Economic and Environmental Sustainability of Bio-Based HMF Production and Recovery from Lignocellulosic Biomass

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Background/Objective

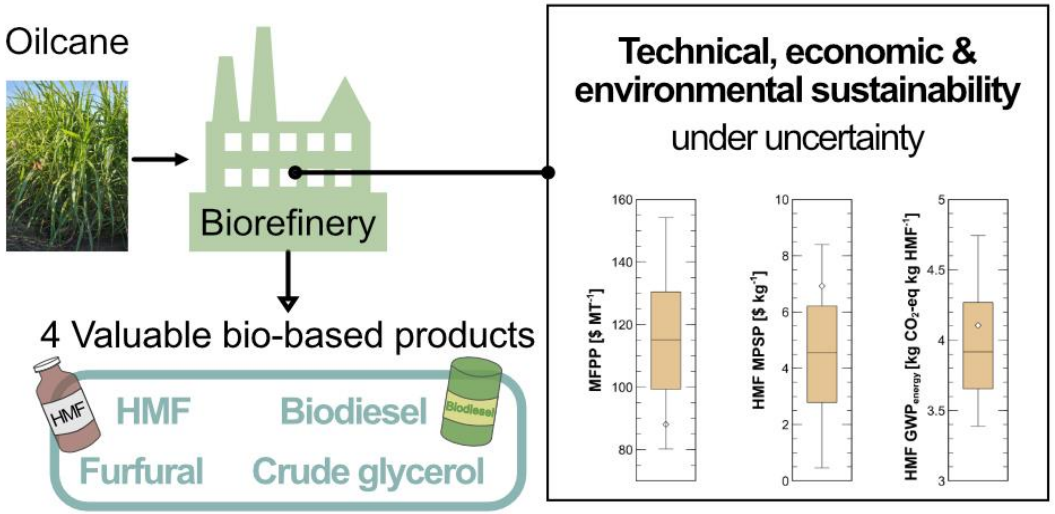
- Hydroxymethylfurfural (HMF) is a versatile bio-based platform chemical which serves as a precursor for production of various commercially important products including polymers, surfactants, solvents, and pharmaceuticals.
- However, current bio-based HMF production methods cannot compete economically with petroleum-based alternatives such as p-xylene.
- This work explores whether co-producing HMF with other valuable bioproducts from transgenic lignocellulosic biomass can improve its environmental and economic sustainability.

Approach

An integrated biorefinery coproducing HMF, furfural, biodiesel, and crude glycerol from transgenic sugarcane-oilcane was designed, simulated, and evaluated using BioSTEAM, an open-source Python-based platform. A detailed technoeconomic analysis and life cycle assessment of the biorefinery was performed.

Results

The proposed biorefinery could afford a maximum feedstock purchasing price of $115.17/MT for oilcane and produce HMF with a minimum selling price of $4.54/kg, which is 75% lower than the commercial price of HMF. The median global warming potential of HMF was 3.92 kg CO_2-eq/kg HMF, which is 32% lower than its counterpart, bio-based p-xylene.



Simplified representation of proposed biorefinery and key results from technoeconomic and environmental analyses of the biorefinery.

Significance/Impacts

This study shows that diverse valuable bioproducts co-produced from transgenic lignocellulosic biomass positively impacted economic feasibility and environmental sustainability of the biorefinery. The study specifically highlights the economic and environmental advantages of co-producing bio-based HMF from an alternative feedstock using green and non-catalytic technology.

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