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CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

An End-to-End Pipeline for Succinic Acid Production at an Industrially Relevant Scale Using Issatchenkia orientalis

Background/Objective

Succinic acid (SA) is a precursor to produce high-value chemicals, such as 1,4-butanediol and tetrahydrofuran, and a monomer for the synthesis of polybutylene succinate, a biodegradable polymer. Microbial production of succinic acid at an industrially relevant scale has been hindered by high downstream processing cost arising from neutral pH fermentation. Here we metabolically engineered *Issatchenkia orientalis*, a non-conventional yeast with superior tolerance to highly acidic conditions, for cost-effective production of SA at low pH.

Approach

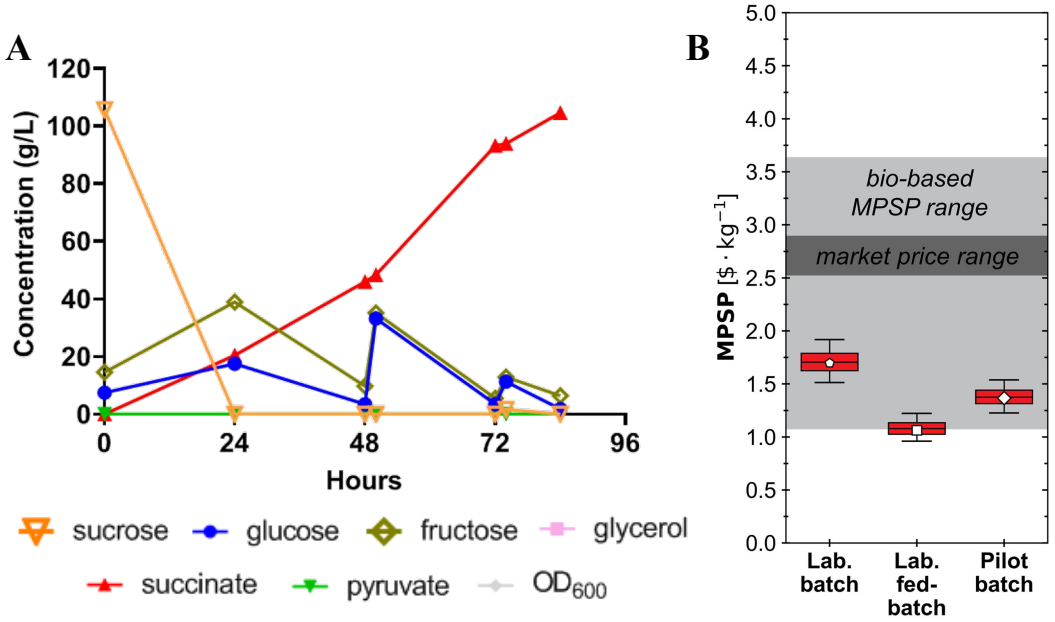
- Applied metabolic engineering strategies, such as deletion of byproduct pathways, metabolic flux analysis, transport engineering, and expanding the substrate scope to improve SA production.
- Performed biorefinery design, simulation, techno-economic analysis (TEA), and life cycle assessment (LCA) under uncertainty.

Results

- The engineered strains produced up to 110 g/L SA at low pH (pH 3) in bench-top reactors and up to 63 g/L in a pilot-scale reactor; SA could be crystallized with 64% recovery yield without additional acidification.
- TEA and LCA showed the process was financially viable and could reduce CO_2 emissions by 34 to 90% relative to fossil-based production processes.

Significance/Impacts

We demonstrate that *I. orientalis* can be engineered for SA production at low pH, lowering operation cost and greenhouse gas emissions, and its development can serve as a template for producing other organic acids.



(A) Bench-top reactor results of fed-batch fermentation in sugarcane juice medium, and (B) the minimum product selling price (MPSP) of the process for several reaction conditions.

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