Photosynthetic Microorganism Platform for Research on Bioproduction

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[Background]

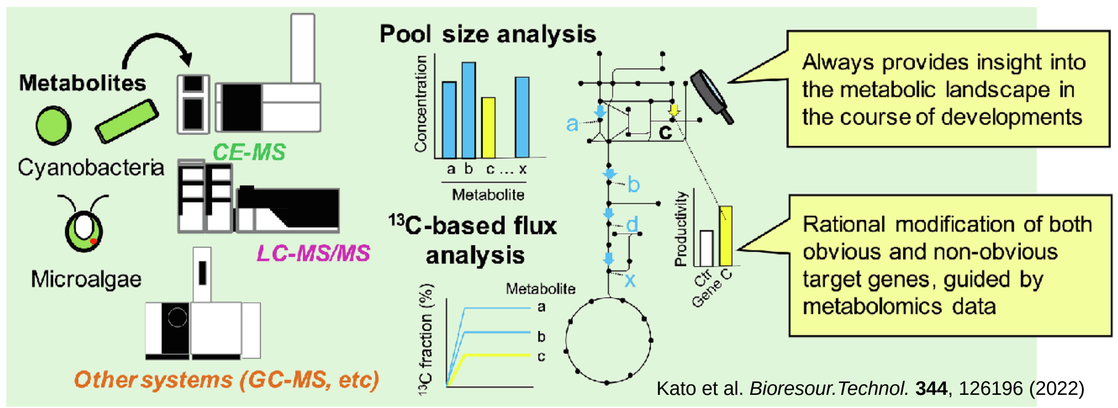
Converting CO_2 into valuable products with photosynthetic microbes is attracting attention as a low-carbon biomanufacturing approach. However, the critical technologies such as the optimal host strain selection, genetic engineering, cultivation method, and cellular-state analysis of photosynthetic microbes differ significantly from those used for general-purpose hosts like *E. coli*, and this poses a major barrier to the practical application of photosynthetic microbes.

[Current Challenges]

In photosynthetic microorganisms, cellular states change rapidly with the light conditions in the environment, making accurate analysis of the metabolism difficult. Genetic engineering tools—including inducible promoters for gene-expression—are less ready available compared to those in model organisms.

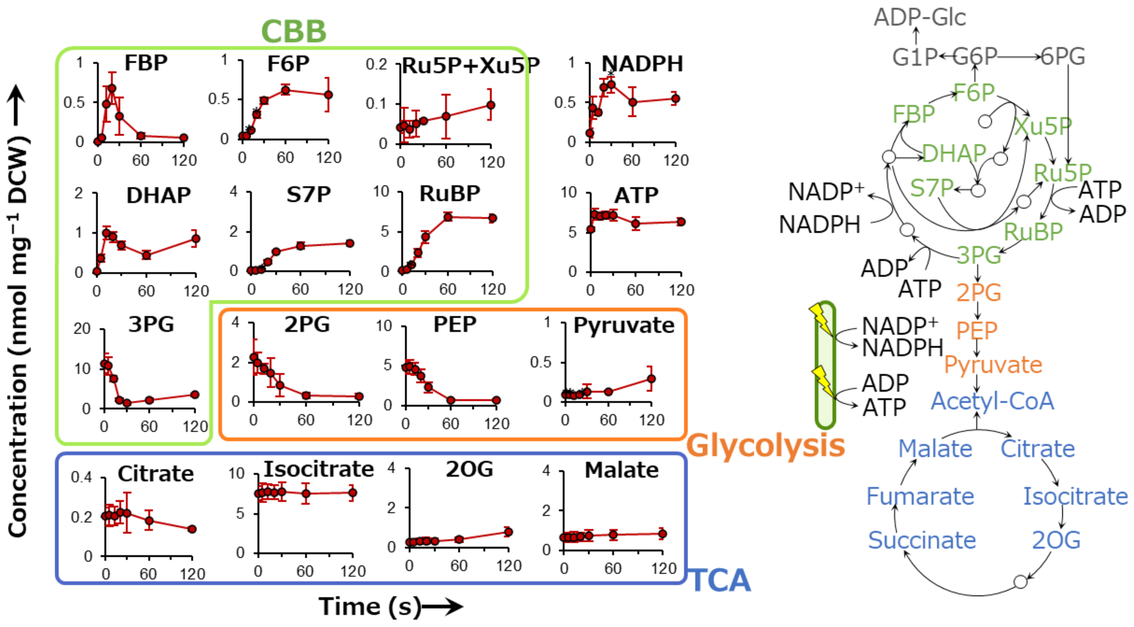
Technology Highlights

1. Metabolomics and Proteomics Tailored to Photosynthetic Microorganisms



Kato et al. *Bioresour.Technol.* **344**, 126196 (2022)

Omics analysis reveals metabolic bottlenecks and guides rational strain engineering



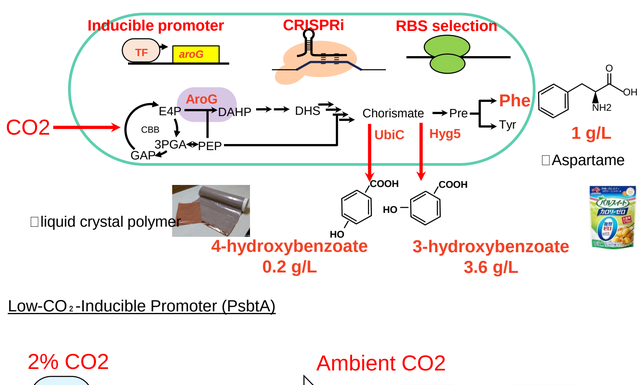
Rapid sampling methods combined with absolute-quantification metabolomics captures fast metabolic shifts at the onset of photosynthesis

2. Experience Across Diverse Photosynthetic Microorganisms

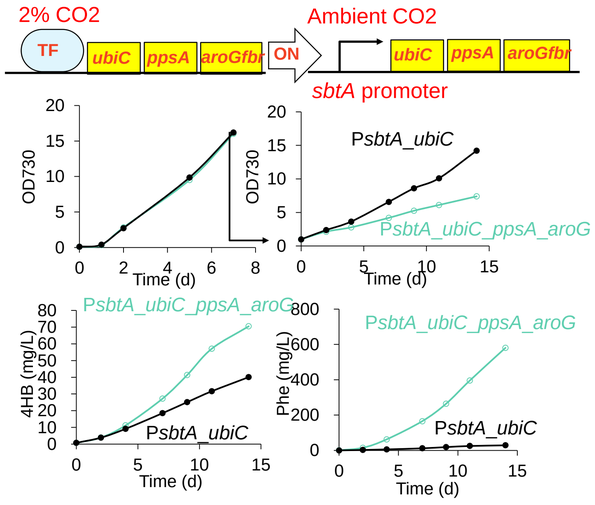
Product Examples

- Organic acids, Carotenoids
- PHA, Aromatic compounds and more

A) Aromatic Production in Cyanobacteria

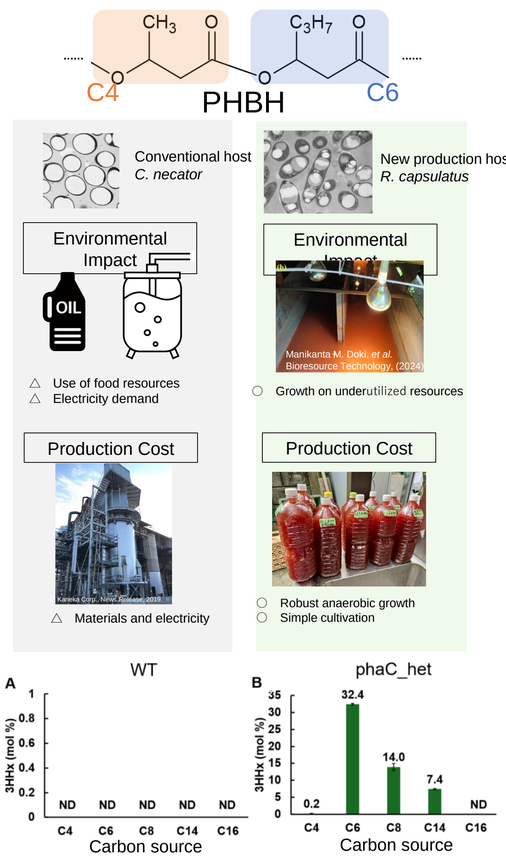


Low-CO_2-Inducible Promoter (PsbtA)



Expression control enables g/L-scale production of aromatic compounds

B) PHA Production in Purple Bacteria



PHBH production demonstrated in R. capsulatus

Pathway to Commercialization

Potential Applications For R&D teams using photosynthetic microorganisms:

- Identification of metabolic bottlenecks and rational strain engineering using metabolomics and proteomics
- Enhancement of product titers by combining low-CO_2-inducible promoters with gene expression control tools
- Development of recovery technologies for target products: The goal is to reduce production costs by minimizing toxicity to the host and improving the efficiency of the recovery process.→Co-Development for Target Production
- Establishment of circular production systems utilizing carbons in wastewater, powered by advanced genetic tools for purple photosynthetic bacteria →Co-Development for Target Production

Collaboration Opportunities

- Joint R&D of photosynthetic production systems tailored for target compounds
- Omics-driven bottleneck analysis for target product lines under development
- Sustainable biomanufacturing utilizing underutilized resources (e.g., industrial wastewater)

Publications & Intellectual Property

- JP Patent Application 2026-034088:
  「CO_2-controlled compound production method, apparatus, and bacteria」
- Miura et al. (2026) Heterologous polyhydroxyalkanoate synthase expression enables P(3HB-co-3HHx) production from fatty acids in *Rhodobacter capsulatus.* J. Biosci. Bioeng., in press
- Tanaka et al. (2023) Dark accumulation of downstream glycolytic intermediates initiates robust photosynthesis in cyanobacteria. Plant Physiol. 191(4), 2400–2413

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