HEMICELLULOSE EXTRACTION FROM SWITCHGRASS, PINE AND POPLAR AND ITS EFFECT ON ENZYMATIC CONVERTIBILITY OF CELLULOSE-RICH RESIDUE

Wenhui Geng, Joel Pawlak, Richard Venditti

Department of Forest Biomaterials, North Carolina State University

431 Dan Allen Drive, 3222 Pulp and Paper Labs

Raleigh, NC 27695, USA

wgeng@ncsu.edu, jjpawlak@ncsu.edu, richardv@ncsu.edu

Hemicelluloses, arguably the second most abundant class of biopolymers, are recognized as an immense renewable resource, with potential for conversion to fuels or to polymer materials. However, during the lignocellulosic based bioethanol conversion process, hemicellulose can be degraded to inhibitors during pretreatments, which will decrease the sugar conversion during enzymatic hydrolysis. In addition, xylose present in the fermentation solution requires a different microorganism than does glucose and it requires a more complex fermentation technology to convert both. Therefore, it would be beneficial to extract hemicellulose before a bioethanol conversion process for cellulose, and to develop a higher valued product from hemicellulose. Lignin present in biomass is expected to limit the extractability of hemicellulose and/or enzyme accessibility of cellulose-rich residue because of the physical barrier and chemical linkage between carbohydrate and lignin. To investigate, untreated and delignified samples of switchgrass, poplar and pine were subjected to hemicellulose alkaline extraction (10% NaOH solution with liquid/solid ratio of 20) and the residual cellulose-rich residue evaluated for enzymatic hydrolysis to sugar. Figure 1 shows that hemicellulose extraction efficiency is high for switchgrass and poplar with or without prior delignification, but pine requires prior delignification for hemicellulose extraction. Figure 2 shows that for switchgrass high convertibility occurs with or without delignification before hemicellulose extraction. For both poplar and pine, delignification before hemicellulose extraction significantly increases the convertibility. Ongoing research includes developing a hemicellulose extraction technology co-located with a pulp mill and evaluating hemicellulose as a feedstock for polymeric applications to substitute for starch.

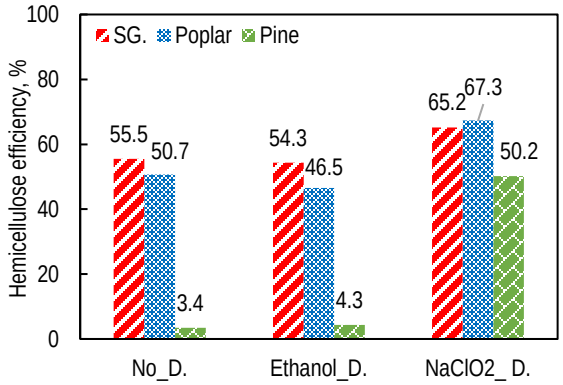

Figure 1. Effect of delignification on hemicellulose extraction efficiency. No_D indicates no delignification, Ethanol_D indicates delignification with ethanol/alkali and NaClO2_D indicates delignification with NaClO2.

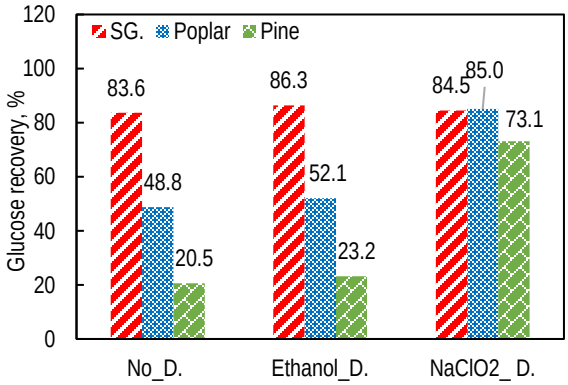

Figure 2. Effect of delignification on enzymatic convertibility of cellulose-rich residue. Enzyme loading of 5 FPU/g substrate, T=50 °C, time =96 h, 5% solid loading.