Renewable chemical ready for biofuels scale-up

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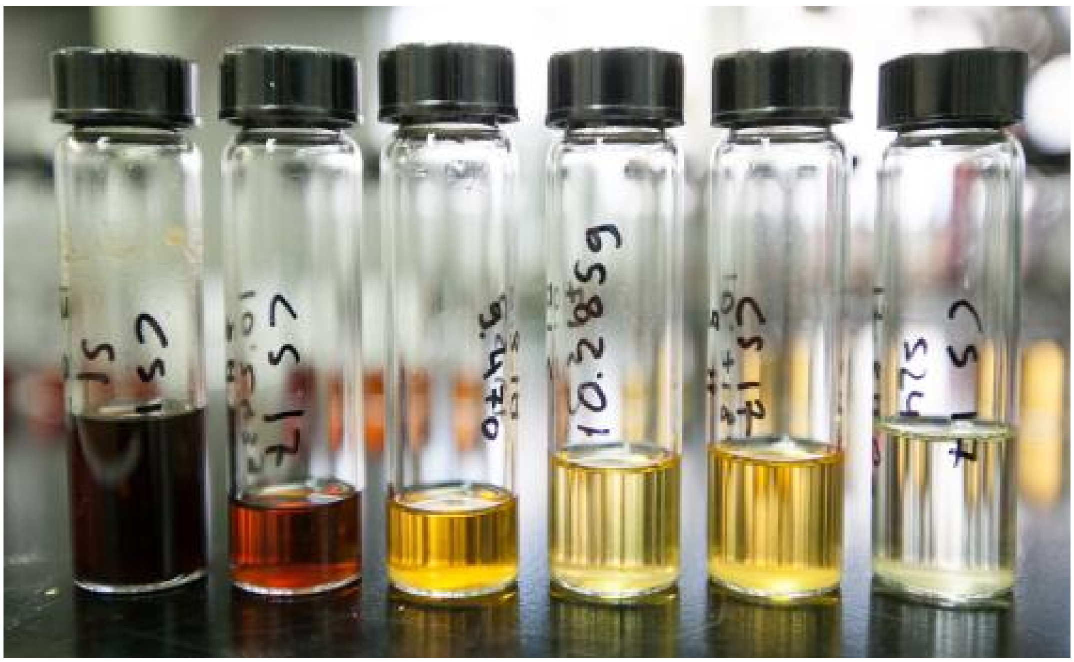

The flow-through reaction setup progressively dissolves biomass producing fractions that are rich in (from left to right) lignin monomers, hemicellulose and cellulose-derived sugars. Credit: Matthew Wisniewski/Wisconsin Energy Institute

Using a plant-derived chemical, University of Wisconsin-Madison researchers have developed a process for creating a concentrated stream of sugars that's ripe with possibility for biofuels.

"With the sugar platform, you have possibilities," says Jeremy

Luterbacher, a UW-Madison postdoctoral researcher and the paper's lead author. "You've taken fewer forks down the conversion road, which leaves you with more end destinations, such as cellulosic ethanol and drop-in biofuels."

Funded by the National Science Foundation and the U.S. Department of Energy's Great Lakes Bioenergy Research Center (GLBRC), the research team has published its findings in the Jan. 17, 2014 issue of the journal *Science*, explaining how they use gamma valerolactone, or GVL, to deconstruct plants and produce sugars that can be chemically or biologically upgraded into biofuels. With support from the Wisconsin Alumni Research Foundation (WARF), the team will begin scaling up the process later this year.

Because GVL is created from the plant material, it's both renewable and more affordable than conversion methods requiring expensive chemicals or enzymes. The process also converts 85 to 95 percent of the starting material to sugars that can be fed to yeast for fermentation into ethanol, or chemically upgraded furans to create drop-in biofuels.

To demonstrate the economic viability of this advance, Luterbacher needed to concentrate the sugar, remove the GVL for reuse, and show that yeast could successfully generate ethanol from the sugar stream.

"Showing that removing and recycling GVL can be done easily, with a low-energy separation step, is a little more of an achievement," says Luterbacher. "By feeding the resulting sugar solution to microorganisms, we proved we weren't producing some weird chemical byproducts that would kill the yeast, and that we were taking out enough GVL to make it nontoxic."

"What's neat is that we can use additives to make the solution separate," says Luterbacher. "It becomes like oil and vinegar." Their additive of choice: liquid carbon dioxide.

"It's green, nontoxic and can be removed by simple depressurization once you want GVL and solutions of sugar to mix again. It's the perfect additive," Luterbacher says.

An initial economic assessment of the process has indicated the technology could produce ethanol at a cost savings of roughly 10 percent when compared with current state-of-the-art technologies.

For the past several years, James Dumesic, Steenbock Professor and Michel Boudart Professor of Chemical and Biological Engineering at UW-Madison, and his research group have studied the production of GVL from biomass, and in more recent work they explored the use of GVL as a solvent for the conversion of biomass to furan chemicals.

"The knowledge gained in these previous studies was invaluable to us in the implementation of our new approach to convert real biomass to aqueous solutions of sugars that are suitable for biological conversion," says Dumesic.

This research has contributed new knowledge to the biofuels landscape, resulted in four patent applications, and gained recognition for GVL's commercial potential from WARF's Accelerator Program. The program helps license high potential technologies more rapidly by addressing specific technical hurdles with targeted funding and expert advice from seasoned business mentors in related fields.

Under the Accelerator Program effort, Dumesic will serve as principal investigator for an 18-month project involving construction of a high-efficiency biomass reactor. The reactor will use GVL to produce concentrated streams of high-value sugars and intact lignin solids.

Carbohydrates and lignin from the reactor will be delivered to scientific collaborators, including fellow GLBRC investigators, who will optimize strategies for converting the materials into valuable chemicals and fuels.

"We're excited by the team's scientific achievements and we look forward to supporting the project's next steps through the Accelerator Program," says Leigh Cagan, WARF's chief technology commercialization officer. "If the project successfully achieves the anticipated cost reductions for production of the sugars, lignin and ethanol, we anticipate significant commercial interest in this novel process."

More information: "Nonenzymatic Sugar Production from Biomass Using Biomass-Derived γ-Valerolactone," by J.S. Luterbacher et al. *Science*, 2014.

Provided by University of Wisconsin-Madison