Key plant traits yield more sugar for biofuels

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Scientists from the Department of Energy's BioEnergy Research Center are testing core samples from poplar trees to identify key characteristics that influence how the plants can be more effectively processed into biofuels. Credit: Oak Ridge National Laboratory

(PhysOrg.com) -- New clues about plant structure are helping researchers from the Department of Energy?s BioEnergy Science Center narrow down a large collection of poplar tree candidates and identify winners for future use in biofuel production.

Led by Charles Wyman of the Bourns College of Engineering's Center for Environmental Research and Technology at the University of

California, Riverside, a research team from Oak Ridge National Laboratory, the National Renewable Energy Laboratory and UCR determined that the amount and composition of lignin in the plant's cell wall interact in an unanticipated way to influence release of sugar from the plant.

The research was published as "Lignin content in natural Populus variants affects sugar release," in the *Proceedings of the National Academy of Sciences*.

Lignin serves as a major roadblock for biofuel production because it forms strong bonds with sugars and interferes with access to these carbohydrates, making it difficult to extract the plant's sugars contained in cellulose and hemicellulose for conversion to transportation fuels.

"The real driver for bioenergy is how to get sugar as cheaply as possible from these recalcitrant materials," Wyman said. "We're looking for clues as to which traits in these poplar materials will lead to better sugar release."

Using a high-throughput screening method, the BESC researchers rapidly analyzed an unprecedented number of poplar core samples in their search to understand the chemical factors that drive sugar yields.

The analysis revealed a correlation between one plant trait, the S/G ratio, and increased sugar yields. The ratio refers to the two main building blocks of lignin – syringyl and guaiacyl subunits.

"The conventional wisdom is that high lignin contents are bad for sugar release," said lead author Michael Studer. "We unexpectedly found that this statement is only valid for low S/G ratios, while at high S/G ratios lignin does not negatively influence yields. However, replacement of carbohydrates with lignin reduces the maximum possible sugar release."

"Another interesting result was that the samples with the highest sugar release belonged to the group with average S/G ratios and lignin contents. This finding points to a need for deeper understanding of cell wall structure before plants can be rationally engineered for efficient biofuels production," Studer said.

The team's study also pinpointed certain poplar samples that produced unusually high sugar yields with no pretreatment. Biofuel production typically requires various pretreatments, such as applying high temperature and pressure to the biomass. Reducing pretreatment would represent a substantial decrease in the price of liquid transportation fuels produced from lignocellulosic feedstocks like poplar.

"It's very enticing that several of the samples released more sugar than typical with no pretreatment," Wyman said.

Poplar trees, botanically known as Populus, represent the leading woody crop candidate for the production of biomass feedstocks for the creation of biofuels in the U.S. Naturally occurring selections of poplar trees contained wide variations in all observed traits, says Gerald Tuskan, an ORNL plant biologist and one of the co-leads of the study.

"We can mine this natural variability and find extreme poplar phenotypes that have value in increasing sugar yield," Tuskan said. "Moreover, these native individuals are adapted to local environments."

From this work, superior poplar cultivars may soon be available for commercial testing and propagation, yielding plant materials that will contribute to reducing the nation's dependence on fossil fuel based transportation fuels.

More information: www.pnas.org/content/early/201 … /1009252108.full.pdf%20html