16. Selection of Superior Transgenic Switchgrass Through Microbial Bioconversion for Enhanced Ethanol Production

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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 researchers provide enabling technologies in characterization, ′□omics, modelir in order to (1) understand chemical and structural changes within biomass and (2) to provide insights into biomass formation and conversion.

Switchgrass is a potential bioenergy feedstock but its inherent recalcitrance to bioconversion is an economic hurdle for biofuel production. Improvement to these feedstocks through the use of transgenic technology is a continuing goal, with efforts focused on generating enhanced phenotypes that display increased fermentation yields while maintaining normal growth characteristics in the field. We evaluated field-grown transgenic switchgrass lines with reduced lignin content due to genetic modifications in the lignin biosynthetic pathway. Microbial bioconversion assays of switchgrass feedstocks (unpretreated and pretreated) were performed with traditional enzymatic hydrolysis and yeast-based fermentation as part of an assessment of plant lines with reduced recalcitrance. In addition, the top lines were subjected to a consolidated bioprocessing platform using Clostridium thermocellum. Previously reported, caffeic acid O-methyltransferase (COMT) knockdown and MYB4 transcriptional regulator overexpression switchgrass lines, field-grown through years one, two and three were screened using microbial bioconversion fermentation assays. Several lines from year one displayed up to 30% increased fermentation ethanol yields over the control lines, a trend which continued throughout subsequent plant generations. However, there was a significant, generalized decrease in bioconversion performance between the plants that spent one year in the field and their subsequent years of growth; a phenomenon that is widely observed but not fully explained. Therefore, for field grown switchgrass, only plants in their second or more years of growth are considered to provide a representative bioconversion profile. We also report the first use of a microbe engineered to produce increased amounts of biofuels on a transgenic energy crop that has been modified for the same purpose, and show a cumulative increase in bioconversion performance. The overall results demonstrate lignin pathway modifications can lead to reduced recalcitrance with improved hydrolysis and fermentation yields under multiple microbial conversion processes.

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