



FKITMCMXIX

Sveučilište u Zagrebu  
Fakultet kemijskog  
inženjerstva i tehnologije

15<sup>th</sup> International Scientific  
and Professional Conference  
WITH FOOD TO HEALTH  
17<sup>th</sup> and 18<sup>th</sup> September 2025

15<sup>th</sup> hranom  
do zdravlja  
with food  
to health  
OSIJEK, CROATIA 2025



*15<sup>th</sup> International Scientific-Professional Conference  
WITH FOOD TO HEALTH*

## *Microbial Synergy for a Greener Future through PHB Production from Sugars*

*Assoc. Prof. Dajana Kučić Grgić, PhD  
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*Osijek, 17<sup>th</sup> – 18<sup>th</sup> September 2025*



**bioPHA-comFPack**

**Proizvodnja i razvoj kompostabilne ambalaže iz otpadne biomase za pakiranje industrijski prerađenih prehrambenih proizvoda**

NPOO.C3.2.R3-II.04.0059

Nacionalni plan oporavka i otpornosti (NPOO)  
Podrška transferu tehnologije

**Prijavitelj projekta**  
Sveučilište u Zagrebu  
Fakultet kemijskog inženjerstva i tehnologije  
Trg Marka Marulića 19, 10 000 Zagreb

**Voditelj projekta**  
Izv. prof. dr. sc. Dajana Kučić Grgić

**Partneri projekta**  
Istraživačka organizacija:  
Sveučilište Josipa Jurja Strossmayera u Osijeku  
Prehrambeno-tehnološki fakultet Osijek  
Franje Kuhaca 18, 31 000 Osijek

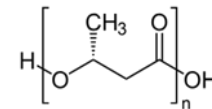
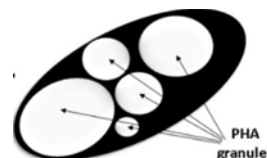
**Poduzeća:**  
Podravka d.d.  
Ante Starčevića 32, 48 000 Koprivnica  
Rotoplast d.o.o.  
Poduzetnička 7, Kerestinec, 10 431 Sveta Nedelja

**Trajanje projekta:** 1. 1. 2024. – 30. 6. 2026.

**Ukupni prihvatljivi troškovi projekta:** 1.628.689,99 €

**Bespovratna sredstva:** 1.488.082,51 €

[www.fkit.unizg.hr](http://www.fkit.unizg.hr)  
[bio-pha-com-f-pack.eu](http://bio-pha-com-f-pack.eu)



*PROJECT - Production and Development of Compostable Packaging from Waste Biomass for the Packaging of Industrially Processed Food Products*

1. *Production of PHA from secondary generation biomass – agroindustrial waste using solid state fermentation*

- Physical and chemical characterisation of waste
- Examine pure and mixed culture
- Examine different extractions methods
- Optimization of process via SmF and SSF

2. *Production of biodegradable and compostable packaging materials Development of biofilms – PHA, PLA, TPS, PBS*

- Using compostable coatings
  - Biodegradable additives
- Examine of produced biofilms:
- biodegradability
  - Ecotoxicity
  - Compostability



**biOPHA-comFPack**  
Production and Development of Compostable Packaging from Waste Biomass for the Packaging of Industrially Processed Food Products  
NPOO.C3.2.R3-IL.04.0059

National Recovery and Resilience Plan (NRRP)  
NextGeneration EU

**Project Applicant**  
University of Zagreb  
Faculty of Chemical Engineering and Technology  
Trg Marka Marulića 19, 10 000 Zagreb, Croatia

**Project Leader**  
Assoc. Prof. Dajana Kuđić Grgić, PhD

**Project Partners**  
Research Organization:  
Josip Juraj Strossmayer University of Osijek  
Faculty of Food Technology  
Osijek  
Franje Kuhača 18,  
31 000 Osijek, Croatia

**Companies:**  
Podravka d.d.  
Ante Starčevića 32, 48 000 Koprivnica, Croatia  
Rotoplast d.o.o.  
Poduzetnička 7, Kerestinec, 10 431 Sveta Nedelja, Croatia

**Duration of the project:** January 1, 2024 – June 30, 2026  
**Total eligible costs of the project:** 1,628,689.99 €  
**Grants:** 1,488,082.51 €

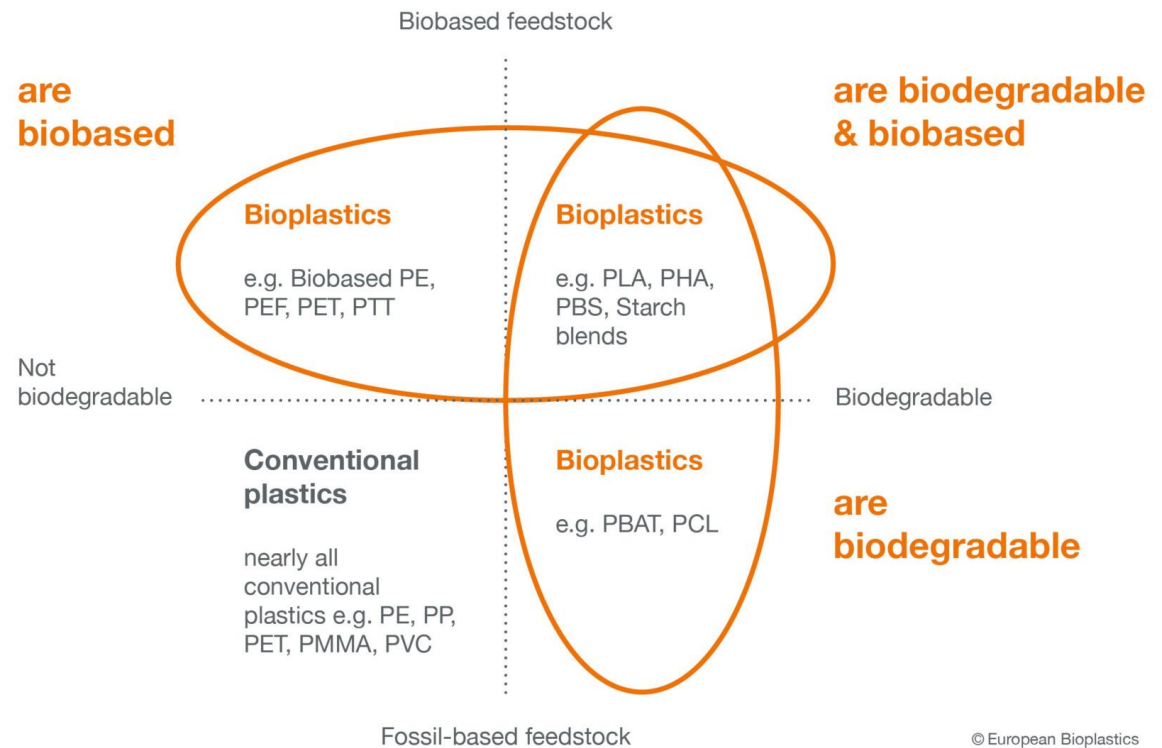
[www.fkit.unizg.hr](http://www.fkit.unizg.hr)  
[bio-pha-com-f-pack.eu](https://bio-pha-com-f-pack.eu)

Funded by the European Union  
NextGenerationEU

The project is financed from the National Recovery and Resilience Plan (NRRP), through the call for Technology Transfer Support

## Material coordinate system for bioplastics

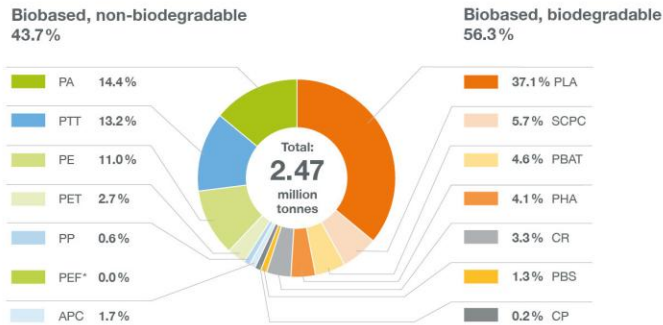
Bioplastics are biobased, biodegradable, or both.



Source: Institute for Bioplastics and Biocomposites (ifBB) and European Bioplastics (EUBP)

© European Bioplastics

## Global production capacities of bioplastics 2024



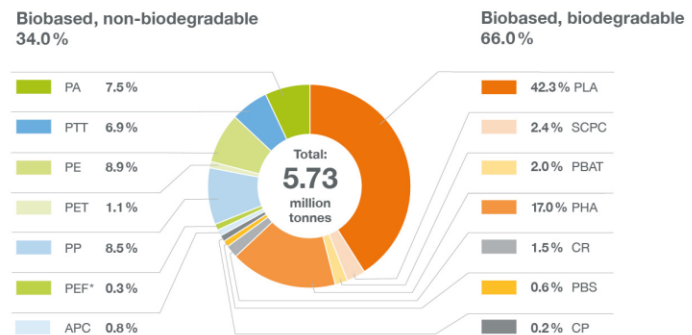
APC Aliphatic Polycarbonates  
CP Casein Polymers  
CR Cellulose Regenerates  
PA Polyamides  
PBAT Poly(Butylene Adipate-co-Terephthalate)

PBS Polybutylene Succinate and Copolymers  
PE Polyethylene  
PEF Polyethylene Furanate  
PET Polyethylene Terephthalate

PHA Polyhydroxyalkanoates  
PLA Polylactic Acid  
PTT Polytrimethylene Terephthalate  
SCPC Starch Containing Polymer Compounds

\* PEF available at commercial scale as of 2024  
Source: European Bioplastics, nova-institute (2024)

## Global production capacities of bioplastics 2029



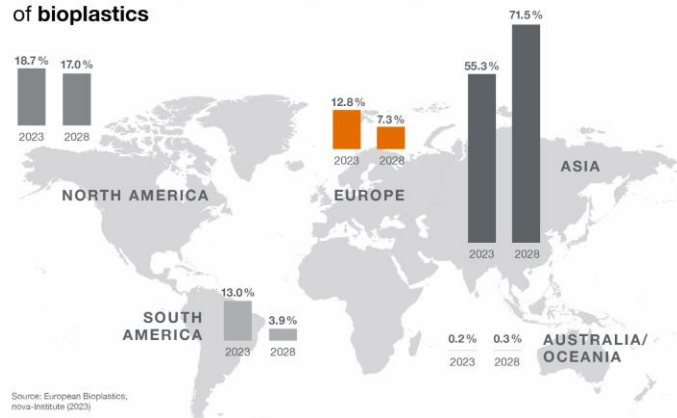
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PHA Polyhydroxyalkanoates  
PLA Polylactic Acid  
PP Polypropylene  
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SCPC Starch Containing Polymer Compounds

\* PEF available at commercial scale as of 2024  
Source: European Bioplastics, nova-institute (2024)

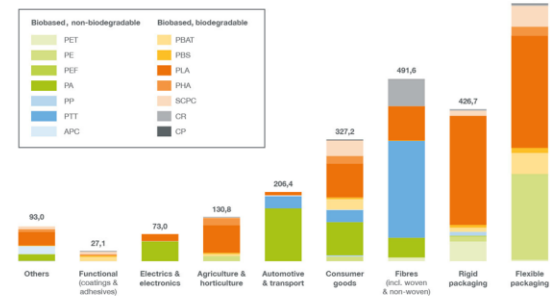
## Global production capacities of bioplastics



Source: European Bioplastics, nova-institute (2023)

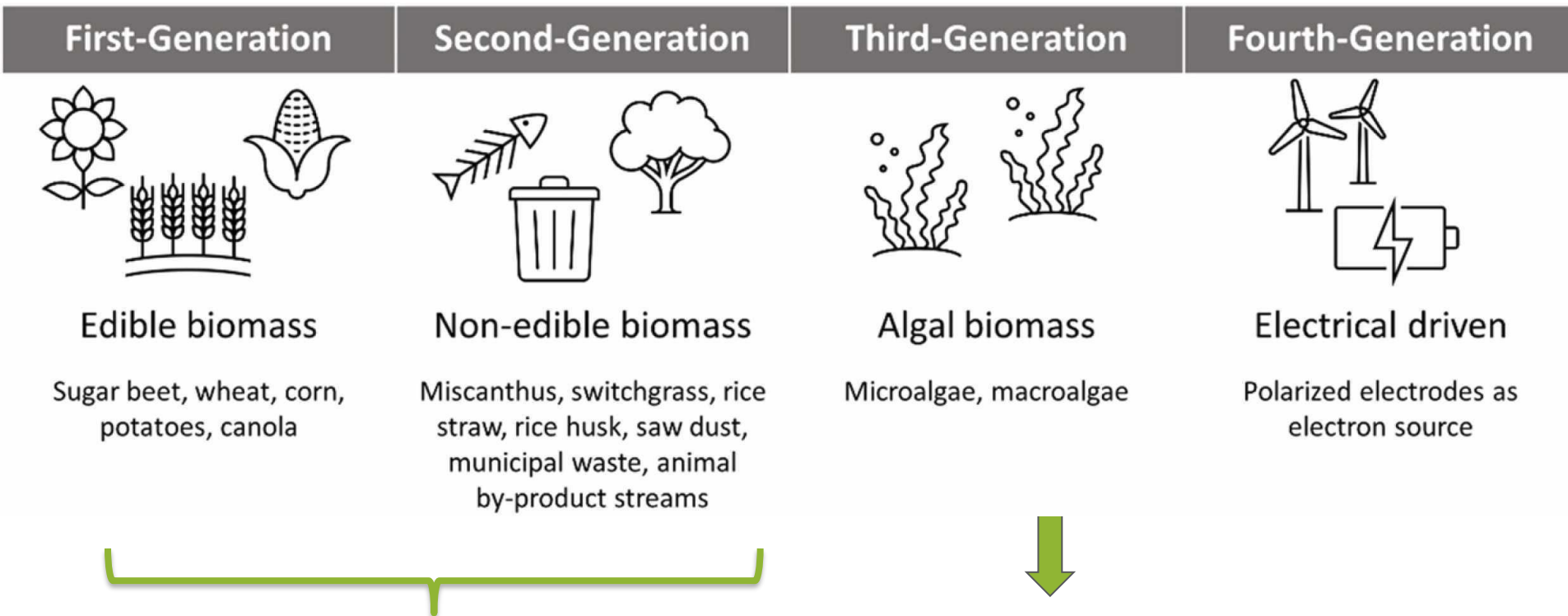
## Global production capacities of bioplastics 2024 (market segments by polymers)

in 1,000 tonnes



Source: European Bioplastics, nova-institute (2024)

# Production of bioplastics from biomass

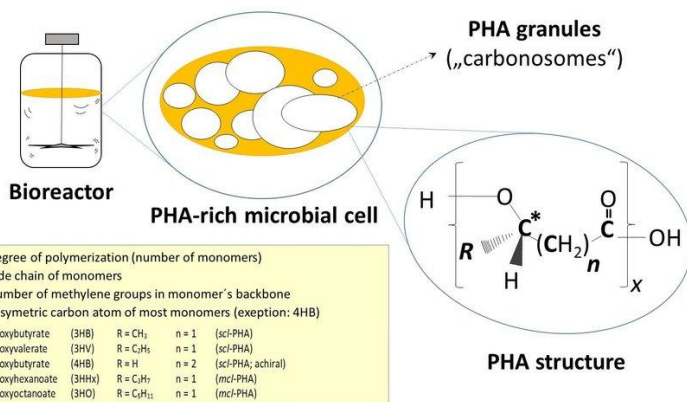
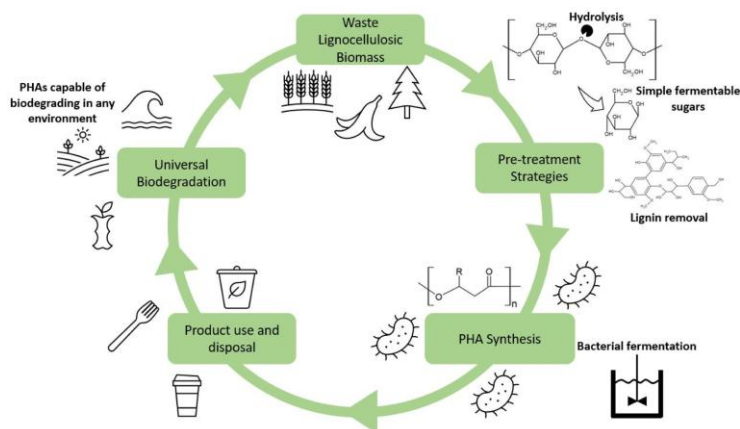


*There is a clear trend in research showing a shift to second-generation feedstock usage, due to concerns about available quantities and food prices.*

*High abundances of second-generation feedstocks and lower market competition lead to lower prices.*

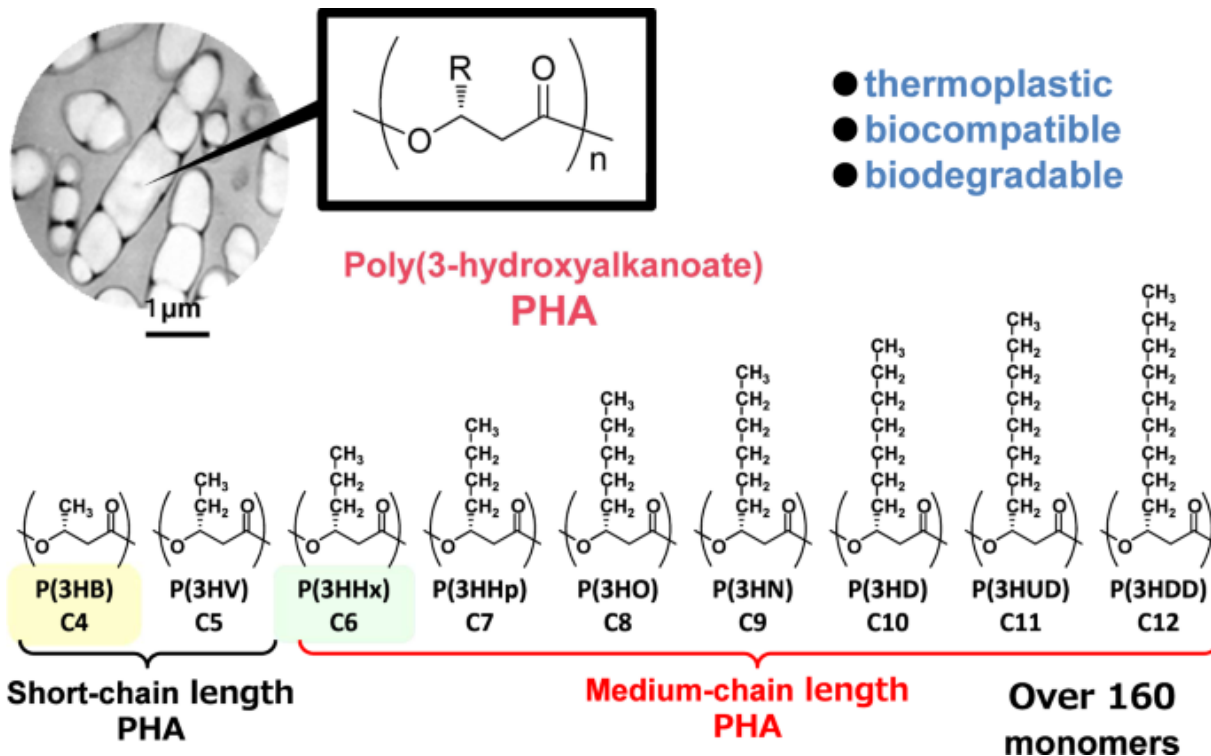
***Potential problems:** the economic feasibility of microalgae production, such as difficult culture conditions, high contamination risks, complex cleaning processes as well as low cell densities and productivities*

# Polyhydroxyalkanoate



- Polyhydroxyalkanoates polyesters are **synthesized and accumulated in various microorganisms**, usually when **entering the stationary phase of growth**.
- PHAs form **intracellular inclusions** and can be synthesized to store carbon and energy, and can reach 80% of cell weight.
- They are synthesized intracellularly as insoluble cytoplasmic inclusions in the presence of **excess carbon, when other essential nutrients such as oxygen, phosphorus, or nitrogen are limited**.
- These polymeric materials may be stored at high concentrations inside the cell, since it does not substantially alter its osmotic state.

# Polyhydroxyalkanoate

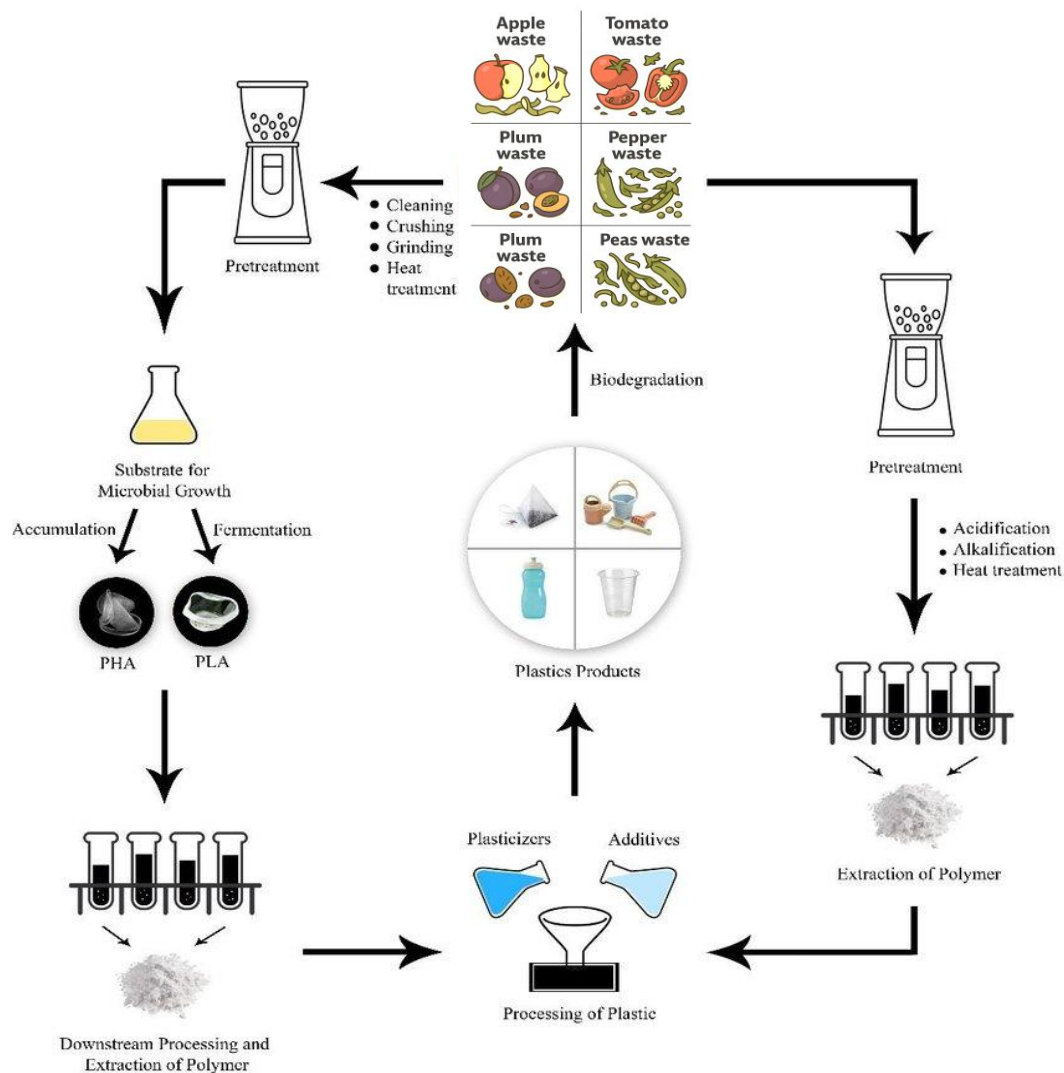




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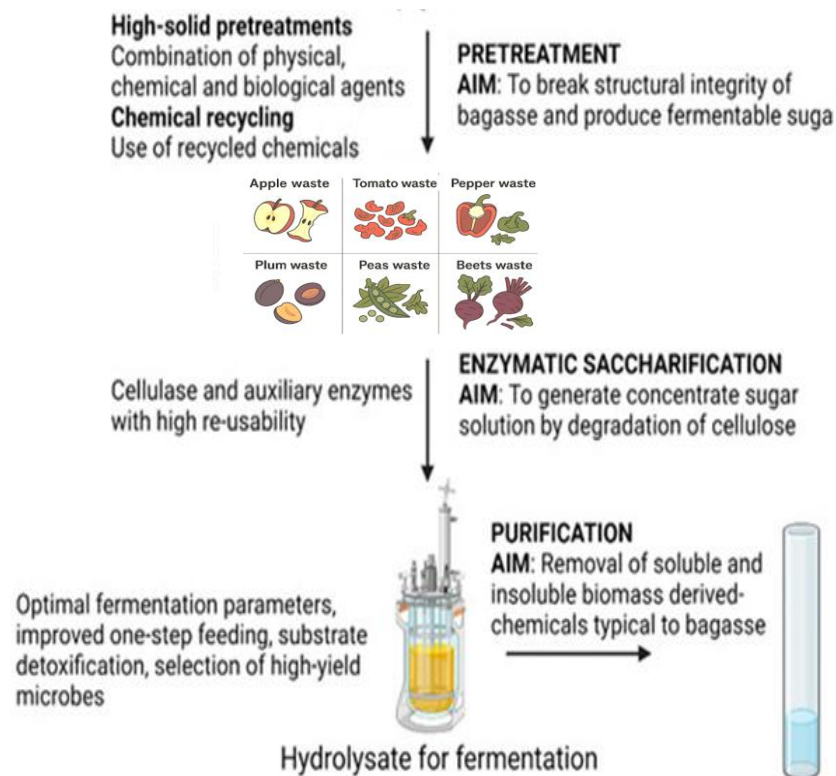
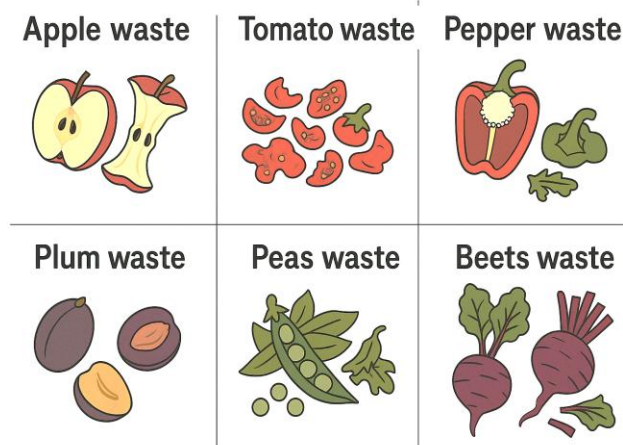


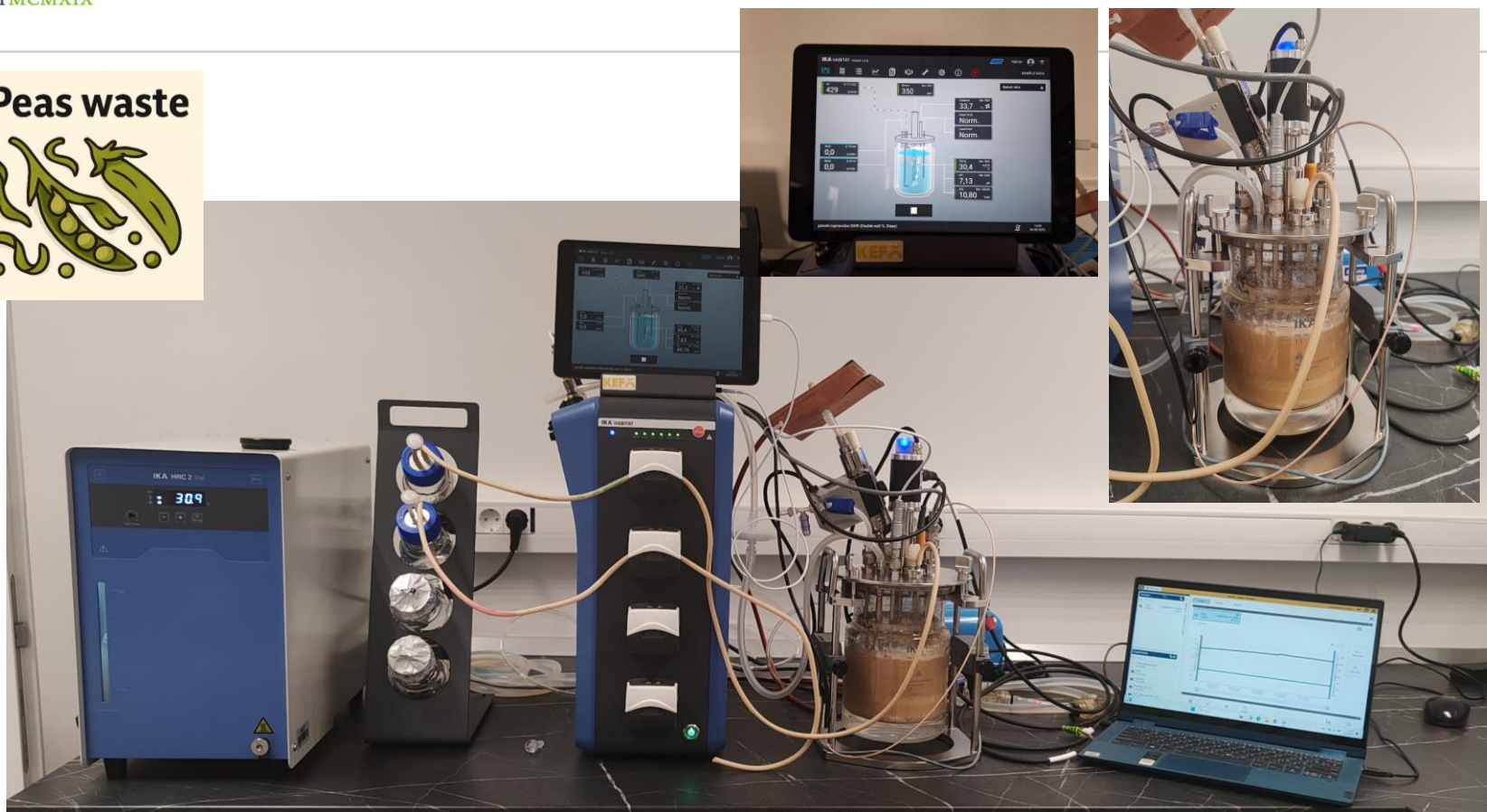
# Production of PHA by SmF



This research was conducted as part of the project „Production and development of compostable packaging from waste biomass for the packaging of industrially processed food products” (NPOO.C3.2.R3-II.04.0059) funded by National Recovery and Resilience Plan (funded by the European Union, NextGenerationEU).

# Production of PHA by SmF





# Production of PHA by SmF

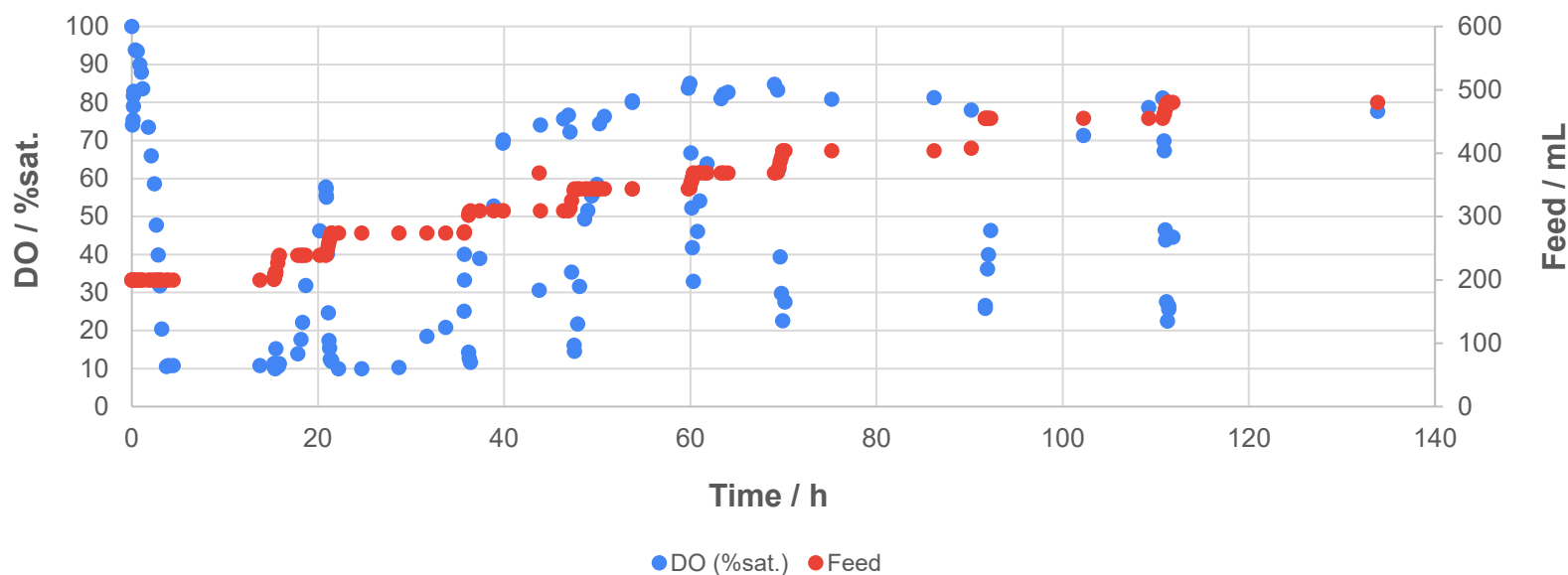
## Initial conditions (duration 6,5 days)\_Experiment 1

$\gamma_{\text{initial}}$ (reducing sugars (fructose, glucose, and sucrose) / g/L	15.0
pH-value / -	6.9
Culture	Mixed culture of <i>C. necator</i> and <i>P. putida</i>
Optical density <sub>600nm</sub> / -	0.9
T / °C	30.0
rpm	250.0
Air / mL/min	300.0

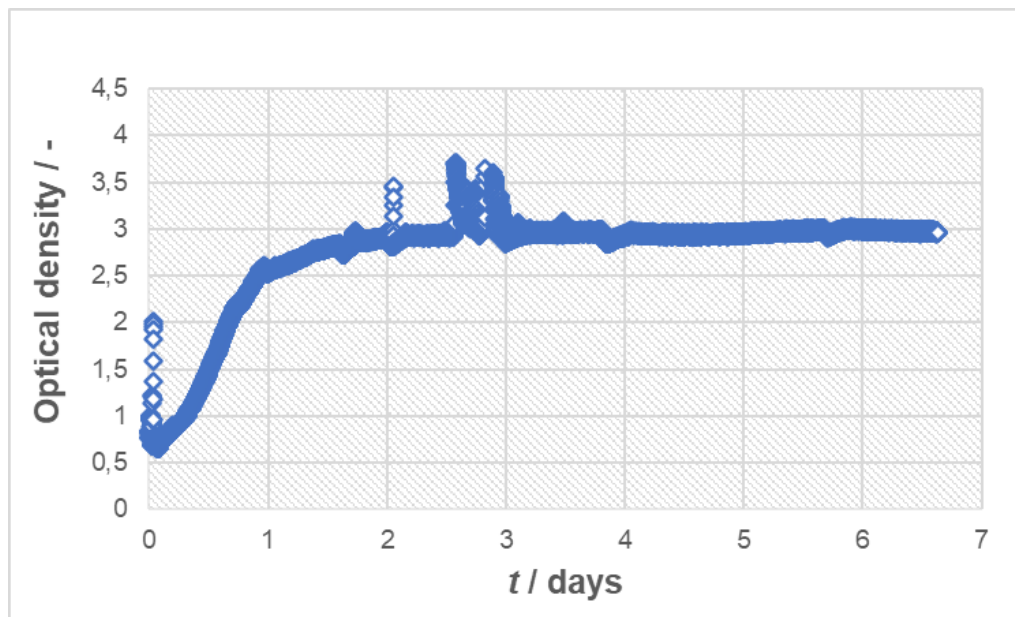
## Initial conditions (duration 2,5 days)\_Experiment 2

$\gamma_{\text{initial}}$ (reducing sugars (agroindustrial waste - peas) / g/L	15.0
pH-value / -	6.9
Culture	<i>C. necator</i>
Optical density <sub>600nm</sub> / -	0.9
T / °C	30.0
rpm	350.0
Air / mL/min	400.0

## Experiment 1



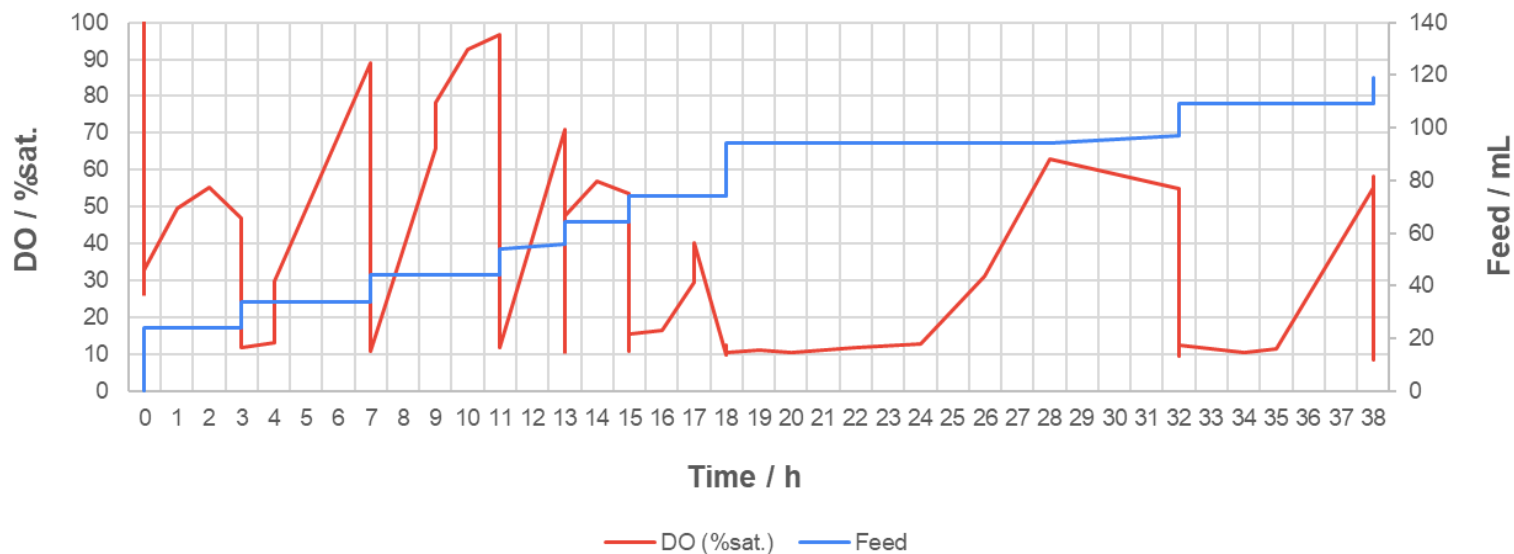
# Production of PHA by SmF



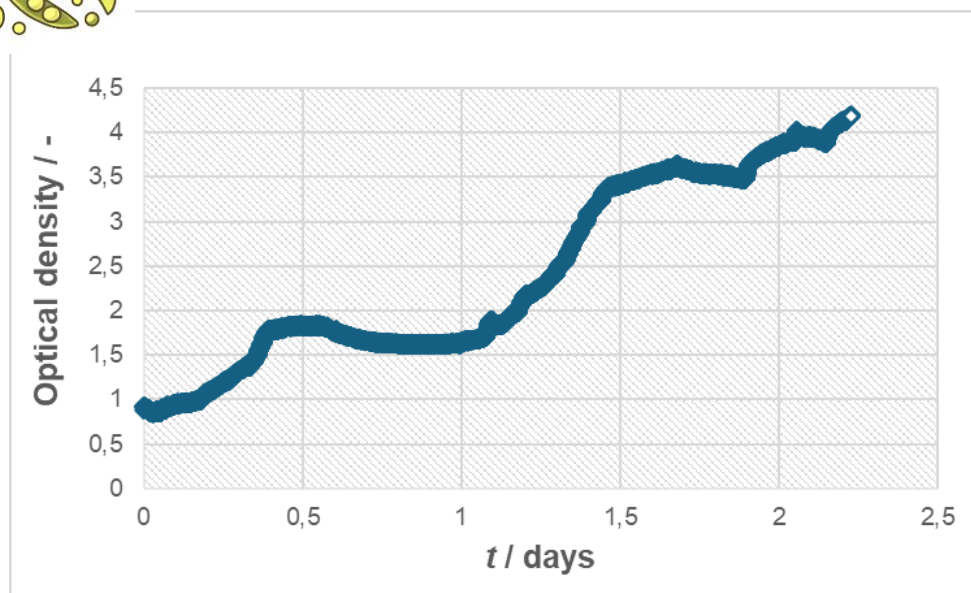
## Peas waste



## Experiment 2



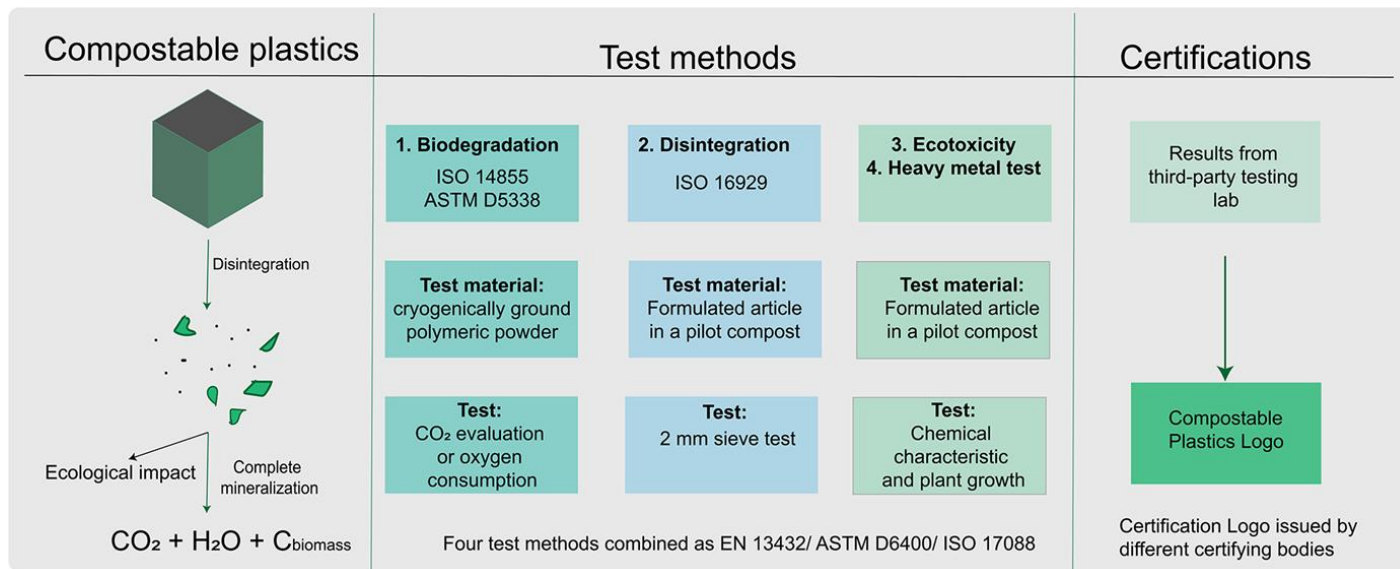
## Peas waste



Funded by  
the European Union

This research was conducted as part of the project „Production and development of compostable packaging from waste biomass for the packaging of industrially processed food products” (NPOO.C3.2.R3-II.04.0059) funded by National Recovery and Resilience Plan (funded by the European Union, Next Generation EU).

# DETERMINATION OF BIODEGRADABILITY



## ISO 17556:2019

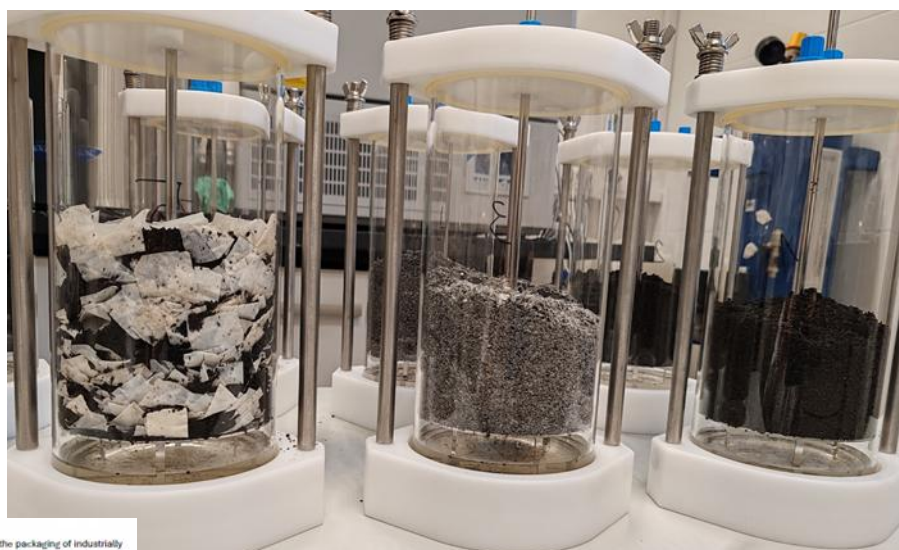
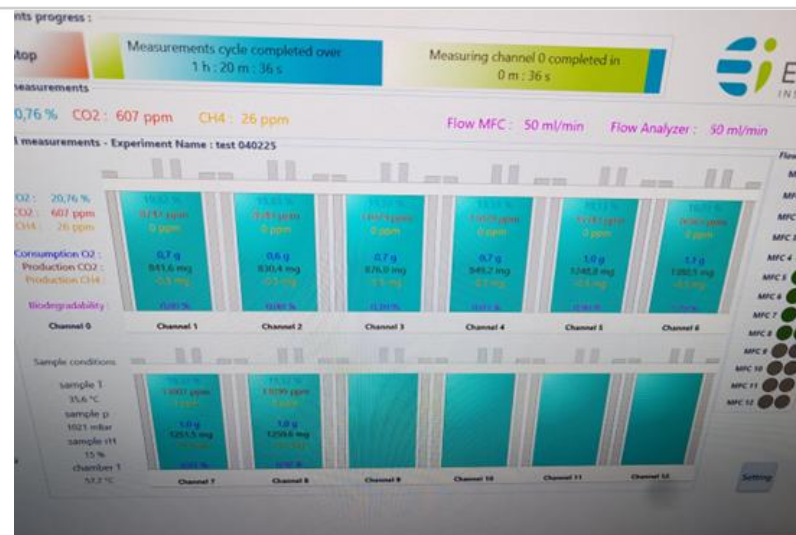
Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved

## ISO 14852:2021

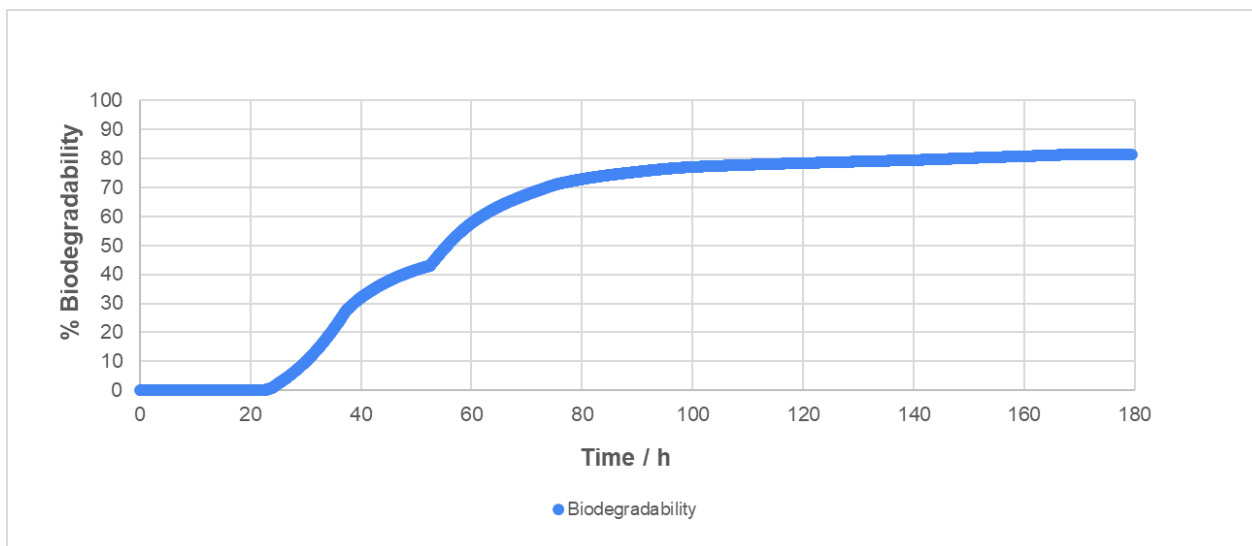
Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide



## *Determination of biodegradability of bioplastics*



# Determination of biodegradability of bioplastics



# RESEARCH TEAM FROM FCET AND PTFOS



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Faculty of Chemical  
Engineering and Technology



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Assoc. Prof. Krunoslav Aladić, PhD, Faculty of Food and Technology Osijek

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Assoc. Prof. Antun Jozinović, PhD, Faculty of Food and Technology Osijek

Asst. Prof. Matija Cvetnić, PhD, FCET

Mr. sc. Marinko Markić, CEO of Comprehensive Water Technology (spin off company); Department of Measurements and Process Control

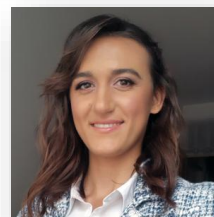
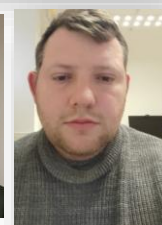
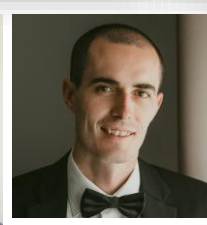
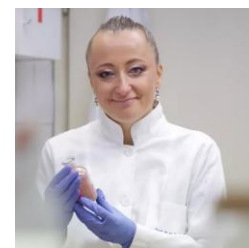
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Dora Bramberger, mag. chem., FCET

Karlo Grgurević, mag. chem., FCET



Thank you  
for your  
attention

