MANIPULATION OF LIGNIN BIOSYNTHESIS IN PLANTS: THE LOW HANGING FRUIT IN FEEDSTOCK IMPROVEMENT FOR THE BIOREFINERY

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Increasing awareness of the impact of global greenhouse gas emissions, dwindling petroleum reserves, and concerns with regard to energy security have led to a dramatic increase in interest in the development of renewable, cellulose-based sources of biofuels. Lignin stands as a significant barrier to this goal because it interferes with the utilization of lignocellulosic biomass. Efforts aimed at decreasing lignin deposition show promise for improving biomass conversion efficiency, but considering that lignin is essential to plant viability, it is clear that novel approaches to the modification of lignin will be required to make efficient cellulose-based biofuel production a reality.

Unlike all other biological polymers, lignin synthesis is not template-directed and the relative amounts of its component monomers (monolignols) is determined solely by the ratios of the precursors synthesized by the lignifying cell. This unique characteristic provides significant opportunity for the manipulation of the chemistry and architecture of lignin in the cell wall because the manipulation of monolignol biosynthesis is all that is required to generate dramatic and impactful changes in the lignin polymer. As a result, at least in model systems, plants with lignins containing essentially solely *p*-hydroxyphenyl (H), guaiacyl (G) and syringyl (S) subunits have been generated, frequently with significant impacts on the ease with which the polymers can be removed from the biomass and/or biomass saccharification efficiency. These changes simultaneously decrease the complexity of lignin, thereby opening the doors to more effective use of lignin degradation products in the biorefinery. In all cases to date, the discoveries made in model systems have been faithfully recapitulated in genuine biomass feedstocks, demonstrating that translation of these discoveries from the lab to the field can be expected to impact the biorefinery in the near term.