BRC Science Highlight
May 2021

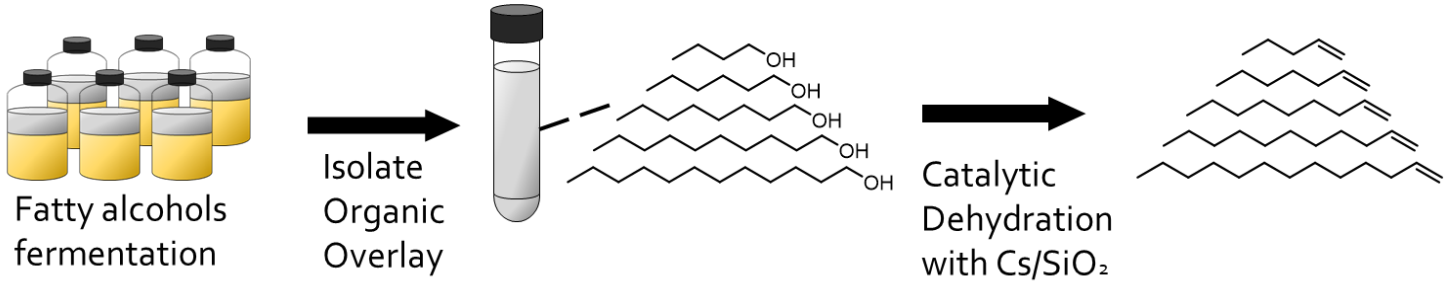
Renewable Linear Alpha-Olefins by Base-Catalyzed Dehydration of Biologically-Derived Fatty Alcohols

Background/objective

Linear alpha olefins (LAOs) are widely used to produce plasticizers, surfactants, lubricants, and polyethylene comonomers. With recent efforts to move society toward a circular economy, there is interest in the production of LAOs from renewable resources — although integrating biological and chemical catalysis is a major challenge for supplying commodify chemicals from renewable resources on an industrial scale. In this study, we take one of our target CABBI products, fatty alcohols, and upgrade it to LAO catalytically. Technoeconomic analysis (TEA) of this combined biological and catalytic process identifies core improvements required for making this process economically viable.

Approach

- Biologically produced fatty alcohols were used as a feedstock for production of LAO.
- Base catalysts were studied for the dehydration of fatty alcohols to LAOs in gas phase with high selectivity (>70%).
- TEA of the integrated process (fatty alcohol production and subsequent dehydration to LAO) was conducted across the potential fermentation TRY (titer, rate, yield) landscape.



Overview of the integrated process components (biological and catalytic) starting from anerobic fatty alcohol production, going to organic overlay isolation, and finishing with catalytic dehydration to LAO.

Results

- Synthetic and biological feeds of fatty alcohols were analyzed for conversion to LAO. Contaminates from cell cultures led to some reduction in conversion.
- Catalytic activity was totally regenerated through calcination.
- From the TEA, baseline fermentation performance showed an increase in minimum product selling price (MPSP) for LAOs due to low titers and high costs of managing water and tridecane solvent flows through the system. However, targeted improvements in fermentation performance (e.g., achieving 40 g/L titer, 0.5 g/L/h productivity, 80% theoretical yield) can enable financially viable production of biologically derived LAOs.

Significance

Integration of biological and chemical catalysis opens more renewable possibilities for chemical production pathways. This study shows an economically viable solution for renewable production of LAO from biologically produced fatty alcohols, one of the CABBI target products.

McClelland, D.J., et al. 2021. "Renewable Linear Alpha-Olefins by Base-Catalyzed Dehydration of Biologically-Derived Fatty Alcohols." Green Chemistry. DOI: 10.1039/D1GC00243K.

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