

Microbial conversion of chemically depolymerized lignin into valuable compounds

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<https://www.glbrc.org/research/efficient-biomass-conversion>

Project Goals: Develop microbes that funnel *p*-hydroxybenzoic acids, and *p*-hydroxycinnamic acids to value added products.

Abstract: Plant cell wall consists mainly of a combination of two major polymers: polysaccharides 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 degradation. This presents a major challenge to full conversion of lignocellulosic biomass into a portfolio of value added products. Chemical deconstruction of lignin produce complex mixtures of aromatic compounds with structures derived from mainly from three phenolic subunits: Syringyl (S), Guaiacyl (G), and *p*-Hydroxyphenyl (H). Some bacterial strains have been shown to utilize multiple lignin-derived aromatic compounds as their source of carbon and energy for growth. In this process they metabolize a variety of aromatic compounds by funneling them through common intermediates. This natural capability presents an attractive opportunity for upgrading aromatic compounds via metabolic engineering of suitable strains. We have shown that the α -proteobacterium *Novosphingobium aromaticivorans* DSM12444 has the ability to simultaneously catabolize multiple S, G, and H type aromatic compounds known or predicted to be present in chemically depolymerized lignin from a wide range of different biomass feedstocks. Using selected mutations, we engineered the bacterium and created a mutant strain capable of transforming aromatic compounds containing S, G, and H type substructures into a single product, 2-pyrone-4,6-dicarboxylic acid (PDC). In addition, we studied the utilization of the engineered microbe to funnel lignin-derived aromatic compounds from different biomass types into PDC in the context of an integrated lignin-to-bioproduct processing chain. We show that products of reductively depolymerized lignin from wild type poplar, sorghum, switchgrass, and maple, as well as from plants containing mutations that alter lignin biosynthesis (in collaboration with researchers in the Joint Bioenergy Institute) can be used as substrates for PDC production by this engineered *N. aromaticivorans* strain.

References

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