Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M17-247L
Published: 4/16/2018

Inventors

David Nielsen

Brian Thompson

Contact

Jovan Heusser
jovan.heusser@skysonginnovations.com

Synthetic Metabolic Funneling for Biochemical Production

Market interest in biosynthesis of important commodity chemicals in a sustainable manner is continually growing, driven by increased environmental awareness. However, most conventional production technologies rely on petroleum as feedstocks. Using engineered microorganisms to synthesize industrially relevant chemical building blocks from renewable resources is a highly attractive alternative.

Phenol and catechol are aromatic building block chemicals and as such are useful and versatile products. Muconic acid is commonly used as a precursor in plastics production. While biosynthesis of these products has been achieved, the associated biosynthetic pathways are limited as a result of feedback inhibition, equilibrium limitations, and/or flux limitations; thus, final titers and yields remain low, limiting the efficacy of their bioproduction.

Researchers at Arizona State University have engineered a series of novel, modular enzyme pathways in microorganisms to produce each of phenol, catechol and muconic acid as focal products from renewable resources. These products can be used as molecular building blocks for the production of numerous fine and commodity chemicals as well as plastic materials. Utilizing a synthetic 'metabolic funnel', where multiple pathways can be co-expressed in parallel to maximize carbon flux toward a final product, significantly enhanced titers of these compounds can be achieved. The methods and engineered pathways, particularly the novel 'funneling', address key thermodynamic and resource limitations associated with the conventional bioproduction of these chemicals, which is what allows for such high production levels of all three compounds.

These methods and microorganisms are a key step forward in reducing reliance on petrochemical feedstocks and support the sustainable production of green products and materials from renewable resources.

Potential Applications

- Bioproduction of Phenol, Catechol, Muconic acid for:
  - Biochemicals
  - Biofuels

- Bioplastics
- Biopolymers
- Flavors
- Fragrances

Benefits and Advantages

- Uses inexpensive and renewable resources for the substrate, such as carbohydrates and sugars
- Addresses key thermodynamic, regulatory, and resource limitations associated with conventional bioproduction methods
- High bioproduction achieved, including with respect to both titers and yields
  - Titers of phenol, catechol, and muconic acid exceeded 500, 600 & 3000 mg/L respectively
- Limited diversity and quantity of by-products
- Same host microorganism can be used to produce all three compounds

For more information about the inventor(s) and their research, please see Dr. Nielsen's laboratory webpage