Clean Technology

Enzymatic Depolymerization of Lignin

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing the first enzymatic method of its kind for processing lignin and other aromatic compounds.

Unlike existing chemical methods, the new bio-based route eliminates expensive catalysts and results in a well-defined set of aromatic monomers that are natural bioproducts, have not undergone chemical transformation and therefore are more amenable to downstream processing/upgrading.

Overview

Lignin is a renewable resource that accounts for up to 30 percent of the dry weight of vascular plant cell walls. It is comprised of aromatic compounds that may be valuable commodities for the biofuel, chemical, cosmetic, food and pharmaceutical industries.

Notoriously difficult to process, the properties of lignin create challenges to using it as an industrial raw material. Existing chemical methods for depolymerizing lignin typically require high temperatures or pressures, expensive catalysts and organic solvents. Consequently, improved tools and methods are intensively sought.

The Invention

UW–Madison researchers **provide the first demonstration** of an *in vitro* enzymatic system that can recycle NAD+ and GSH while releasing aromatic monomers from natural and engineered lignin oligomers, as well as model compounds composed of similar chemical building blocks. Nearly 10 percent of beta-ether units were cleaved when the system was tested on actual lignin samples.

The relevant enzymes include dehydrogenases, β-etherases and glutathione lyases. In an exemplary version, the system uses the known LigD, LigN, LigE and LigF enzymes from *Sphingobium* sp. strain SYK-6. A newly discovered heterodimeric β-aryl etherase (BaeA) can be used in addition to or instead of LigE.

Applications

- Bio-based system for depolymerizing lignin

Key Benefits

- Advantages over chemical routes include:
  - Does NOT require high temperatures or pressure
  - Does NOT require expensive catalysts
  - Could be performed in an aqueous environments, eliminating the need for solvents (and subsequent separation/recycle)
  - Results in a well-defined set of aromatic monomers amenable to downstream processing/upgrading

Stage of Development

The researchers' findings provide the first demonstration that *in vitro* depolymerization of lignin is possible with β-etherase enzymes – an important step towards the development of biotechnological applications designed to derive high-value monomeric compounds from actual lignin polymers.

The activity of this set of enzymes on oligomeric substrates provides an opportunity to develop and optimize conditions for aromatic release from lignin fraction derived from biomass deconstruction chemistries that are, or will, be used by industry.

Additional Information

For More Information About the Inventors

- John Ralph
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- Brian Fox

Tech Fields

- Clean Technology : Biobased & renewable chemicals & fuels

For current licensing status, please contact Jennifer Gottwald at jennifer@warf.org or 608-960-9854