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Degradability evaluation of waste-derived polyhydroxyalkanoates



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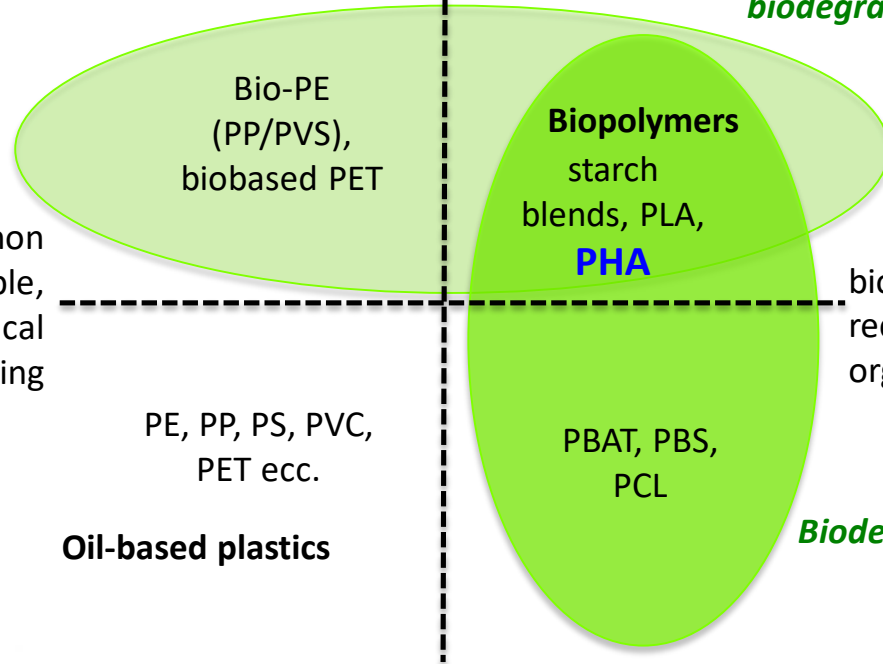


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“Ca Foscari” University of Venice

Bioplastics

Bio-based feedstock

Bio-based feedstock and biodegradability



non biodegradable, mechanical recycling

biodegradable, recycling with organic waste

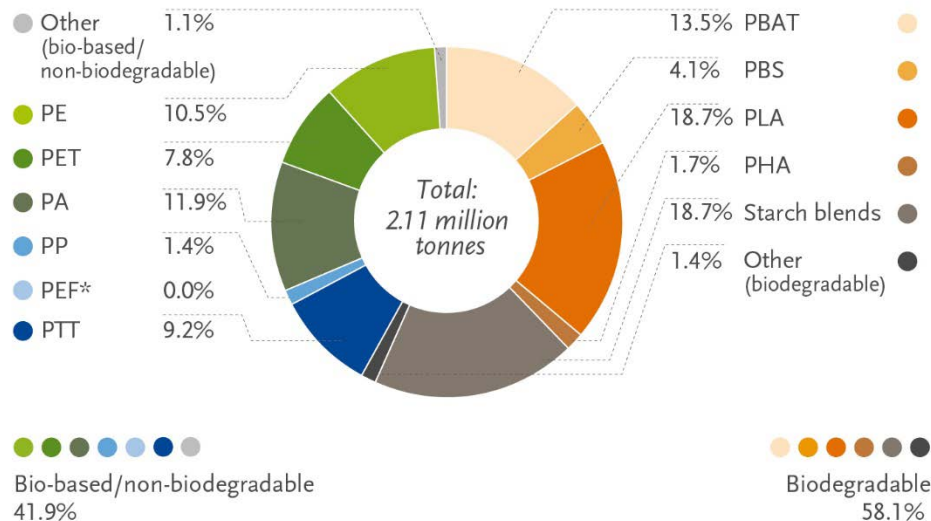
Oil-based plastics

Biodegradability

Unlike conventional plastics, which are made from FOSSIL OIL,...

...**BIO-BASED** plastics are derived from **RENEWABLE** resources.

Fonte: European Bioplastics



- ✓ The **European Strategy for Plastics** asks for decreasing dependency on oil-based plastics, increasing recycle
- ✓ **Bioplastic** market is still very less than oil-based plastics, but much faster growth is expected.

*PEF is currently in development and predicted to be available in commercial scale in 2023.

Source: European Bioplastics, nova-Institute (2020)

More information: www.european-bioplastics.org/market and www.bio-based.eu/markets

COLLECTION

Consumer discards product and decides on its fate

Plastics and packaging waste collection



Biowaste collection



Sorting
Mixed plastic stream split into homogenous fractions



Sorting
Not applicable



Processing
Remelting or granulation



Processing
Organic recycling



Biobased refuse derived fuels for renewable energy



Recycled plastics in different qualities



Compost as valuable soil improver

Residues

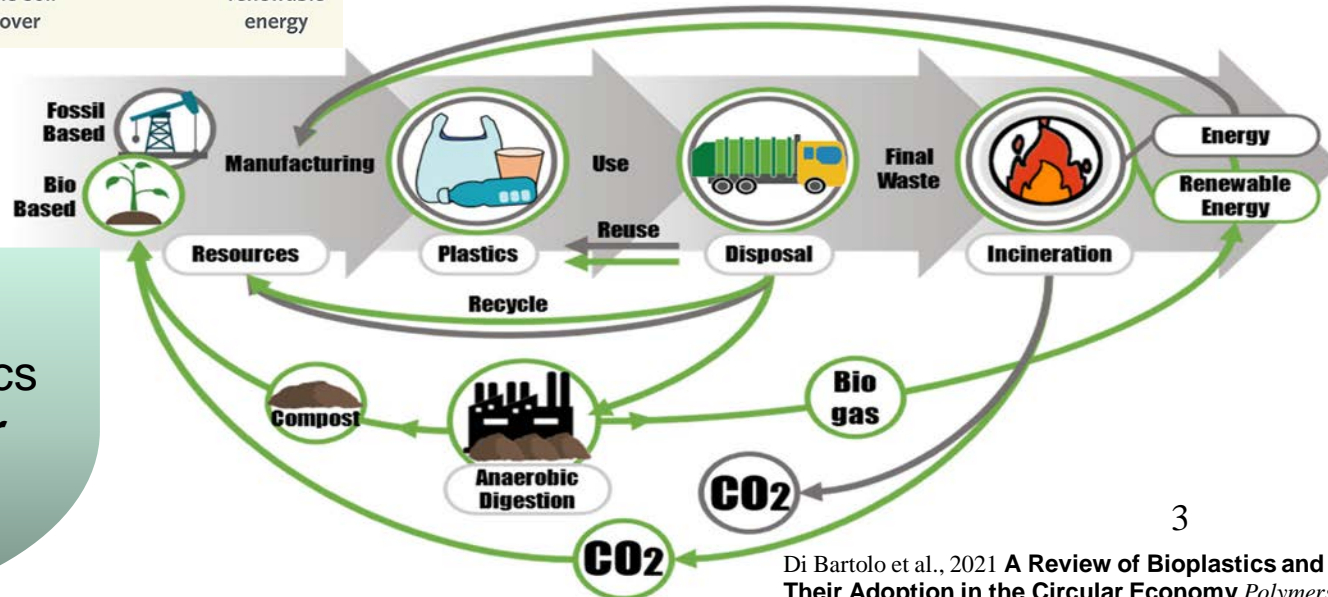


Biogas as renewable energy

Definition of **biodegradability** has a pivotal role in the final destination of waste

Fonte: European Bioplastics

The role of bioplastics within the **Circular Economy**

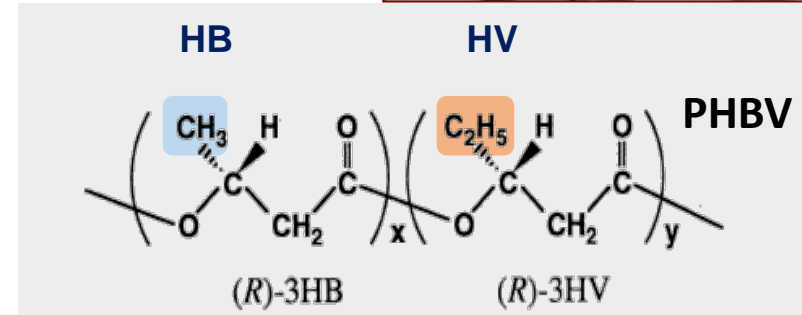
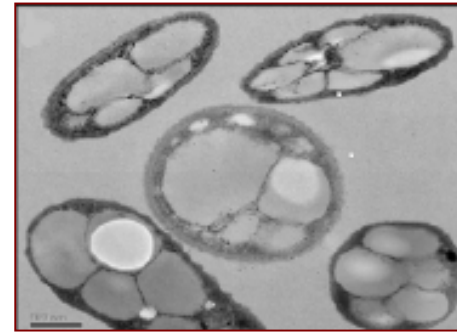


Why focusing on PHA?

Product related Pro's

Family of copolymers with tunable composition
PHA can be the main constituent of several bioplastics, with a wide portfolio of applications.

- Biodegradable commodity film
- Packaging interlayer film
- Specialty durables (such as electronics)
- Slow C-release system for groundwater remediation



Production process Pro's

- A novel open microbial cultures process (not pure strains), to better cope with large heterogeneity of the waste feedstock;
- PHA production process is mostly biological, under mild conditions and reliable.
- Easier integration with existing biological plants for waste and wastewater treatment.

Appealing

- Produced from renewable feedstock (no food)
- Produced in biological process (no OGM)
- **Biodegradable**: not recycled but virgin material

Applications and economics

High market potential

As higher as more PHA cost decreases; but still higher value than traditional plastics

Pilot platform

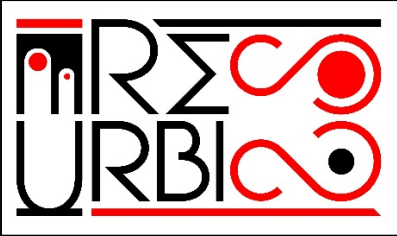
Wastewater Treatment Plant ATS (Alto Trevigiano Servizi) Treviso (TV)



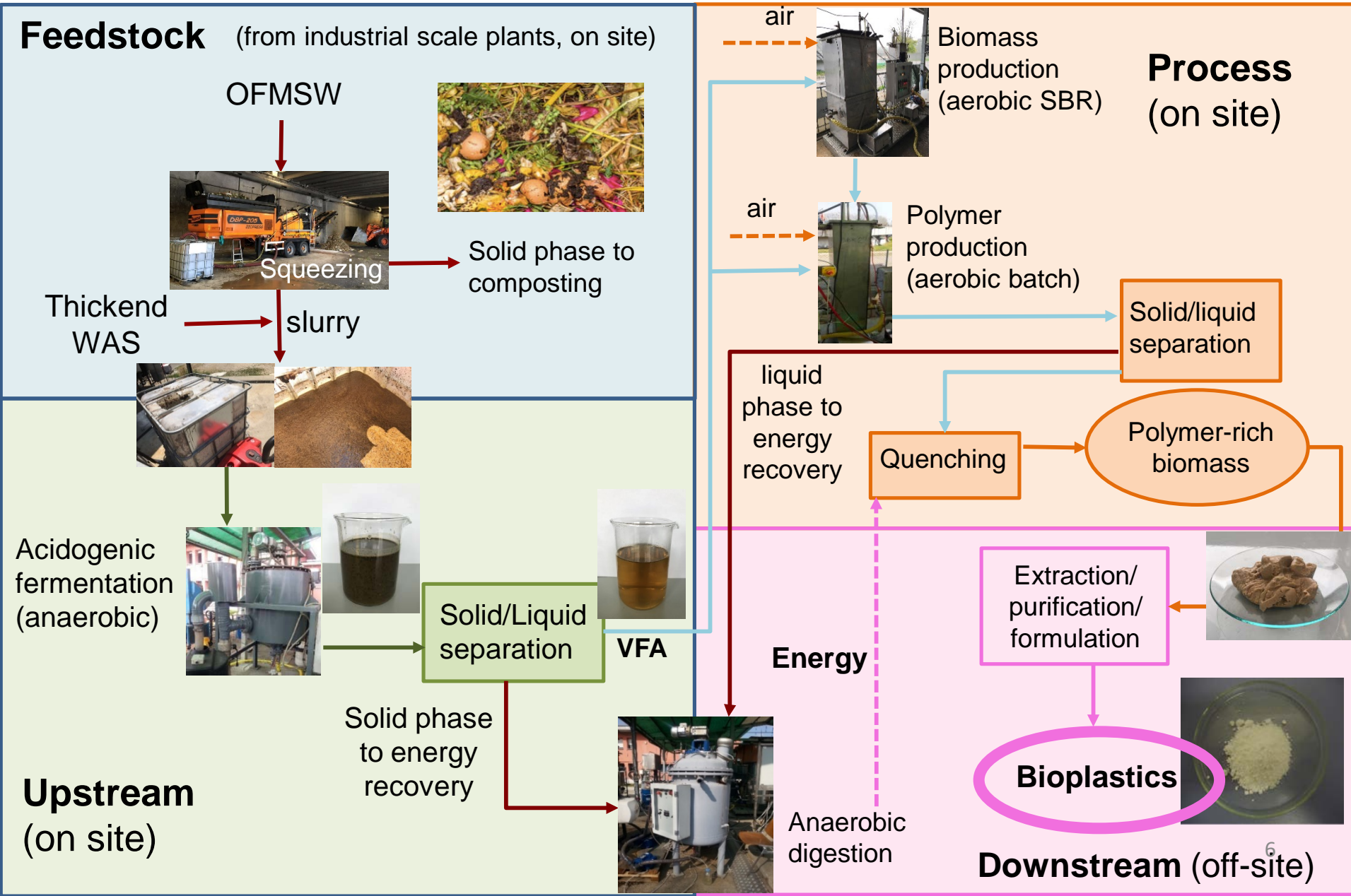
**OFMSW from waste
sorting**



**Slurry (Pressed OFMSW +
thickened secondary sludge)**



Process scheme



PHA produced within RES URBIS context



Acid stabilized PHA-rich biomass

Sent to the company in charge for polymer extraction

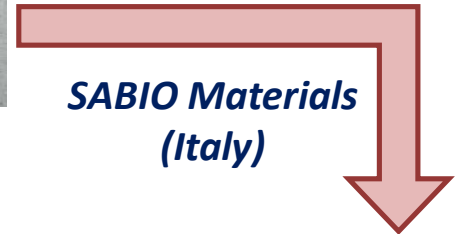


**Biotrend
(Portugal)**



PHA extracted by aqueous inorganic reagents

Sent to the company in charge for compounding



**SABIO Materials
(Italy)**

PHA pellet obtained by melt compounding with additives and following extrusion

Sent to the company in charge for blown extrusion



**Mi-Plast
(Croatia)**

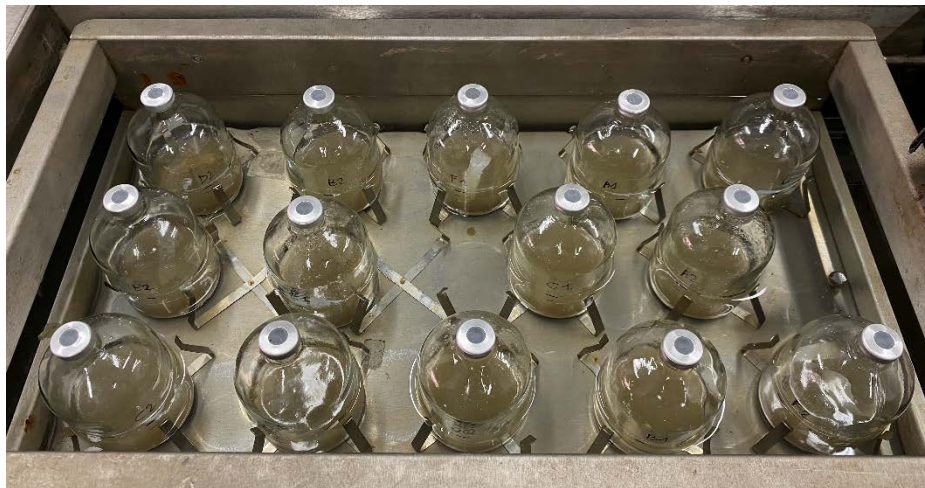
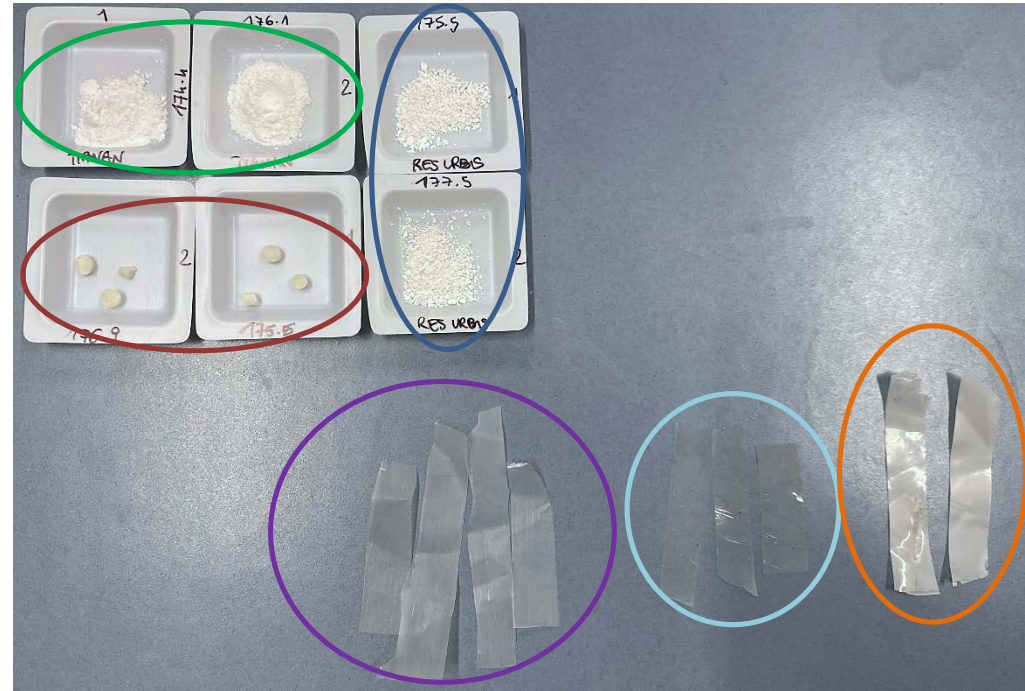
Blend PHA-PBS film at different compositions obtained by *blown extrusion*



Experimental set up

Tested materials:

- PHBV RU (HV 12 %w/w) powder
- Film from RU powder (by melting)
- RU pellet (SABIO Materials)
- Film from RU pellet (by melting)
- Blend PHA-PBS (25:75) (Mi-Plast)
- PHBV Tianan (HV 3 %w/w) powder



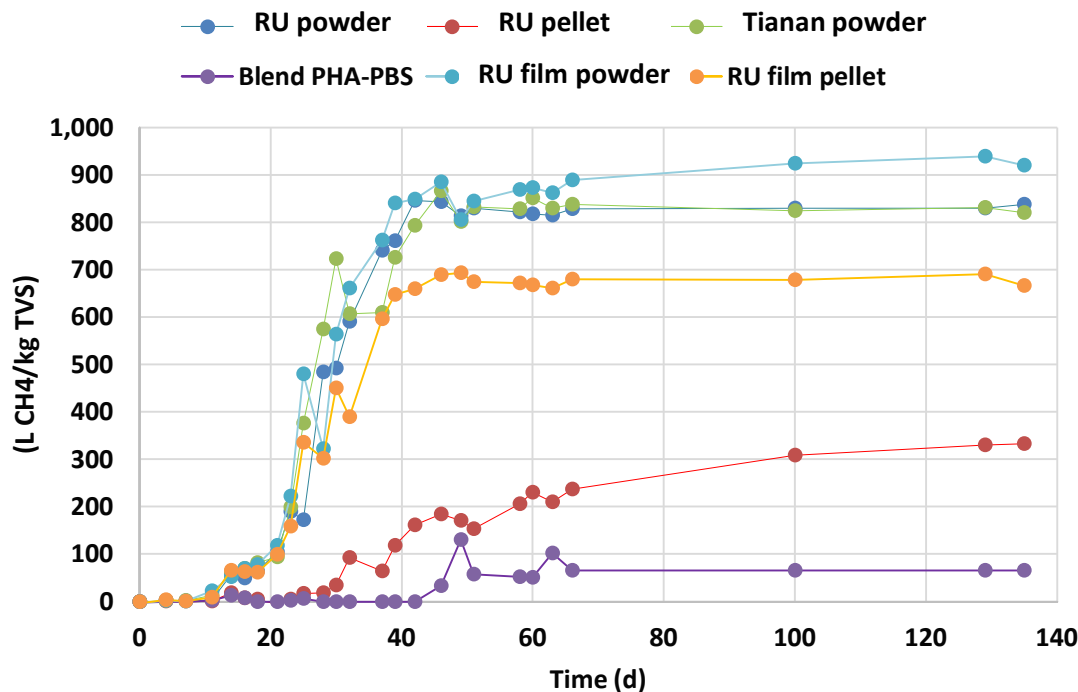
2 replicates for
each material

$V_{liq} = 125 \text{ mL}$
 $I/S = 2$
 $\text{pH } 7.5$
 $T = 35^\circ\text{C}$

Specific methane production

	PHBV RU powder	RU pellet	RU film powder	RU film pellet	Blend PHA-PBS	Tianan powder
TS (% w/w)	99,8 ± 0,2	96,9 ± 0,1	99,8 ± 0,2	99,5 ± 0,1	99,7 ± 0,3	99,6 ± 0,1
VS/TS (%)	99,2 ± 0,2	93,2 ± 0,03	99,2 ± 0,2	93,6 ± 0,03	99,9 ± 0,01	99, ± 0,1

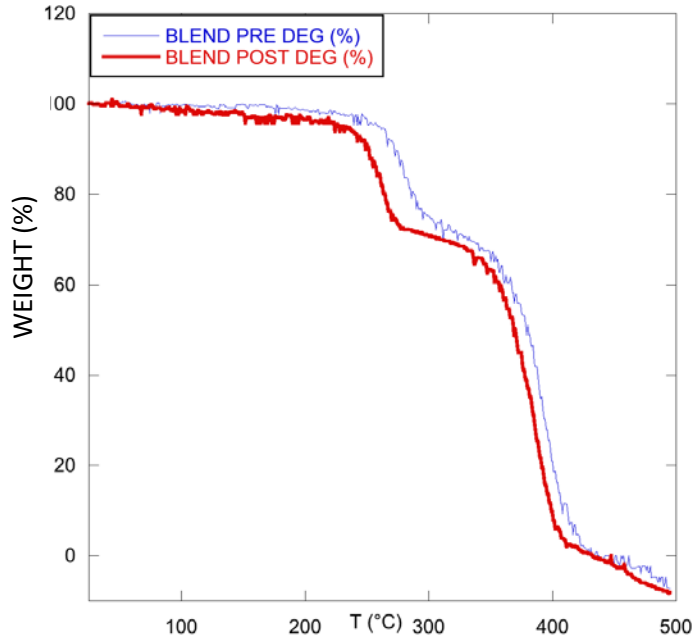
- Lag phase: 11-28 days
- Fast degradation of samples
- Additives and PBS affected the kinetics of anaerobic digestion



Recovered residual materials



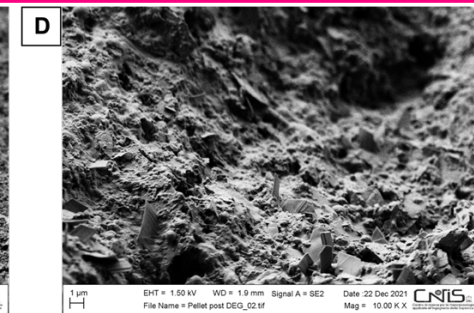
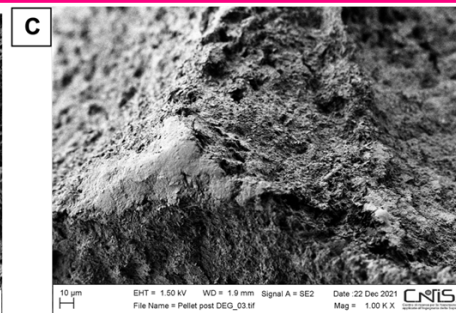
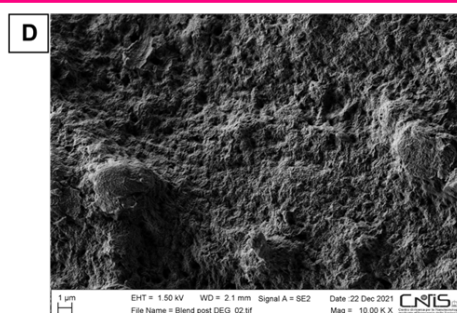
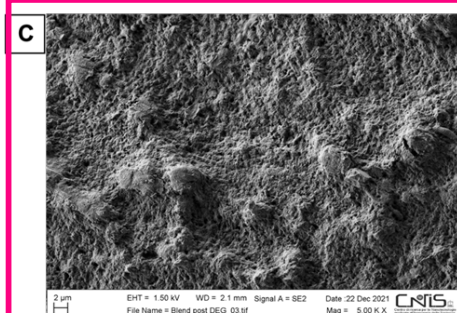
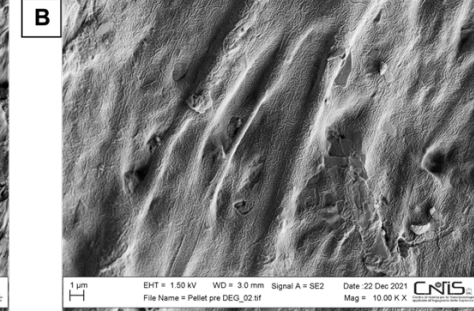
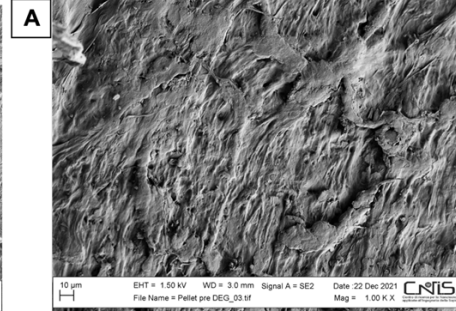
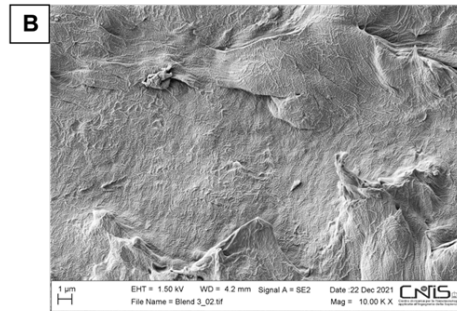
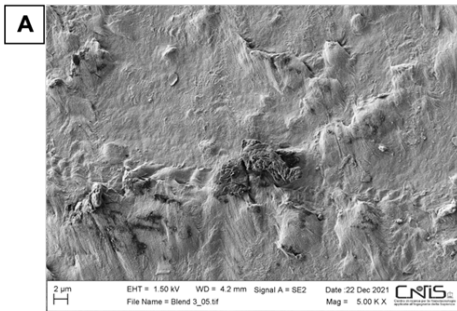
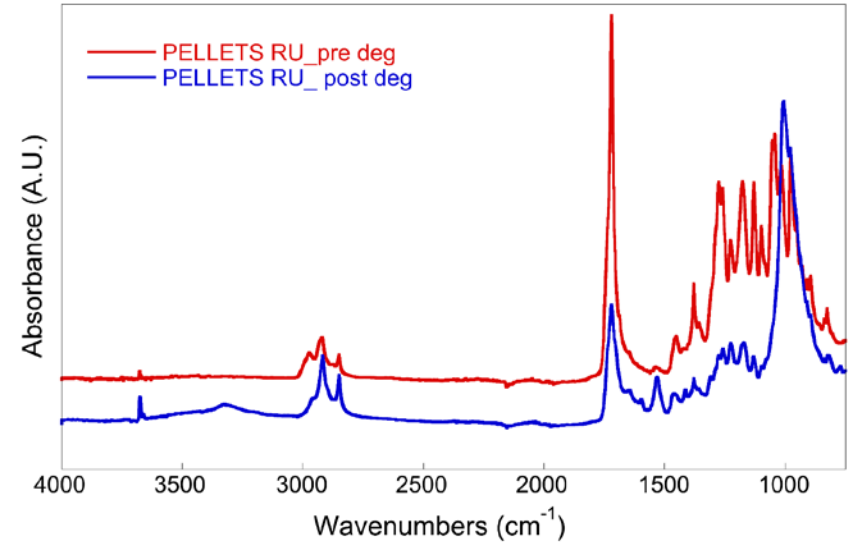
Characterization of residual materials



T_d MAX
decreases:

280 °C

263 °C



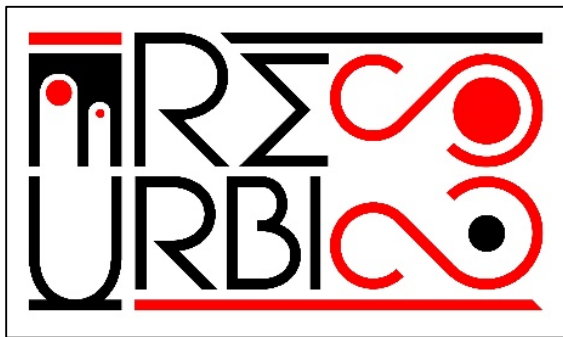
Concluding remarks

- PHA are easily biodegradable in anaerobic digestion conditions
- Additives and blended polymers (PBS) affect the overall biodegradability and kinetics
- The macroscopic configuration of pellet may influence kinetics

The possibility to dispose PHA-based materials with the organic fraction of waste closes the circle of the waste valorization



Thanks for your kind attention!



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www.resurbis.eu

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