Microbial Conversion of Chemically Depolymerized Lignin Into Valuable Compounds

Miguel Perez[1,2]* (perez8@wisc.edu), Wayne Kontur[2], Manar Alherech[2,3], Steven Karlen[2], Shannon S. Stahl[2,3], **Timothy J. Donohue**[2,4], Daniel R. Noguera[1,2]

[1] Department of Civil and Environmental Engineering, University of Wisconsin-Madison, Madison, WI.; [2] DOE Great Lakes Bioenergy Research Center, Madison, WI.; [3] Department of Chemistry, University of Wisconsin-Madison, Madison, WI.; and [4] Department of Bacteriology, University of Wisconsin-Madison, Madison, WI.

https://www.glbrc.org/

Project goals: The project aims to valorize the lignin fraction of plant biomass via chemical fractionation and depolymerization followed by conversion of the resulting mixtures of aromatic compounds into single valuable chemicals by genetically engineered bacteria.

Plant cell wall consists mainly of a combination of three different types of chemical polymers: cellulose, hemicellulose, and lignin. Lignin is a heteropolymer of different types of aromatic compounds whose chemical properties make it highly insoluble and recalcitrant to chemical and biological breakdown. This presents a major challenge for a full valorization of lignocellulose.

Recently developed chemical approaches for lignin deconstruction result in mixtures of different aromatic compounds that share common aromatic structures of three types: Syringyl (S), Guaiacyl (G), or *p*-hydroxy (H). On the other hand, some microbial strains have evolved to utilize multiple lignin-derived aromatic compounds as their source of carbon and energy for growth via metabolic funneling into a few aromatic intermediates before complete degradation. This natural capability presents an attractive opportunity for upgrading aromatic compounds via metabolic engineering of suitable strains.

Novosphingobium aromaticivorans DSM12444 has the ability to catabolize multiple S, G, and H type aromatic compounds present in oxidized and formic acid induced depolymerized lignin. Of particular interest, this strain can transform guaiacyl and syringyl-derived diketones, which can result from oxidative chemical depolymerization, but are not found in natural environments. In this work, we analyze the metabolism of these and other lignin-derived aromatics by *N. aromaticivorans*, identify genes required for metabolism of S, G and H aromatic units and demonstrate how the use of mutants to transform these compounds into potentially valuable products.

This work was supported by U.S. Department of Energy (DOE) Great Lakes Bioenergy Research Center grants (DOE Office of Science BER DE-FC02-07ER64494 and DE-SC0018409).