Engineering of Plants with Decreased Xylan and Lignin Contents and Increased Cell Wall Density

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Project Goals:
Using synthetic biology tools to redesign the regulation of secondary cell wall biosynthesis to reduce biomass recalcitrance and increase biomass density and sugar yield.

Plant biomass for bioenergy purposes is composed largely of secondary cell walls, about a third of which is hemicellulose and up to a quarter is lignin, a strong recalcitrant aromatic polymer. Lignin embeds cell wall polysaccharides and inhibits enzymatic degradation, and hemicellulose is mainly composed of xylans, pentoses and polymers which are less desirable than hexoses for fermentation. Unfortunately, none of these polymers can be easily removed without impacting cell wall cohesion thus integrity of vessels and their water and nutrient transport function. In order to improve plant biomass quality with optimized hexose/pentose ratio, reduced lignin content or enhanced cell wall deposition, we developed modular strategies to spatially and temporally fine-tune the deposition of xylan or lignin to vessel by disconnecting their biosynthetic regulation from the network controlling secondary cell wall deposition in fiber cells. With this approach, we generated healthy plants with reduced xylan or lignin and enhanced cell wall deposition in fiber cells, which resulted in significant improvements in sugar releases after various pretreatments.

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