Analyzing changes in lignin chemistry due to biofuel production process

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From the perspective of producing cellulosic biofuels from plant biomass, lignin is often considered the enemy. It encases cellulose fiber in plant biomass and restricts hydrolytic enzymes from accessing the cellulose, and it inhibits hydrolytic activity by adsorbing the enzymes to its surface. Biomass pretreatment processes during biofuels production are designed in part to separate lignin from cellulose fibers, increasing the accessibility of enzymes to the cellulose. However, while numerous different biomass pretreatment methods have been investigated in detail with regard to their process chemistry, yield, and economics, relatively little work has been done to elucidate the changes to the lignin chemistry that occur during biomass pretreatment. Advancing this understanding is especially important to the development of value-added co-products from the residues left over after biofuel production. The work presented here was undertaken specifically to understand how lignin chemistry is affected by wet oxidation and mild bisulfite pretreatment of Douglas fir wood within the NARA project. First, fermentation residual solids (FRS) obtained from the biofuel production process were characterized with respect to their lignin, carbohydrate, and ash contents. Then, high-purity lignin was isolated from the FRS utilizing the enzymatic mild acidolysis lignin (EMAL) procedure previously developed to isolate lignin from Kraft pulps and wood flour. The chemistry and molecular weight of the isolated lignin was analyzed using NMR and GPC methods and compared to lignin isolated from the untreated wood feedstock. The application of these methods has resulted in a nearly comprehensive characterization of the lignin in NARA feedstocks.