Biodiesel Production from Engineered Sugarcane Lipids under Uncertain Feedstock Compositions: Process Design and Techno-Economic Analysis

Background/objective

Metabolically engineered sugarcane (sugarcane that produces lipids, or lipidcane) possesses enormous potential for producing large quantities of biodiesel as an alternative feedstock because of sugarcane's higher plant productivity. Despite the excellent potential for lipidcane to produce biodiesel, specific challenges are associated with lipid composition and quality. In this study, we have proposed four different process schemes to handle feedstock with varying lipids composition and conducted a rigorous techno-economic analysis with detailed sensitivity analyses (single parameter analysis, conjoint analysis, worst-case and best-case analysis) along with Monte Carlo simulation to predict the probability of plant profitability under varying conditions.

Approach

❖ Four different process schemes were compared under thermal glycerolysis and enzymatic glycerolysis approaches to produce biodiesel from lipidcane with uncertain fatty acid compositions to achieve an economically viable process strategy.

❖ These schemes were based on the biodiesel yield and economic indicators such as the net present value (NPV) and the minimum selling price (MSP) of biodiesel.
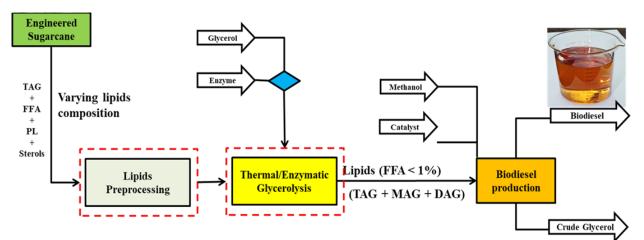
Results

❖ The cane lipid percentage is the most significant factor influencing process economics.

❖ Polar lipid separation under a thermal glycerolysis scheme resulted in the maximum NPV ($96.5 million) and minimum MSP ($1,107/ton biodiesel).

❖ Positive NPV was obtained for 15% lipid content with a low lipid procurement price ($0.536/kg), and a 20% lipid content should be considered to achieve a positive NPV for higher lipid prices (>$0.80/kg).

Processing vegetative lipids into biodiesel.

Significance

A cost-effective technology was proposed for converting vegetative lipids to biodiesel using thermal and enzymatic glycerolysis processes. This type of processing supports the "plants as factories" strategy of converting lipids from plants into biofuels and bioproducts.