Effect of inorganic carbon sources in succinic acid biosynthesis using acid-tolerant engineered yeast

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INTRODUCTION

- Succinic acid (SA) is one of the high-value platform chemicals recognized by the Department of Energy, US.
- In 2019, the global SA market was valued at $137.4 million and is expected to reach $217.6 million by 2026.
- Biological process of SA production can simultaneously reduce the dependency on fossil-based resources and sequester CO_2 to synthesize value-added products.
- Acid-tolerant non-model yeast, *Issatchenkia orientalis*, has been developed to eliminate acidification step from the overall process flow diagram (Fig. 1) (Tran et al., 2023).

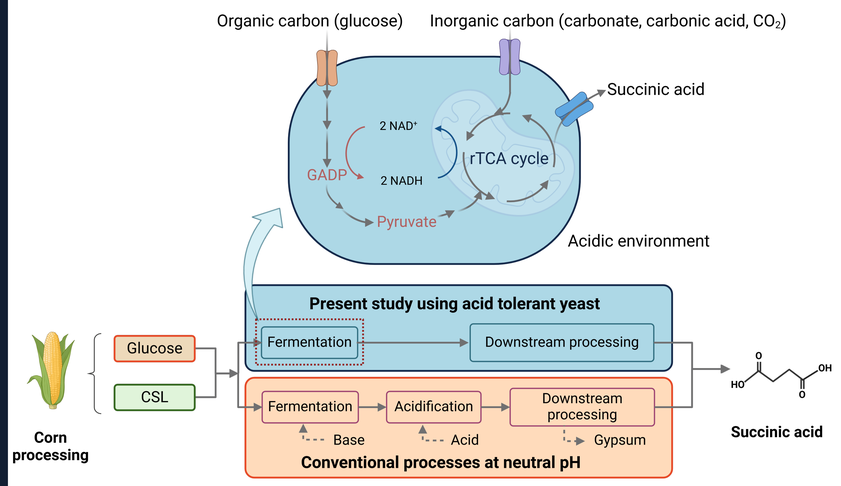


Fig. 1 Schematic diagram of the biosynthesis of succinic acid

- Low-pH fermentation leads to minimize waste (e.g., gypsum) generation and contamination risks.
- Synergistic effect of gaseous CO_2, carbonate/carbonic acid, and organic carbon can enhance SA biosynthesis.

METHODOLOGY

- Acid-tolerant strain, *I. orientalis*, was used to produced SA from low-cost medium comprises of corn steep liquor (CSL).
- Sodium carbonate, carbonic acid along with atmospheric CO_2 was studied on SA production.

METHODOLOGY

- Preliminary studies were performed in 500 mL shake flasks with the working volume of 100 mL, followed by in 1 L controlled fermenters (Fig. 2).

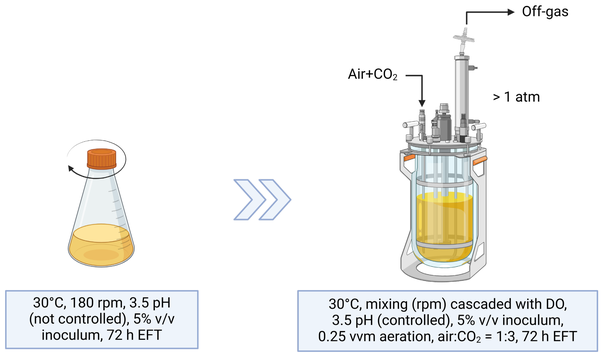


Fig. 2 Schematic diagram of experimental procedure

RESULTS

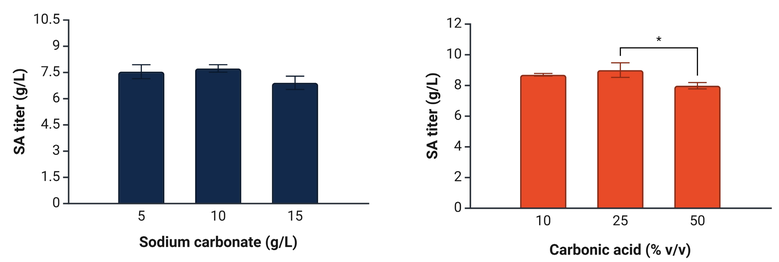


Fig. 3 Effect of inorganic carbon sources in shake flask without CO_2 sparging

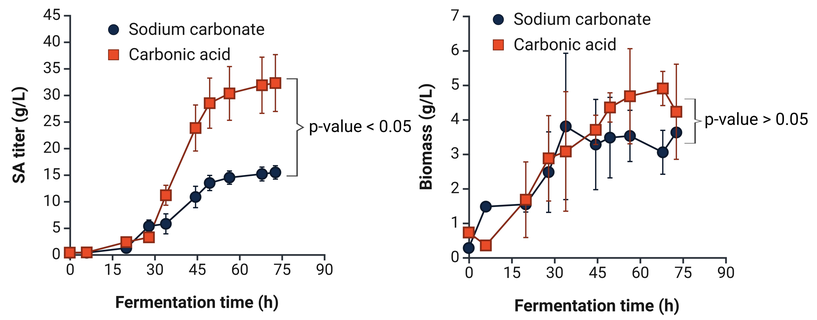
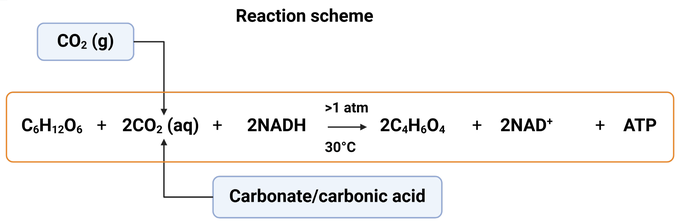


Fig. 4 Effect of inorganic carbon sources in fermenters with CO_2 sparging



RESULTS

- Supplementation of sodium carbonate in preliminary experiments exhibited the maximum SA titer of 7.6 g/L, whereas carbonic acid showed the maximum SA titer of 9.1 g/L (Fig. 3).
- Carbonic acid with gaseous CO_2 had SA titer of 35 g/L, whereas carbonate with gaseous CO_2 showed SA titer of 14 g/L (Fig. 4).

FUTURE SCOPE

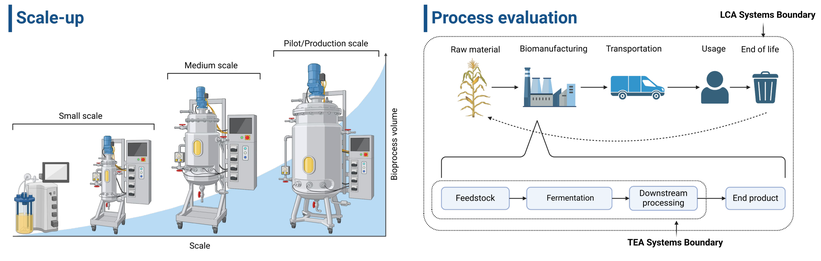


Fig. 5 Future scopes in scaling-up of biomanufacturing and process evaluation

- To develop an industry scale end-to-end process, scale-up study and process evaluation using LCA and TEA tools can be the next step (Fig. 5).

CONCLUSIONS

- Addition of inorganic carbon sources has shown a positive impact of SA biosynthesis.
- Synergistic effect of gaseous CO_2 and carbonic acid significantly increased SA titer. However, no significant effect on biomass proliferation.

REFERENCE

- Tran, V. G., Mishra, S., Bhagwat, S. S., Shafaei, S., Shen, Y., Allen, J. L., Crosly, B. A., Tan, S., Fatma, Z., Rabinowitz, J. D., Guest, J. S., Singh, V., & Zhao, H. (2023). An end-to-end pipeline for succinic acid production at an industrially relevant scale using *Issatchenkia orientalis*. Nature Communications, 14(1), 1-14.

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