Dividing corn stover makes ethanol conversion more efficient

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(PhysOrg.com) -- Not all parts of a corn stalk are equal, and they shouldn't be treated that way when creating cellulosic ethanol, say Purdue University researchers.

When corn stover is processed to make cellulosic ethanol, everything is ground down and blended together. But a research team found that three distinct parts of the stover the rind, pith and leaves break down in different ways.

Michael Ladisch, a distinguished professor of agricultural and biological engineering and director of Purdue's Laboratory of Renewable Resources Engineering; Eduardo Ximenes, a Purdue research scientist in LORRE; and doctoral graduate student Meijuan Zeng are trying to determine if there is a better method to process corn stover and optimize efficiency.

Cellulosic ethanol is created by using enzymes to extract sugars from cellulosic feedstocks, such as corn stover, grasses and woods, and then fermenting and distilling those sugars into fuels.

"Today, researchers grind the parts together and treat it based on what's needed to get at the hardest part," Ximenes said. "We show that there are major differences in degradability among the tissues."

Stover's pith, the soft core that makes up more than half the weight of a corn stalk, is the easiest for enzymes to digest, according to the findings in two papers published in the journal Biotechnology and Bioengineering. Rind is the most difficult, while leaves fall in between. Significant amounts of lignin, the rigid compound in plant cell walls, make the cellulose resistant to hydrolosis, a process in which cellulose is broken down into sugars.

Ximenes said converting the rinds only adds about 20 percent more ethanol while requiring 10 times more enzymes, driving up the price of the process.

"Is that extra 20 percent worth the added cost?" asked Nathan Mosier, associate professor of agricultural and biological engineering and co-author of the study. "Because if there is a way to separate out pith, you could burn the leftover rinds to generate steam, creating energy needed to operate the plant."

Ladisch added that separating pieces of corn stover and treating them differently would be a new way of approaching cellulosic ethanol production.

"It uses existing conversion technology, but it enables us to think about a new way of getting the most from that technology," Ladisch said. "There is absolutely no reason a ligno-cellulosic non-food material such as corn stalk cannot be used to make ethanol if you understand the science."

Also involved in the research were Youngmi Kim, a Purdue research engineer; Wilfred Vermerris, an associate professor of agronomy at the University of Florida; Debra Sherman, director of the Purdue Life Science Microscopy Facility; Chia-Ping Huang, microscope technologist at the Life Sciences Microscopy Facility; and Bruce Dien, a chemical engineer with the Bioenergy Research Unit of the U.S. Department of Agriculture's Agricultural Research Service.

Ladisch and Ximenes said they would next work with colleagues to explore ways to improve the ability of enzymes to create sugars from cellulose and remove the compounds that inhibit those enzymes, as well as adapting the findings for other feedstocks such as switchgrass and wood.

More information:
Tissue-specific Biomass Recalcitrance in Corn Stover Pretreated with Liquid Hot-water: Enzymatic Hydrolysis (Part 1)

ABSTRACT
Lignin content, composition, distribution as well as cell-wall thickness, structures and type of tissue have a measurable effect on enzymatic hydrolysis of cellulose in lignocellulosic feedstocks. The first part of our work combined compositional analysis, pretreatment and enzyme hydrolysis for fractionated pith, rind and leaf tissues from a hybrid stay-green corn in order to identify the role of structural characteristics on enzyme hydrolysis of cell walls. The extent of enzyme hydrolysis follows the sequence rind

Tissue-specific Biomass Recalcitrance in Corn Stover Pretreated with Liquid Hot-water: SEM Imaging (Part 2)

ABSTRACT
In the first part of our work, we combined compositional analysis, pretreatment and enzyme hydrolysis for fractionated pith, rind and leaf tissues from a hybrid stay-green corn in order to identify the role of structural characteristics on enzyme hydrolysis of cell walls. Hydrolysis experiments coupled with chemical analysis of the different fractions of corn stover showed significant differences in cell-wall structure before and after liquid hot-water pretreatment. The extent of enzyme hydrolysis followed the sequence rind

Provided by Purdue University