

Influence of Inorganic Carbon Sources on Low-pH Succinic Acid Production by *Issatchenkia orientalis*: Process Insights and Kinetic Analysis

Background/Objective

Bio-based succinic acid (SA) production has attracted significant interest; however, the relationship between fermentation conditions and SA biosynthesis remains insufficiently understood, particularly under low-pH operation. In this study, an engineered, acid-tolerant, nonmodel yeast, *Issatchenkia orientalis*, was used to investigate the role of inorganic carbon supplementation in SA production from glucose.

Approach

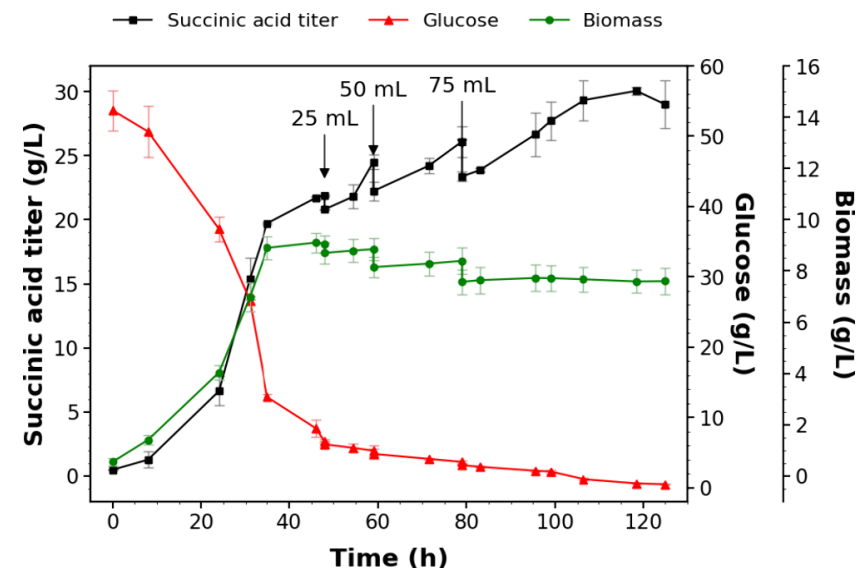
The study was designed to demonstrate the SA production process utilizing glucose as a substrate and inorganic carbon as a co-substrate. Because regulation of gas-phase CO₂ during fermentation is challenging due to low solubility and off-gas losses, liquid-phase inorganic carbon sources, carbonic acid (H₂CO₃) and sodium carbonate (Na₂CO₃), were evaluated as indirect CO₂ donors. Fermentations were conducted in a corn steep liquor-based medium under acidic conditions.

Results

Shake-flask experiments demonstrated that H₂CO₃ supplementation increased SA production, achieving a maximum titer of 8.9 g/L and a yield of 0.46 g/g glucose. Kinetic analysis of bench-scale fermentations showed that the SA formation was well described by the Luedeking–Piret model, indicating mixed growth-associated product formation with a substantial nongrowth-associated contribution under carbonic acid supplementation. Guided by these kinetic insights, a two-stage fed-batch fermentation strategy was implemented, resulting in an SA titer of 30 g/L and a yield of 0.57 g/g glucose within 115 h.

Significance/Impacts

This study highlights how integrating inorganic carbon donors can improve the performance of low-pH fermentation and provide improved process designs for bio-based SA production.



Fed-batch fermentation profiles with H₂CO₃ feeding, with the pH of the fermentation medium was continuously maintained at 3.5 using acid-base dosing pumps.