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CYANOBACTERIA MICROBIOMES FOR BIOPLASTIC PRODUCTION: CRITICAL REVIEW OF KEY FACTORS AND CHALLENGES IN SCALING FROM LABORATORY TO INDUSTRY SET-UPS

Main message

Cyanobacteria-rich microbiomes present a promising avenue for sustainable and high-yield PHB production under non-sterile conditions, offering new opportunities for the bioplastics industry. Achieving optimal PHB yields necessitates careful control of microbial community composition and cultivation parameters. Advanced analytical techniques enable real-time monitoring and analysis. While scaling up remains a challenge, a two-stage cultivation strategy, focusing on biomass growth followed by PHB synthesis, holds significant potential for achieving large-scale, cost-effective PHB production using these microbiomes in open systems.

Background

Current industrial-scale polyhydroxybutyrate (PHB) production primarily uses heterotrophic bacteria (e.g., *Cupriavidus necator*, *Halomonas* sp., recombinant *Escherichia coli*) cultivated on refined feedstocks like glucose or sucrose, leading to high production costs. To explore more sustainable and cost-effective alternatives, **photoautotrophic cyanobacteria, which use CO2 and sunlight rather than organic carbon, are being explored**. While cyanobacteria are promising platforms for various high-value products, their application in PHB production remains limited compared to heterotrophic systems, representing less than 5% of related scientific publications. Furthermore, the use of mixed microbial consortia (microbiomes) is being explored to enhance process robustness and flexibility, potentially enabling non-sterile cultivation and the utilisation of low-cost waste streams. Although research on cyanobacterial microbiomes for PHB production is scarce, the combined benefits of cyanobacteria and microbiome approaches present a significant area for future development.

Objective

Managing microbiome population dynamics in non-sterile environments requires effective monitoring and control. Overcoming these challenges involves integrating molecular biology techniques with quantitative and qualitative PHB analysis. While cyanobacteria microbiomes show promise for PHB production, optimising strategies is essential to address non-sterile conditions and scalability. The transition from lab-scale to industrial-scale PHB production remains complex, requiring carefully integrated approaches.

Highlights

- Cyanobacteria microbiomes offer a method for PHA production in non-sterile setups.
- Cyanobacteria microbiomes show great long-term productivity.
- Sustained production has allowed to achieve 27% dcw PHB yield over time.
- Scaling up PHB production poses challenges but promising strategies are explored.
- Microbiome cultures reduce scaling risks versus current PHB production methods.

Source

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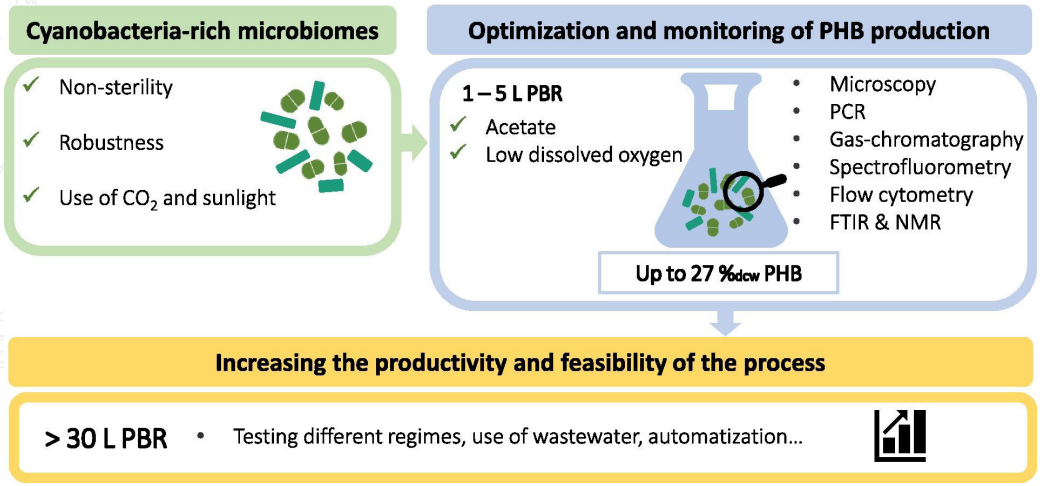

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