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Microbial Production of 2-Phenylethanol & 2-Phenylacetic Acid from Renewable Substrates

2-Phenylethanol is a naturally-occurring aromatic alcohol and key molecule used in the flavor and fragrance industries due to its floral, rose-like aroma. Additionally, 2PE has been considered as a potential biofuel or fuel additive due to its low volatility, high energy density and non-hygroscopic properties. Natural 2PE can be obtained from various flower essential oils via extraction, but the bulk of the global supply is currently derived via chemical synthesis from styrene. While this process is relatively inexpensive it is non-renewable, unsustainable and relies upon a potentially carcinogenic precursor as feedstocks.

2-Phenylacetic acid is also a flavor molecule with a honey or floral profile and is similarly used in the flavor and fragrance industries. PAA also serves as a molecular building block for certain pharmaceutical compounds, most notably synthetic penicillin G and diclofenac. Traditional PAA production routes involve the chemical hydrolysis of benzyl cyanide which is unsustainable.

Researchers at Arizona State University have developed more robust and sustainable production routes for both 2-phenylethanol and 2-phenylacetic acid using microbial biocatalysts. Specially, a novel biosynthetic pathway was developed that boasts a nearly 10-fold greater thermodynamic driving force than previously investigated and naturally evolved routes. The novel enzyme pathways engineered enable high level production of 2-phenylethanol and 2-phenylacetic acid as individual products using biomass-derived substrates and strictly minimal media.

This method enables the high-level production of 2-phenylethanol and 2-phenylacetatic acid for the flavor, fragrance, pharmaceutical and renewable energy industries using inexpensive, sustainable, and non-carcinogenic resources.

Potential Applications

- Bioproduction of 2-phenylethanol and 2-phenylacetatic acid:
  - Flavors
  - Fragrances

- Pharmaceuticals
- Biofuels & fuel additives

Benefits and Advantages

- Utilizes inexpensive, sustainable and non-carcinogenic resources such as biomass-derived sugars
- More robust and efficient biosynthetic pathways
- High production levels in strictly minimal media
  - Titers approaching 2 g/L for 2-phenylethanol and 503 mg/L for 2-phenylacetatic acid
- Limited diversity and quantity of by-products
- Pathways are host and feedstock agnostic; same host can be used to produce either compound
- Significantly reduced acetate byproduct accumulation

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