18. Understanding Why Knockdown Expression of Populus GAUT12.1 Results in Decreased Recalcitrance and Increased Growth in This Woody Feedstock

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Project Goals: The BioEnergy Science Center (BESC) is focused on the fundamental understanding and elimination of biomass recalcitrance. BESC's approach to improve accessibility to the sugars within biomass involves (1) designing plant cell walls for rapid deconstruction and (2) developing multi-talented microbes or converting plant biomass into biofuels in a single step (consolidated bioprocessing). BESC biomass formation and modification research involves working directly with two potential bioenergy crops (switchgrass and Populus) to develop varieties that are easier to break down into fermentable sugars. We are using both testing and generating tools for detailed studies into poorly understoond cell wall biosynthesis pathways.

The major challenge to use bioenergy feedstocks like woody Populus as a source of second-generation biofuel is the recalcitrance of the biomass to facile deconstruction. Populus biomass is rich in cellulose, xylan and lignin whose degree of cross-linking and interactions result in highly recalcitrant woody biomass that is difficult to bioconvert into ethanol without extensive chemical and enzymatic treatment. GAUT12 (GAlactUronosylTransferase12)/IRX8 (irregular xylem8) is a putative glycosyltransferase proposed to be involved in secondary cell wall glucuronoxylan and/or pectin biosynthesis based on concomitant reductions of both xylan and a subfraction of the pectin homogalacturonan (HG) in Arabidopsis irx8 mutants. Two GAUT12 homologs exist in Populus trichocarpa, PtGAUT12.1 and PtGAUT12.2. Here we down-regulated GAUT12.1 expression in Populus deltoides using an RNAi approach to determine the effects of reduced expression on recalcitrance. The 50–67% knockdown expression of GAUT12.1 in Populus deltoides yielded 4–8% greater glucose release upon enzymatic saccharification than the controls. Unexpectedly, the transgenic lines also displayed 12–52% increased plant height and 12–44% radial stem diameter compared to the controls. Knock-down of GAUT12.1 resulted in 25–47% reduced galacturonic acid (GalA) and 17–30% reduced xylan without affecting the total lignin content, revealing that in Populus wood as in Arabidopsis stems, GAUT12 affects both pectin and xylan formation. Our results suggest that targeting xylan and pectin in woody feedstock genetic improvement programs may be an effective means to increase biomass production and simultaneously improve saccharification efficiency in biofuel biorefineries.

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