Development of microbial consortia for valorizing post-consumer polyethylene via thermal-biological process

The Plastic Biorefinery

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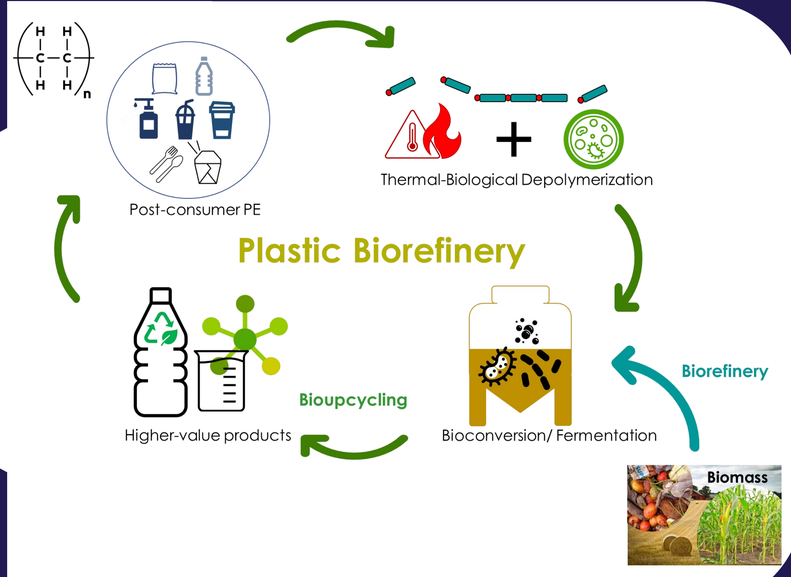
SCAN ME

Introduction

Plastic production worldwide has doubled in the last two decades and is expected to reach a four-fold increase by 2050. **Polyethylene (PE) is the most produced plastic globally.** Its short lifespan as single-use plastic makes it one of the most abundant plastic wastes.

Disappointingly, only 9% of total plastic waste is recycled currently, indicating inefficiency of conventional recycling process. Biotechnological process could be the complementary approach to valorize unrecyclable plastic waste stream. As PE composes of the very recalcitrant C-C bond, combining thermal and biological treatment opens the window for PE valorization.



Previous work in our group: Activity of microbial consortia toward PE was enhanced by **co-degradation with lignin,** but the process is extremely slow because of PE recalcitrancy.

*Ref: Alba Martinez i Quer. Development of different optimized strategies and characterization of a Defined Mixed Consortia (DMC) for enhanced LDPE bacterial biodegradation. Master thesis, Sustainable biotechnology section. Aalborg University. June 10, 2019. Supervisor: C. Varrone. https://projekter.aau.dk/projekter/files/306570992/AlbaMartinezQuer_MasterThesis.pdf

Aim of this work: To enhance PE valorization potential via the combination of pyrolysis and microbial consortia bioconversion

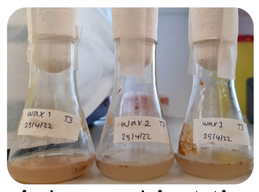
Methods

PE pyrolysis wax was supplied by Technical University of Denmark (DTU)

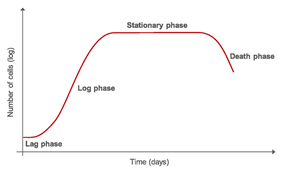
Composition analysis by 1H-NMR

Development of mixed microbial consortia

Soil and leachate from plastic landfill

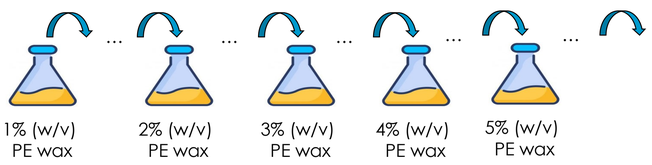


Enrichment in Mineral Salt Media with 1% (w/v) PE wax



Study growth characteristics

Select the potential consortia



Adaptive Laboratory Evolution by repeated transfer in batch condition during exponential phase

Analysis of products from bio-conversion process

- FTIR
- NMR
- GC-MS

Future work

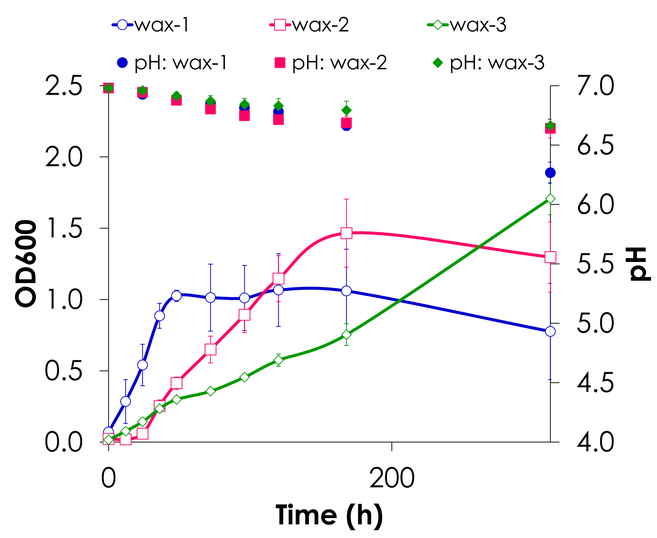
- Investigate co-substrate bioconversion (biomass and PE) to boost **plastic biorefinery**, i.e., lignin could induce the secretion of different enzyme families (hydrolases and monooxygenases), enhancing also PE degradation
- Biofunneling for selective conversion to specific products

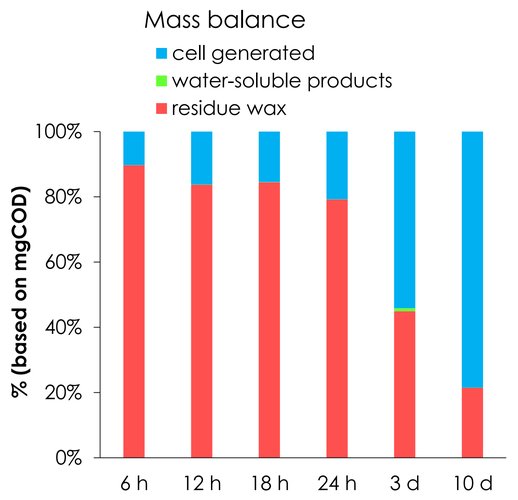
Results

1. PE pyrolysis wax's composition by 1H-NMR

Hydrocarbon types	% v/v
Aromatics	3.51
Paraffins	74.95
Olefins	21.53

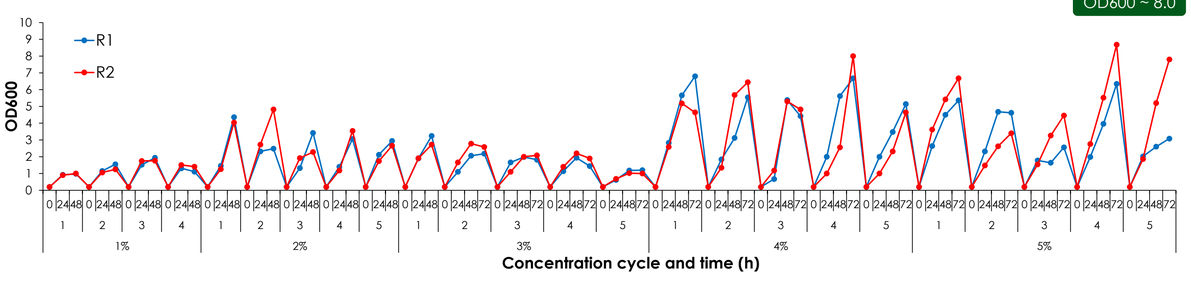
2. Growth characteristics of 3 enriched consortia



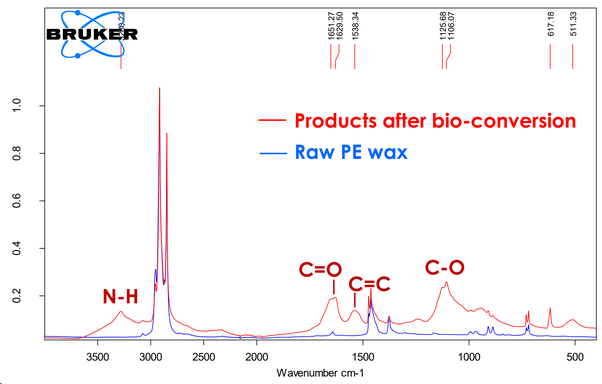


3. Adaptive Laboratory Evolution (*Example:* consortium wax-2)

OD600 ~ 8.0



4. Products from bio-conversion process



- Bio-conversion of 5% PE wax by consortium wax-2 resulted in the product contained ester group.
- Wax ester are widely used in pharmaceuticals, cosmetics, lubricants, and food industries.

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