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**Formaldehyde stabilization facilitates lignin monomer production during biomass depolymerization**

Formaldehyde addition during biomass pretreatment leads to near-theoretical yields of lignin monomers.

**The Science**

We report that using formaldehyde to stabilize lignin during extraction leads to near-theoretical yields of lignin monomers after hydrogenolysis of the extracted product. These yields were three to seven times higher than those obtained when using the analogous method without formaldehyde.

**The Impact**

The longstanding interest in lignin valorization has translated into few commercial processes because of the lack of practical high-yield lignin depolymerization methods that can be used while upgrading biomass polysaccharides. Our formaldehyde stabilization results suggest that lignin upgrading could be easily integrated into current biorefinery schemes, especially considering that formaldehyde is a relatively inexpensive bulk chemical that can be produced from biomass-derived syngas or methanol, either sourced biologically or from lignin methoxyl groups.

**Summary**

Practical, high-yield lignin depolymerization methods could greatly increase biorefinery productivity and profitability. However, development of these methods is limited by the presence of inter-unit carbon-carbon bonds within native lignin, and further by formation of such linkages during lignin extraction. We report that adding formaldehyde during biomass pretreatment produces a soluble lignin fraction that can be converted to guaiacyl and syringyl monomers at near theoretical yields during subsequent hydrogenolysis (47 mole % of Klason lignin for beech and 78 mole % for a high-syringyl transgenic poplar). These yields were three to seven times higher in the presence of formaldehyde, which prevented lignin condensation by forming 1,3-dioxane structures with lignin side-chain hydroxyl groups. By depolymerizing cellulose, hemicelluloses, and lignin separately, monomer yields were between 76 and 90 mole % for these three major biomass fractions.

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**Publications**

Shuai, L. *et al.* “Formaldehyde stabilization facilitates lignin monomer production during biomass depolymerization**.”** *Science* **354**, 329-333 (2016) [DOI: 10.1126/science.aaf7810].

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