Glue made from ethanol-production leftovers may be worth more than the fuel

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Mixing up a batch of ethanol from alfalfa or switchgrass isn't nearly as efficient as creating it from corn, but that doesn't mean growing grass crops for fuel won't pay, says Paul Weimer.

Rather than dwelling on finding ways to squeeze extra ethanol out of biomass from crops such as switchgrass, Weimer is concentrating his research on the leftovers. He thinks that the large heap of fermentation residue from the ethanol-making process — what many people consider a byproduct — could be far more valuable than the ethanol itself.

"A lot of people want to do the same thing with biomass material that we've been doing with corn," says Weimer, a research microbiologist at the USDA-ARS Dairy Forage Research Center and associate professor of bacteriology at the University of Wisconsin-Madison. "They want to hit it with enzymes to break it down into sugars, and ferment those sugars into ethanol.

The problem with this, he explains, is that the enzymes needed to break down celluose biomass are very expensive, and they don't work nearly as effectively as the enzymes used to convert starch.

In fact, Weimer adds, both corn and cellulosic biomass must be subjected to costly pretreatment to maximize the ethanol yield.

"Our philosophy is a little bit different," Weimer says. "We think that the fermentation residue may actually be more valuable than the ethanol.

And it may mean that we can do without pretreatment."

He came to this conclusion as he took a closer look at the residue — the fermentation leftovers. He determined that the organisms that he uses to convert biomass do their job by sticking to the cellulose fibers with a glue-like substance called a glycocalyx.

"Because glycocalyx works so effectively at holding organisms to cellulose material, we found that we couldn't get the glue off of the fibers without destroying the glue," Weimer says. "So, we took the entire fermentation mixture — the glue, plus the bacteria, plus the rest of the cellulosic biomass — and used it as an adhesive."

Specifically, they used it as wood glue. To explore the glue's potential as value-added product for biomass crops, Weimer set out to test it by enlisting help from a research team at the USDA Forest Products Lab led by adhesive scientist Chuck Frihart. Their primary performance concerns were pressure and durability in wet conditions.

"One of the biggest drawbacks of any bio-based adhesive is that it will stick stuff together well but falls apart once it gets wet," Weimer says.

While Weimer's bio-based adhesive does have this problem if used as a standalone product, it works well when mixed with another adhesive, a commonly used petroleum-based resin. In some applications the researchers have successfully used a mix in which up to 73 percent of the resin was replaced with the bio-based adhesive.

Although the adhesive appears to have great potential, there are still a few hurdles. For one, it's quite viscous. For use in an industrial application, the glue would need to be made easier to apply. A second challenge is to bring the process to a larger scale. A third is to develop formulations that incorporate the bio-based glue into other types of adhesive mixtures. These challenges, says Weimer, will simply take time.

Weimer hopes to get the wood products industry interested in replacing half of the phenol formaldehyde (PF), a petroleum-based adhesive now used to make plywood, with the biomass-based adhesive.

"The PF that the fermentation process would partially replace sells for considerably more that ethanol, and the fermentation would still generate ethanol on the side," he says.

But the economic incentive is only part of the picture, according to Weimer.

"We'd like to keep alfalfa on the landscape because it has a lot of environmental benefits," Weimer says. "It's a good cover crop, it's drought-tolerant and fixes nitrogen. But because farmers are moving away from it as a dairy feed, we're trying to find another use, and we think this glue might be a solution."

Source: University of Wisconsin-Madison

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