

ENZYMATIC HYDROLYSIS OF ETHANOL ORGANOSOLV PRETREATED LOBLOLLY PINE AND SWEETGUM

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Abstract

The interaction between xylan/lignin and cellulase enzymes plays a key role in the effective hydrolysis of lignocellulosic biomass. Elucidation of the distinct roles of residual xylan and lignin has been investigated in this study. We pretreated loblolly pine (*Pinus taeda*) and sweetgum (*Liquidambar styraciflua*) in an ethanol organosolv process and characterized the enzymatic hydrolysis of pretreated biomass quantitatively based on the initial hydrolysis rates and the final hydrolysis yields. The initial hydrolysis rates of organosolv pretreated loblolly pine (OPLP) and sweetgum (OPSG) were $1.45 \text{ g}\cdot\text{L}^{-1}\cdot\text{h}^{-1}$ and $1.19 \text{ g}\cdot\text{L}^{-1}\cdot\text{h}^{-1}$ under the enzyme loading of 20 FPU. The final glucan hydrolysis yields of OPLP and OPSG at 72 h were 76.4% and 98.9%. By correlating the amount of residual lignin and xylan to the initial hydrolysis rate and the final hydrolysis yield in OPLP and OPSG, a more accurate fundamental understanding of the roles of xylan and lignin in limiting the enzymatic hydrolysis has been developed. The higher amount of residual xylan (9.7%) in OPSG resulted in lower initial hydrolysis rate ($1.19 \text{ g}\cdot\text{L}^{-1}\cdot\text{h}^{-1}$). The higher amount of residual lignin in OPLP (11.2%) resulted in lower final hydrolysis yield of glucan (76.4%). Apparently, xylan was much closer to cellulose structurally than lignin, and consequently the initial interaction between xylan and cellulases decreased the initial hydrolysis rate. The interaction between lignin and cellulases came later and affected the final hydrolysis yield. The Langmuir adsorption isotherm between cellulases and pretreated substrates further confirmed the distinct roles of residual xylan and lignin on enzyme affinity to the substrates. The addition of xylanase could increase the initial hydrolysis rates from 60% to 67% in OPLP and from 89% to ~100% in OPSG under the enzyme loading of 10 FPU. In addition, we observed in the simultaneous saccharification and fermentation (SSF) that ethyl xyloside was produced by the enzymatic catalysis of xylose and ethanol.