BRC Science Highlight
January 2021

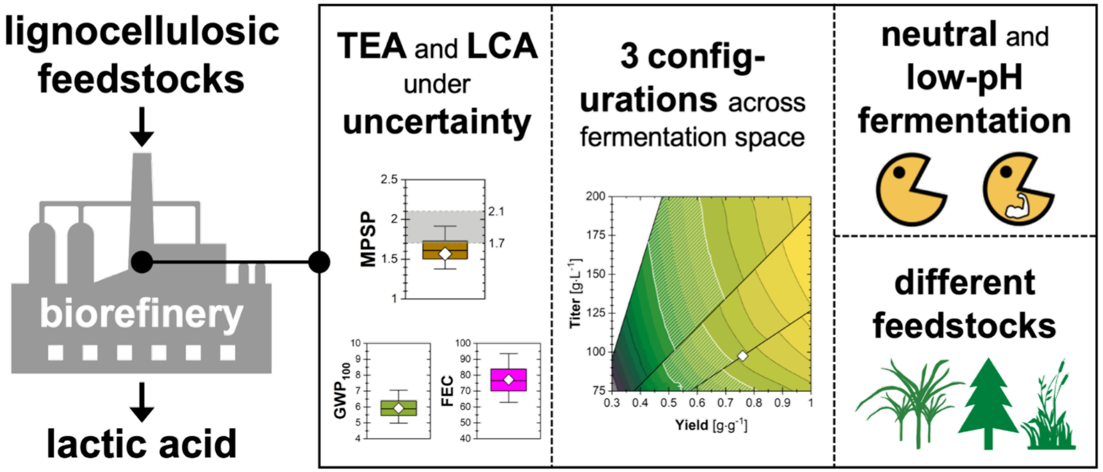
Sustainable Lactic Acid Production from Lignocellulosic Biomass

Objective

Lactic acid is a promising bioproduct with a wide range of industrial applications and a fast-growing market, but it is predominantly produced from first-generation sugars. Sustainable production of lactic acid from lignocellulosic feedstocks will help expedite the phasing-out of high-volume, energy- and emissions-intensive fossil-based plastics and toxic solvents, which is critical for society to transition into a carbon-neutral future. Here, a biorefinery for lactic acid production from lignocellulosic feedstocks was designed and evaluated through techno-economic analysis (TEA) and life cycle assessment (LCA) under uncertainty.[1]

Approach

- BioSTEAM[2] was leveraged for the design, simulation, TEA, and LCA of the biorefinery.
- Three conversion configurations were designed to evaluate the biorefinery across the titer-yield-productivity performance space, and each of the configurations was assessed under neutral-pH and low-pH fermentation scenarios.
- Feedstocks with different prices and carbohydrate content were also examined.



A lignocellulosic biorefinery for lactic acid production was designed and evaluated through techno-economic analysis (TEA) and life cycle assessment (LCA) for multiple configurations, fermentation scenarios, and feedstocks under uncertainty.

Results

- Under baseline conditions, the biorefinery was capable of producing market-competitive lactic acid. Its performance could be further enhanced with advancements in key technological parameters (fermentation yield and separation process conversions) and process operation optimization.
- Titer and yield were critical to the price of generated lactic acid, but environmental impacts were primarily affected by titer and less sensitive to yield.
- Development of acid-resistant strains for low-pH fermentation could significantly lower the price and environmental impacts of lactic acid.

Significance

Unlike previous TEA and LCA studies, which used static, constrained approaches that primarily focused on a single or few sets of discrete assumptions, this study used BioSTEAM to account for the rapidly evolving state of technology in multiple disciplines along the lactic acid production line — highlighting the ability of agile TEA/LCA to screen promising biorefinery designs, prioritize research needs, and establish a road map for the continued development of bioproducts and biofuels.

[1] *Li et al. 2021. "Sustainable Lactic Acid Production from Lignocellulosic Biomass." ACS Sustainable Chemistry and Engineering. DOI: 10.1021/acssuschemeng.0c08055.*
[2] *Cortes-Peña, et al. 2020. "BioSTEAM: A Fast and Flexible Platform for the Design, Simulation, and Techno-Economic Analysis of Biorefineries under Uncertainty." ACS Sustainable Chemistry and Engineering. DOI: 10.1021/acssuschemeng.9b07040.*

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