Development of Plants with Multiple Traits for High Yield of Fermentable Sugars

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Project Goals: Development of bioenergy crops with increased ratio between hexoses and pentoses, low lignin content and low recalcitrance.

Second-generation biofuels produced from biomass can help to decrease dependency on fossil fuels, which would have many economical and environmental benefits. To make biomass more suitable for biorefinery use we need a better understanding of plant cell wall biosynthesis. Increasing the ratio of C6 to C5 sugars in the wall is an important target for engineering of plants that are more suitable for downstream processing for second-generation biofuel production. Likewise, decreasing the content of lignin is an important goal. We have studied the basic mechanisms of cell wall biosynthesis and identified genes involved in biosynthesis of pectic galactan including the GALS1 galactan synthase[1] and the URGT1 UDP-galactose transporter[2]. We have applied these findings to engineer plants that have a more suitable biomass composition and have developed synthetic biology and gene stacking tools to achieve this goal. Plants were engineered to have up to three-fold increased content of pectic galactan in stems by expressing GALS1, URGT1 and a UDP-glucose epimerase. Furthermore, the increased galactan was engineered into plants that were already engineered to have low xylan content by restricting xylan biosynthesis to vessels where this polysaccharide is essential[3]. Finally, the high galactan and low xylan traits were stacked with low lignin obtained by expressing the *QsuB* gene encoding dehydroshikimate dehydratase[4]. By targeting the transgene expression to specific cell types, we could substantially improve saccharification while avoiding adverse effects on plant growth and development.

References

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