High Yield Method to Produce HMF from Fructose

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WARF: P180329US01

View U.S. Patent No. 10,781,195 in PDF format.

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method for producing 5-hydroxymethylfurfural (HMF) from C6 carbohydrates using a solvent system containing water and a polar aprotic solvent.

The reaction can be integrated into the conventional route for making high fructose corn syrup. The process is efficient in converting a concentrated fructose stream from an HFCS process to HMF in high yield (>90 percent) at high fructose conversion (>94 percent). HMF produced via this process is easily separated from the solvent system by traditional unit operations.

OVERVIEW

The platform molecule 5-hydroxymethylfurfural (HMF), produced from the dehydration of C6 sugars (hexoses), is considered to be one of the top value-added chemicals. The efficient production of HMF from carbohydrates and its subsequent separation from the solvents remains a challenge.

Current methods to produce HMF from biomass-derived sugars using water as a solvent suffer from the drawback of poor selectivity. Improvement in selectivity is observed when solvent systems composed of water and an organic solvent are used; however, HMF loss during difficult product separation typically limits the application of such methods. Moreover, high HMF purity is critical for downstream applications, especially in production of HMF-derived monomers used in sustainable polymer synthesis (e.g., FDCA required for production of PEF).

THE INVENTION

UW–Madison researchers have discovered that a solvent system comprising water and a polar aprotic solvent (e.g., acetone) is ideally suited for converting C6 carbohydrates into HMF at reasonably low temperatures (such as 120°C), low acid concentration and at very high yields and efficiencies.

The C6 carbohydrate used in the method can be derived from any source including biomass (processed or unprocessed), cellulose and lignocellulosic sources, etc. The

THE WARF ADVANTAGE

Since its founding in 1925 as the patenting and licensing organization for the University of Wisconsin-Madison, WARF has been working with business and industry to transform university research into products that benefit society. WARF intellectual property managers and licensing staff members are leaders in the field of university-based technology transfer. They are familiar with the intricacies of patenting, have worked with researchers in relevant disciplines, understand industries and markets, and have negotiated innovative licensing strategies to meet the individual needs of business clients.

nature of the C6 carbohydrate is not critical to the method, although fructose is preferred.

BUSINESS OPPORTUNITY

As the high fructose corn syrup market is mature (with ample capacity and infrastructure), it is economically feasible to incorporate the new method using glucose or mixtures of glucose and fructose as the starting material. The resulting HMF can be used as a platform chemical to make other, value-added materials, such as levulinic acid (LA), furandicarboxylic acid (FDCA), diformylfuran (DFF), dimethylfuran (DMF), adipic acid (AA) and formic acid (FA). This approach was shown to be practical in a proof-of-concept reaction in which selectivity to HMF was >95 percent and HMF yield > 90 percent.

APPLICATIONS

- Production of HMF from fructose/biomass-derived sugars

KEY BENEFITS

- High fructose conversion (>94%)
- High HMF selectivity (>95%)
- High purity HMF (>96% purity)
- Compatible with existing infrastructure in the high fructose corn syrup industry
- Solvents are stable, environmentally benign and easy to separate.

STAGE OF DEVELOPMENT

The new method has been shown to convert fructose, in quantitative yield, to HMF, which can be easily separated from the solvent using inexpensive and traditionally used separation techniques. The method improves the economic viability of the biomass upgrading process by reducing the costs associated with the production and separation of HMF, and by also enabling the use of glucose as the feedstock.

ADDITIONAL INFORMATION

Related Portfolios
UW–Madison Technologies Developed Through the Great Lakes Bioenergy Research Center

Tech Fields
Clean Technology - Bio-based & renewable chemicals

CONTACT INFORMATION

For current licensing status, please contact Mark Staudt at mstaudt@warf.org or 608-960-9845.