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**Next-generation ammonia pretreatment enhances cellulosic biofuel production**

Improving cellulosic biomass deconstruction while extracting lignin.

**The Science**

Lignocellulosic crop residues are a promising alternative feedstock for producing liquid fuels and chemicals for modern biobased economies, and biochemical conversion of lignocellulosic biomass to liquid fuels requires pretreatment and enzymatic hydrolysis of the biomass to yield fermentable sugars. To compete with traditional refineries, biorefineries must achieve high carbohydrate-to-fuel yields with low enzymatic input and facilitate lignin valorization to co-products extending beyond simply using lignin to generate heat and power. Most pretreatment processes require high enzymatic loadings to achieve higher sugar yields under industrially-relevant conditions.

**The Impact**

By using liquid ammonia to pretreat lignocellulosic biomass under certain conditions, it is possible to convert native cellulose to a highly digestible cellulose allomorph (i.e., cellulose III) and simultaneously extract a lignin fraction for downstream catalytic upgrading. Using this method, enzyme loadings can be significantly reduced by removing inhibitors caused by lignin presence in the stream, while increasing the enzyme accessibility to structural carbohydrates and enhancing cellulose activity. Furthermore, the resulting hydrolysate from this process are readily fermentable due to the removal of lignin-derived inhibitors.

**Summary**

In collaboration with researchers at the Joint BioEnergy Institute and Bioenergy Science Center, researchers in the Great Lakes Bioenergy Research Center developed a new liquid ammonia pretreatment called Extractive Ammonia (EA) to simultaneously convert native crystalline cellulose I to a highly digestible cellulose III allomorph and selectively extract up to ~45% of the lignin from lignocellulosic biomass with near-quantitative retention of all polysaccharides. EA pretreated corn stover yielded higher fermentable sugars compared to the older Ammonia Fiber Expansion (AFEX) process while using 60% lower enzymatic loading. EA preserves extracted lignin functionalities, offering the potential to co-produce lignin-derived fuels and chemicals in the biorefinery. This single-stage EA fractionation process achieves high biofuel yields (18.2 kg Et-OH/100 kg untreated corn stover on a dry weight basis), comparable to those achieved using ionic liquid pretreatments. The EA process achieves these ethanol yields at industrially-relevant conditions using low enzyme loadings (7.5 mg protein/ g glucan) and high solids loading (8% glucan, w/v).

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**Publications**

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