accessible surface area and induces a significant increase in hydrolysis.

Studies carried out on the fractions of “stay green” variety corn stover show that stalk pith is always the most readily hydrolyzed fraction compared to leaves and stalk fiber. Enzymatic hydrolysis on pretreated pith show that both glucose and xylose conversion can reach ~90% in 24 hours at 60FPU/g glucan cellulase loading. Pretreated leaves and fiber achieve 70~80% and 50~60% respectively. Different types of lignification patterning of secondary cell walls are all observed upon hydrolysis. Compositional analyses of pretreated fractions indicate that distribution of lignin in the cell wall may offer an explanation.