

Session XXIV Recovery of materials from wastewater & sludge – Sludge management

**Downstream processing for
Polyhydroxyalkanoates from mixed
microbial cultures:
Study of microbial activity inhibition,
polymer recovery and characterizations**

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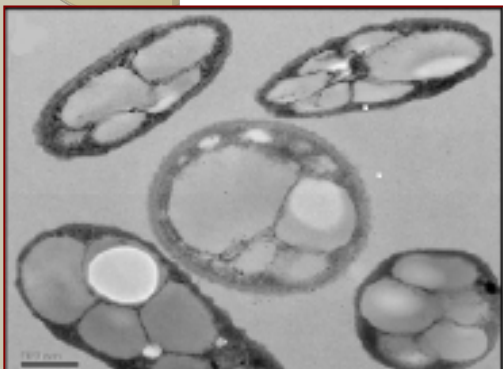
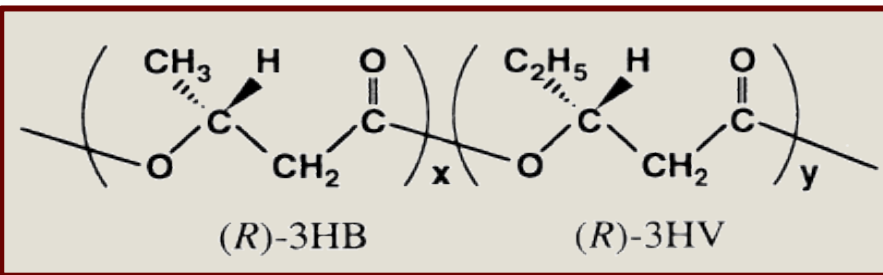
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Polyhydroxyalkanoates (PHA)

Product related Pro's

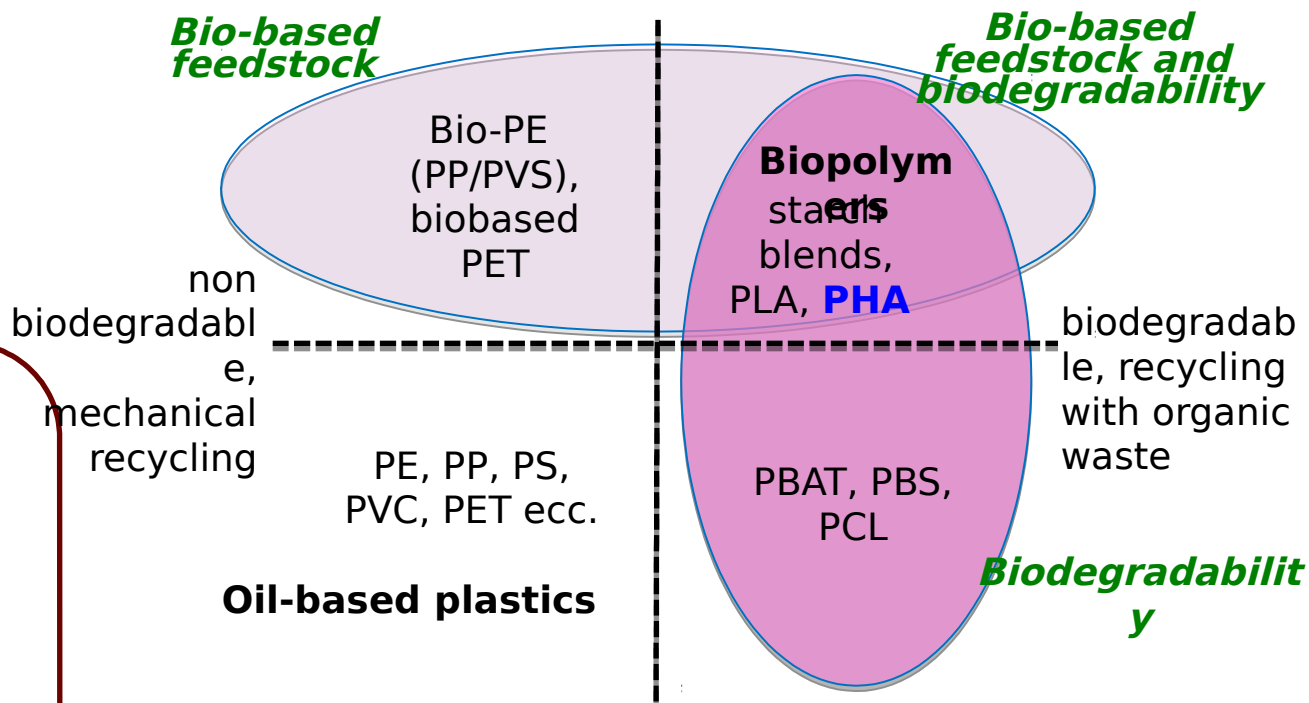
Family of copolymers with tunable composition

Main constituent of several bioplastics

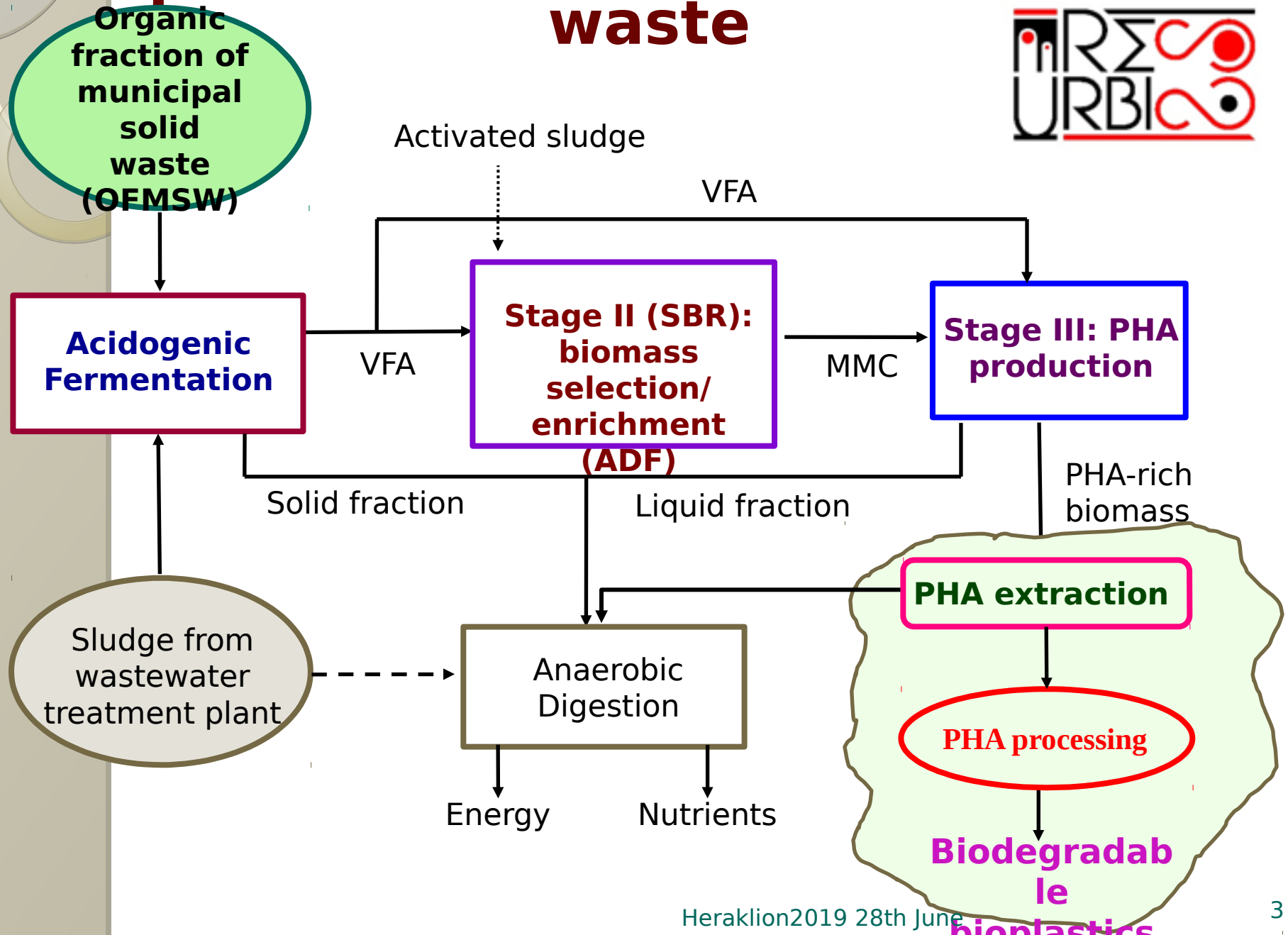


(Kunansudari, Exp Polym Let 2010)

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



PHA production from MMC and organic waste



Pilot platform Wastewater Treatment Plant in Treviso (North-East of Italy)



Aim of the study

Optimization of a stabilization method

- ✓ *Influence of pH* → H₂SO₄; NaOH
- ✓ *Oxidation* → NaClO
- ✓ *Excess of substrates*
- ✓ *Thermal treatments* → oven dried at 70°C (with or without shock at 170°C)

Innovative extraction and recovery methods

- ✓ *Non-chlorinated solvent: ethyl acetate*

Characterization of extracted polymer:

- ✓ *GC-FID* → purity, recovery yield and monomeric composition
- ✓ *Capillary viscosimetry* → molecular weight
- ✓ *DSC* → thermal properties

Selection of PHA-producing biomass (SRP)



**Operative cycle
(12 h)**

Feeding= 10 min

Reaction 1= 140 min

Withdrawal= 3 min

Nitrogen feeding= 5
min

V = 1L

Organic load rate (OLR)

4.25 gCOD/L d

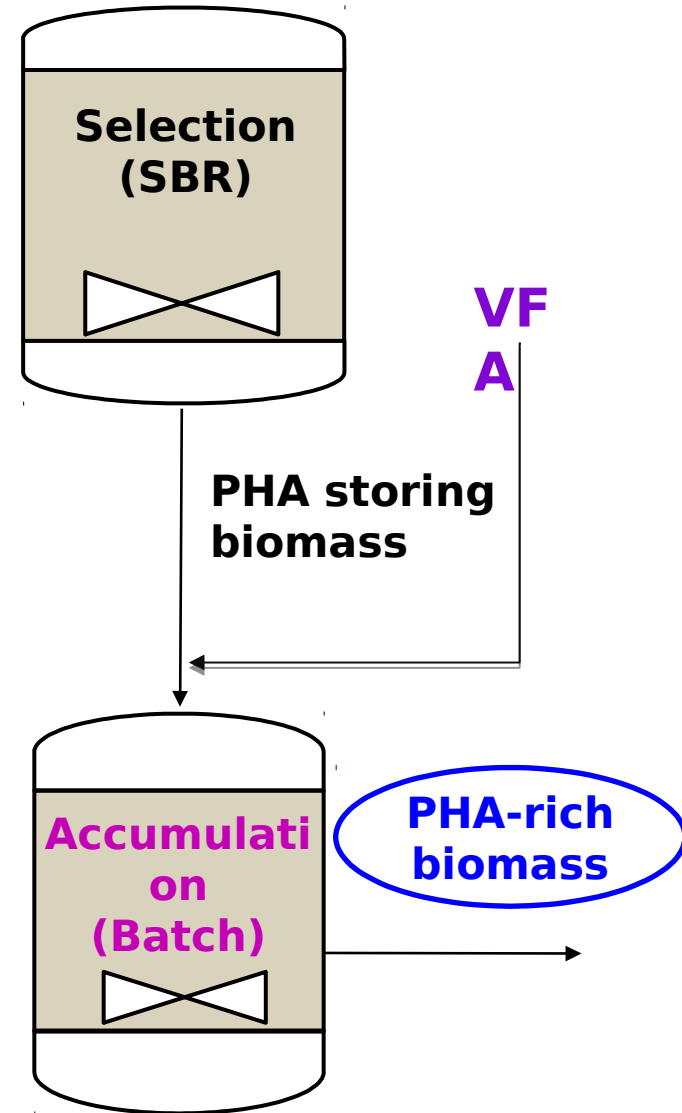
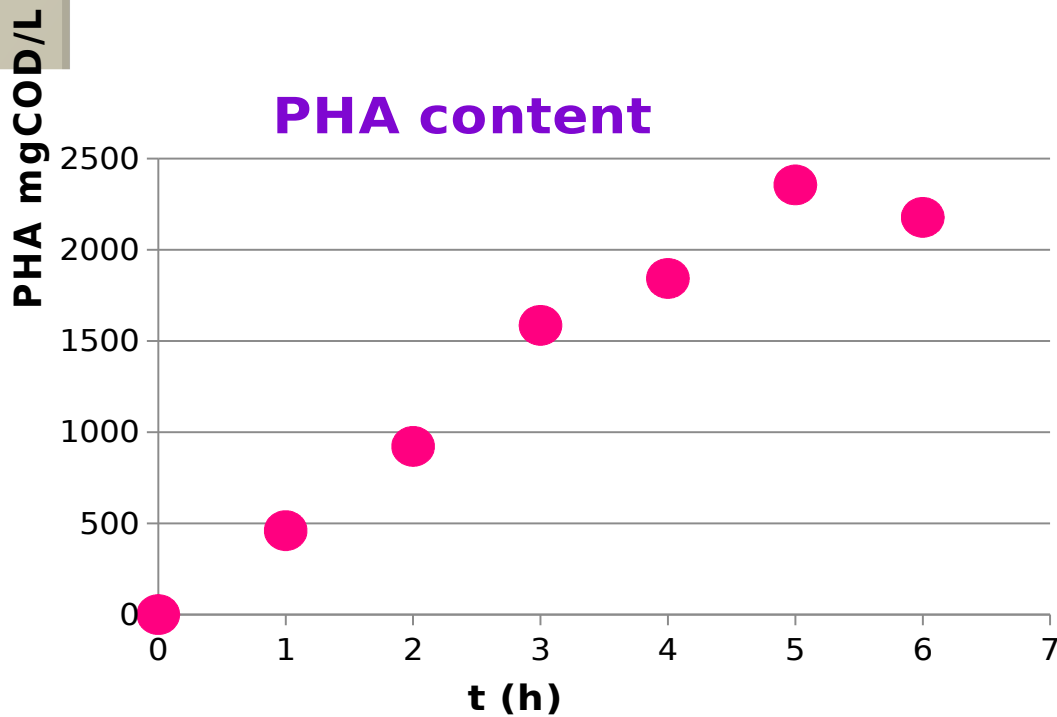
VFA (85% Acetic acid;

15% Propionic acid)

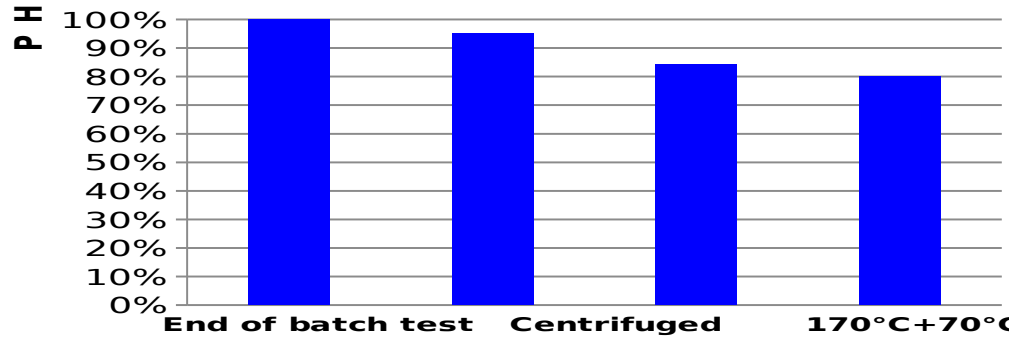
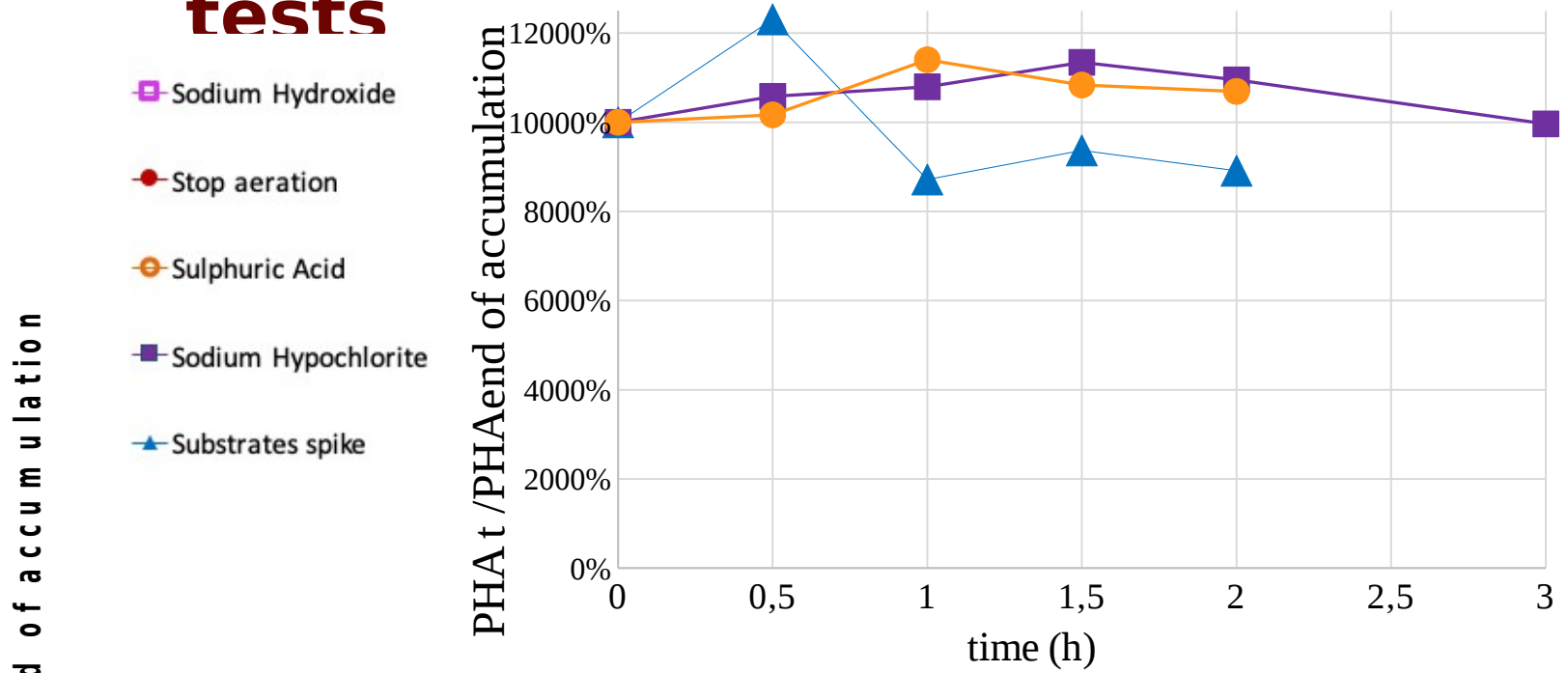
T= 25°C

PHA accumulation step

- Batch reactor $V = 0.5L$
- 6h test
- Multispike strategy (85% Acetic acid; 15% Propionic acid)



Stabilization tests



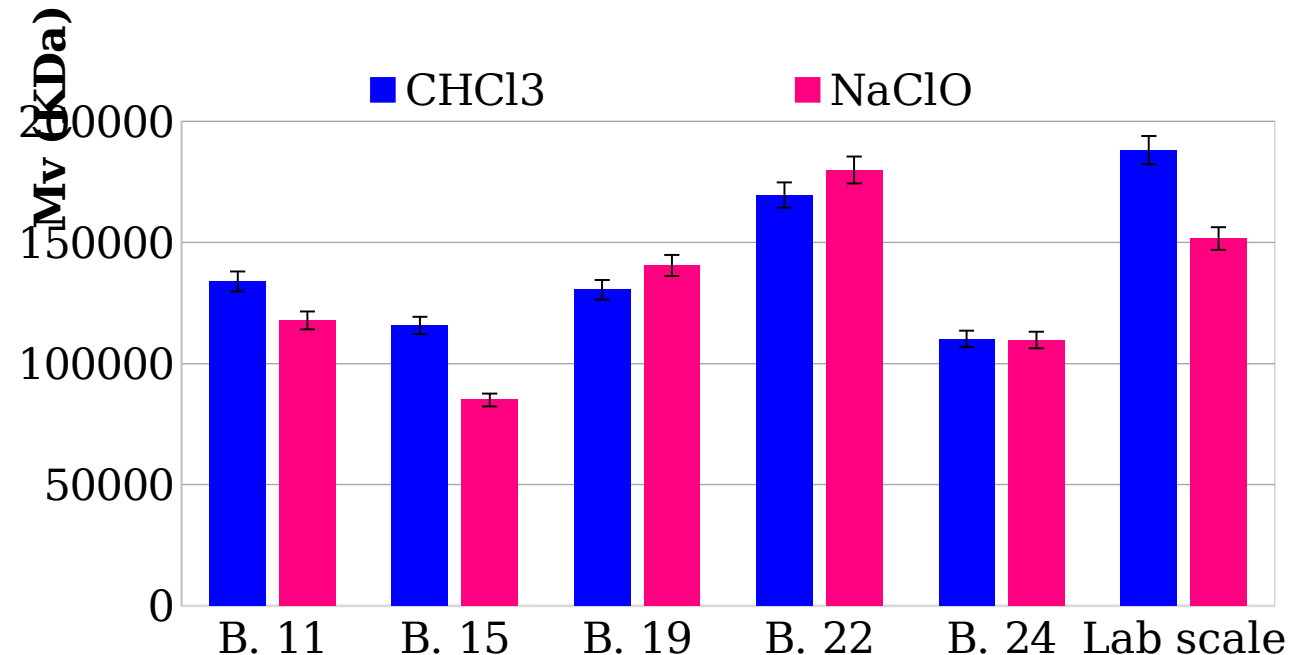
Two kinds of thermal treatment

Extraction and characterization

5 different batches (**Pilot scale** Batches 11, 15, 19, 22, 24)
and 1 batch (**Lab scale**) thermally stabilized



Soxhlet extraction with CHCl_3
Oxidation with NaClO



Purity (PHA %w/w)

95.3 % (CHCl_3);

85.2 % (NaClO)

Recovery yield (%w/w)

83.2 % (CHCl_3);

87.4 % (NaClO)

Non-chlorinated solvent extraction

Batch 11 thermally stabilized

Extraction in a pressurized steel reactor with Ethyl acetate (100 and 125°C)
for 1h

Residues extracted with CHCl_3

Treatment	Purity (PHA %w/w)	Mv (g/mol)	% HV	χ_c %	T_m (°C)
CHCl_3	92.9 ± 6.1	133947	19	40	164
Ethyl Acetate 100°C	75.7 ± 1.8	71667	31	28	164
Ethyl Acetate 125°C	100 ± 4.5	48880	20	36	163
Residue 100°C CHCl_3	99.5 ± 7.9	126250	12	48	167
Residue 125°C CHCl_3	90.7 ± 1.1	75000	25	31	161

Conclusions and future prospectives

- Thermal treatment applicable at pilot scale
- NaClO gave results comparable to traditional chloroform extraction
- Ethyl acetate selectively extracts shorter chains

- *Evaluation of the effects of thermal treatment on the polymer, in comparison with an acidification method applied at pilot scale*

- *Optimization of Ethyl acetate extraction and use of other non-chlorinated solvents*



Thanks for your attention