Plants for Improved Biomass Deconstruction: Native Zip-lignins across the Plant Kingdom.

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Project Goals: To determine the extent of natural monolignol ferulate conjugate utilization in cell wall lignification, in which readily cleavable ester linkages ('zips') are introduced into the lignin polymer backbone in ways that significantly improve biomass-processing energetics.

Angiosperms represent the majority of terrestrial plants and are the primary research focus for conversion of biomass to liquid fuels and co-products. Accessing the fibers and chemical energy stored in plant cell walls often requires high temperatures and/or harsh chemical treatments to cleave the lignin inter-unit bonds. However, if base-labile ester bonds, are introduced into the lignin polymer, as can be accomplished by augmenting the prototypical monomers with monolignol ferulate (ML-FA) conjugates, then lignin fragmentation occurs under mild alkaline conditions. The findings presented here provide evidence that 'zip-lignins', lignins derived in part from ML-FAs, have developed naturally via convergent evolution in diverse angiosperm lineages. The discovery of a putatively native *FERULOYL-CoA MONOLIGNOL TRANSFERASE* (FMT) enzyme in rice, encoded by *OsAT5 (OsFMT)*, and in *A. sinensis*, encoded by *AsFMT*, provides new avenues into designing plants for deconstruction, by engineering new or elevated levels of ML-FAs, as has been demonstrated in poplar and rice. This also means that breeders can select for high-zip-lignin plants that are significantly easier to process, and perhaps already inadvertently have done so. Such approaches have the potential to significantly reduce the costs and improve the energy balance of converting biomass to liquid fuels, cellulose pulps, and other value-added products.

Publication:

1. "Monolignol ferulate transferase introduces chemically labile linkages into the lignin backbone" Wilkerson, C. G.; Mansfield, S. D.; Lu, Fachuang; Withers, S.; Park, J.; Karlen, S. D.; Gonzales-Vigil, E.; Padmakshan, D.; Unda, F.; Rencoret, J; Ralph, J *Science*, **2014**, *344*, 90−93.

The Great Lakes Bioenergy Research Center is a U.S. Department of Energy Bioenergy Center supported by the DOE Basic Energy Research Office of Science (DE-FC02-07ER64494).