Biodegradable mulch film monomer metabolization: Optimization via Adaptive Laboratory Evolution

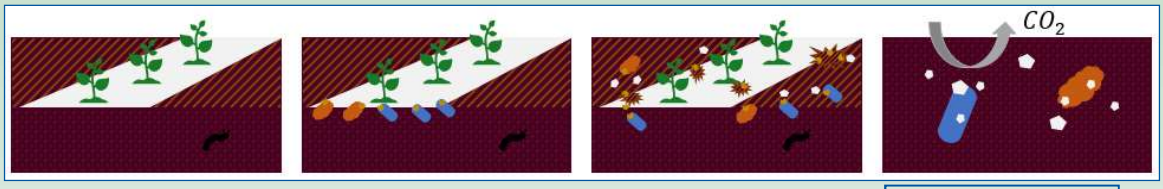
Kristina S. Bitter *, R. Nugraha C. Utomo *, Lars M. Blank *

* RWTH Aachen University, Institute of Applied Microbiology, Worringerweg 1, 52074 Aachen, Germany

Kristina.bitter@rwth-aachen.de

Background

Biotic degradation of mulch films in soil:



Mulch film is introduced to agricultural soil

Colonization of the mulch film by different soil microorganisms

Depolymerization of mulch film into smaller fragments by enzymes

Metabolization of mulch film monomers by soil microbes

Objective

Enhance mineralization performances of biodegradable mulch films to avoid microplastic residues and its imaginably negative effects on soil and soil organisms.

First step: Examine biodegradability of mulch film monomers.

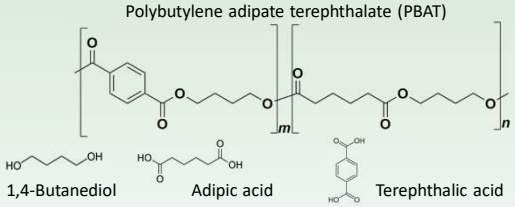
Polymers

Two biodegradable mulch films:

- Oil-based PBAT-PLA[1]
- Bio-based PHB

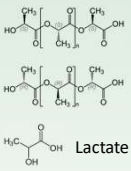
Monomers:

Polybutylene adipate terephthalate (PBAT)



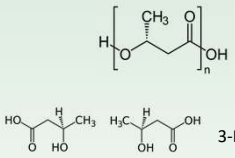
1,4-Butanediol | Adipic acid | Terephthalic acid

Polylactide (PLA)



Lactate

Polyhydroxybutyrate (PHB)



3-Hydroxybutyrate

Methods

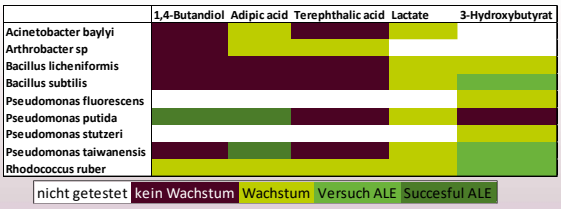
Literature study → Screening growth of potential monomer metabolizing, available microbes on monomers in EnzyScreen growth profiler[2]

→ Adaptive Laboratory Evolution[3] with most promising strains

→ Comparative monomer degradation test with *Rhodococcus ruber* in EnzyScreen growth profiler and System Duetz shaker; Analytics of monomer dissipation with High Pressure Liquid Chromatography

Results

Screening tests for monomer metabolization with potential degrading soil microbes [1,4,5]



Adaptive Laboratory Evolution (ALE) with promising strains

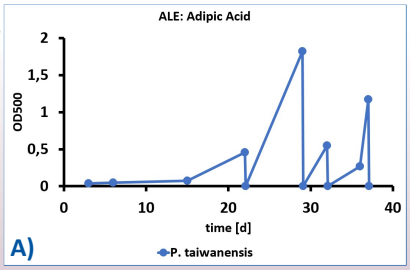
A) ALE with *P. taiwanensis* on adipic acid
(ALE successful with *P. putida* on 1,4-Butandiol in previous work).

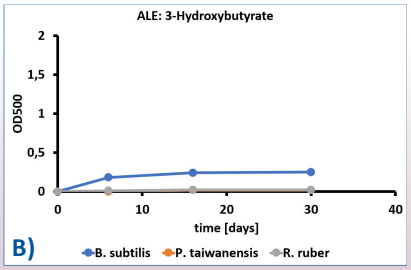
B) ALE with B. subtilis, P. taiwanensis and R.ruber on 3-Hydroxybutyrate.
Almost all tested microogranisms were able to grow on 3-Hydroxybutyrate in the screening tests, but only to a small extend which did not increase during ALE.

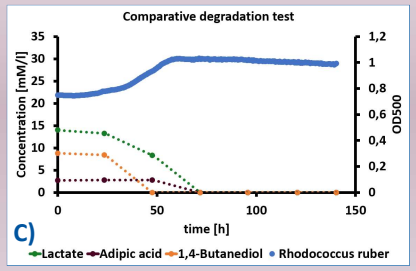
Comparative degradation test with monomer-metabolizing *Rhodococcus ruber* and PBAT-PLA monomers

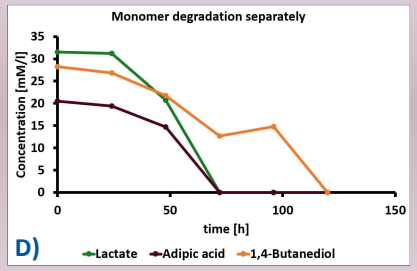
C) Monomer dissipation and microbial growth during one week degradation test with monomer mixture according to [1] (terephthalic acid dissipation will be analyzed).

D) Monomer dissipation test with *Rhodococcus ruber* incubated with single monomers separately under same conditions as C) (terephthalic acid dissipation will be analyzed).









Outlook

- This work was a first step into examination of the biodegradation process of biodegradable mulch films based on screening for potential key species in literature.
- In the next step, soil samples from different agricultural fields will be incubated with mulch films to isolate and identify polymer-degrading soil microbes or consortia.
- Further, the degradation performance under different conditions shall be examined.
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References

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