A Robust Microbe for Efficient Biomass Conversion: Insights from Bacillus coagulans B-768

Background

- Microbes can convert lignocellulosic biomass into valuable fuels, chemicals, and materials.
- A technical challenge is developing microbial catalysts are efficient under harsh industrial conditions.
- *B. coagulans* is a facultative thermophilic anaerobe capable of utilizing a wide range of sugars (C5, C6, C12) and thriving across diverse temperatures (37 ~ 60 °C) and pH levels (4 ~ 7).
- Despite its potential, the genetic and molecular basis of its robustness remains largely unexplored.

Approach

- We combined genome sequencing, functional genomics, fermentation, and proteomics to investigate *B. coagulans* B-768 — a novel strain grown on refined sugars and switchgrass hydrolysate (SGH).

Results

- *B. coagulans* B-768 has the largest sequenced genome in its species to date at 3.9 Mbp, featuring expanded carbohydrate transport and metabolism compared to its relative 36D1 (Figs. 1A, 2A, and 2B).
- B-768 demonstrated no growth inhibition or lactate production decline in SGH (Figs. 1B,1C).
- Lactate production reached 60 g/L from glucose, achieving 93% of the theoretical yield (Fig. 1D).
- Proteome reallocation from carbohydrate metabolism to energy generation enabled B-768 to meet higher energy demands when grown on xylose, at the cost of reduced lactate production (Fig. 1E).
- Faster growth and glucose uptake rates result in lactate overproduction, while slower xylose uptake diminished overflow metabolism due to the high energy demand of sugar assimilation.
- Stress-responsive proteins, such as sporulation proteins, glyoxylase, and putative transcriptional regulators, were overexpressed in B-768 grown in SGH, contributing to the strain's robust growth.

Significance

- A fundamental understanding of robustness of B-768 enables its optimization for efficient lignocellulosic biomass conversion into high-value products.

Dooley, D. et al. *mSystems* (2024). https://doi.org/10.1128/msystems.00952-24

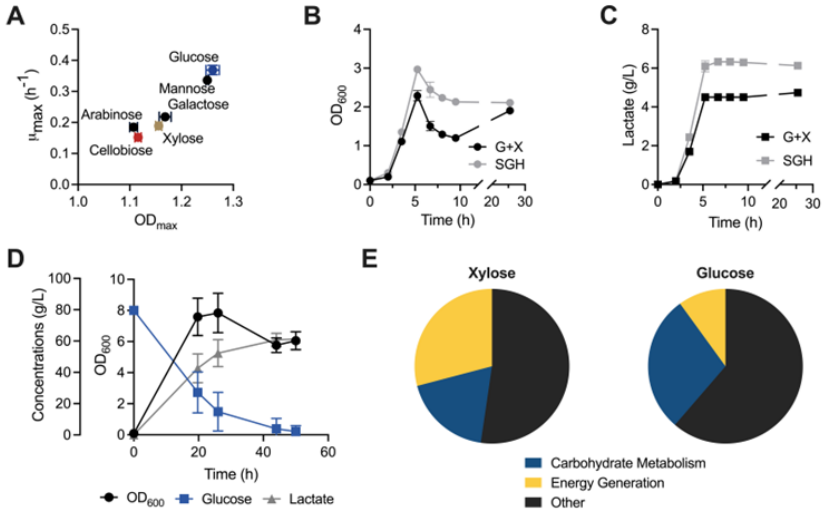

Figure 1. Cellular robustness of B-768 for (**A**) utilization of various sugars, (**B**) growth and (**C**) lactate production in glucose + xylose mixture (G+X) and undetoxified switchgrass hydrolysate (SGH). (**D**) Lactate production, glucose consumption, and growth of B-768 on glucose in a controlled bioreactor. (**E**) Proteome reallocation of B-768 on xylose and glucose

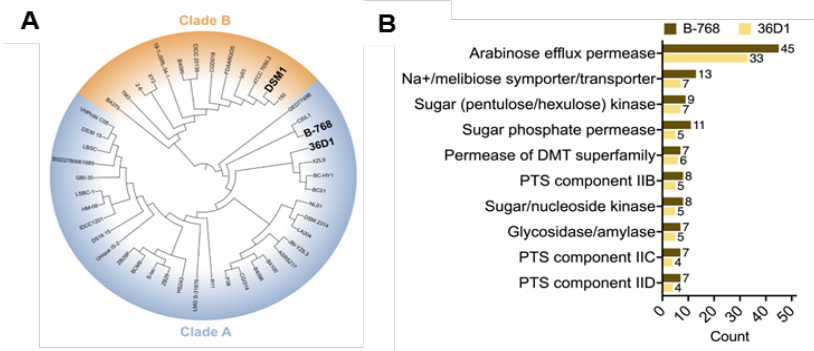

Figure 2. (**A**) Pan-genome of *B. coagulans*. (**B**) Expanded carbon metabolism of B-768.