Pretreatment, proper harvest time boost ethanol from switchgrass

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Adding a pretreatment step would allow producers to get more ethanol from switchgrass harvested in the fall, according to a Purdue University study.

Michael Ladisch, a distinguished professor of agricultural and biological engineering, and Youngmi Kim, a research scientist, compared switchgrass based on growing location, harvest time and whether it was given a pretreatment step. They found that location wasn't important, but the other two factors could significantly increase the amount of ethanol obtained from the feedstock.

"Switchgrass harvested in the spring had more cellulose, but also more lignin," said Kim, whose findings were published in the early online version of the journal *Bioresource Technology*. "You do not get the advantage of the increased cellulose content because it's more difficult to extract those sugars because of the lignin."

Lignin, a rigid substance found in plant cell walls, is one of the most significant problems with cellulosic ethanol production. Besides the harvest time, a pretreatment step - cooking switchgrass in hot water under pressure for about 10 minutes - would also help work around lignin.

Before pretreatment, Kim said about 10 percent of cellulose was converted to glucose, the yeast-fermentable sugar that produces ethanol. After pretreatment, that number jumped to as much as 90 percent. The

pretreatment dissolves hemicellulose, which bonds cellulose and lignin in the plant. Once it is gone, there is more access to the sugars contained in the cellulose.

"There is more surface area for the enzymes to digest cellulose," Kim said.

Ladisch said advancements in techniques to work around lignin could make spring switchgrass more attractive. But he said that fall switchgrass given a pretreatment and fermentation with special yeast shows potential to give as much as 800-1,000 gallons of ethanol per acre per year, compared with 150-250 gallons per year without pretreatment. Ladisch said corn ethanol from grain produces about 500-600 gallons per acre per year.

"This shows that we can improve the processes and increase the amount of ethanol we get from switchgrass," Ladisch said.

More information: Comparative Study on Enzymatic Digestibility of Switchgrass Varieties and Harvests Processed by Leading Pretreatment Technologies, by Youngmi Kim et al.

ABSTRACT
Feedstock quality of switchgrass for biofuel production depends on many factors such as morphological types, geographic origins, maturity, environmental and cultivation parameters, and storage. We report variability in compositions and enzymatic digestion efficiencies for three cultivars of switchgrass (Alamo, Dacotah and Shawnee) grown and harvested at different locations and seasons. Saccharification yields of switchgrass processed by different pretreatment technologies (AFEX, dilute sulfuric acid, liquid hot water, lime and soaking in aqueous ammonia) are compared in regards to switchgrass genotypes and harvest seasons. Despite its higher cellulose content per dry mass, Dacotah

switchgrass harvested after wintering consistently gave a lower saccharification yield than the other two varieties harvested in the fall. The recalcitrance of upland cultivars and over-wintered switchgrass may require more severe pretreatment conditions. We discuss the key features of different pretreatment technologies and differences in switchgrass cultivars and harvest seasons on hydrolysis performance for the applied pretreatment methods.

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