From wine pomace and potato wastes to novel PHA-based bio-composites: examples of sustainable routes for full valorisation of the agro-wastes

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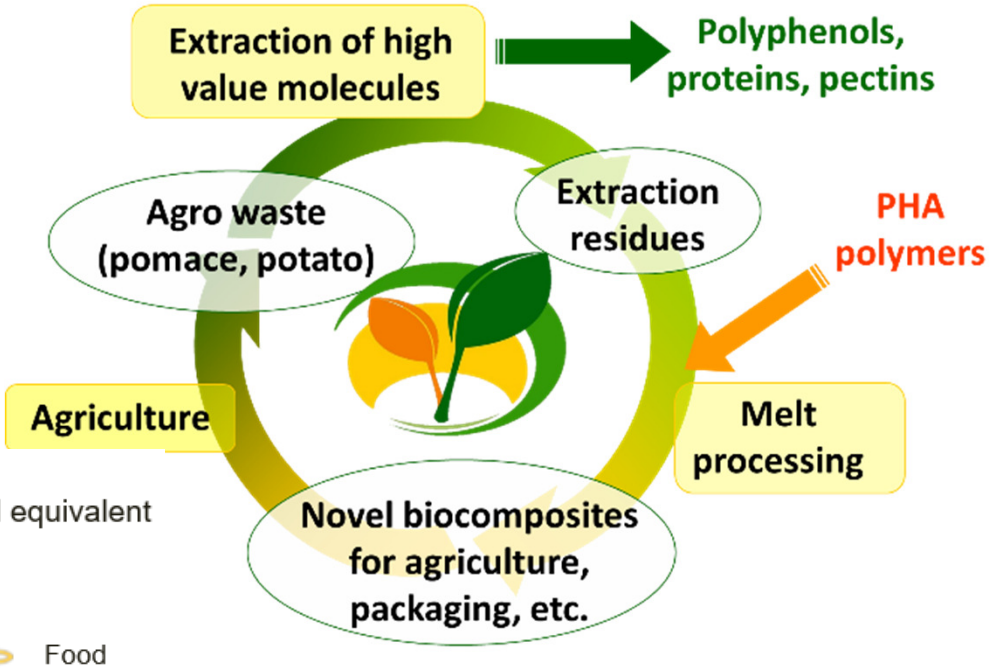
	Now the situation	NoAW's ambitions
Available	86	25
Energy	450	420
	16	30
Fertllizer	3	6
	3	
Plastics	79	60
	1	20
Chemicals	79	60
	1	20

MTOE: million tons oil equivalent

Oil Vs. Food

Vs. Agro-waste



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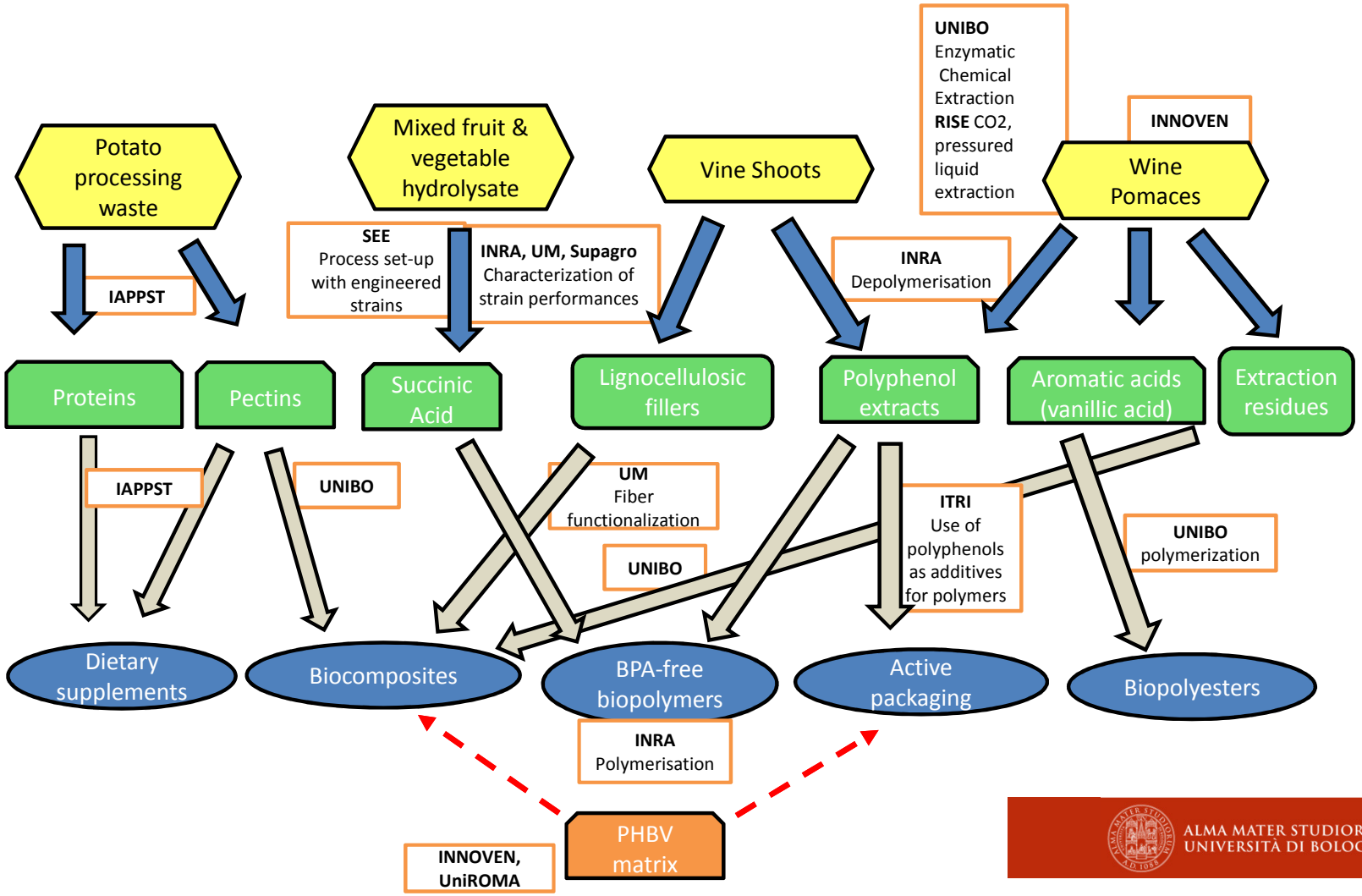
WP4 Task 1



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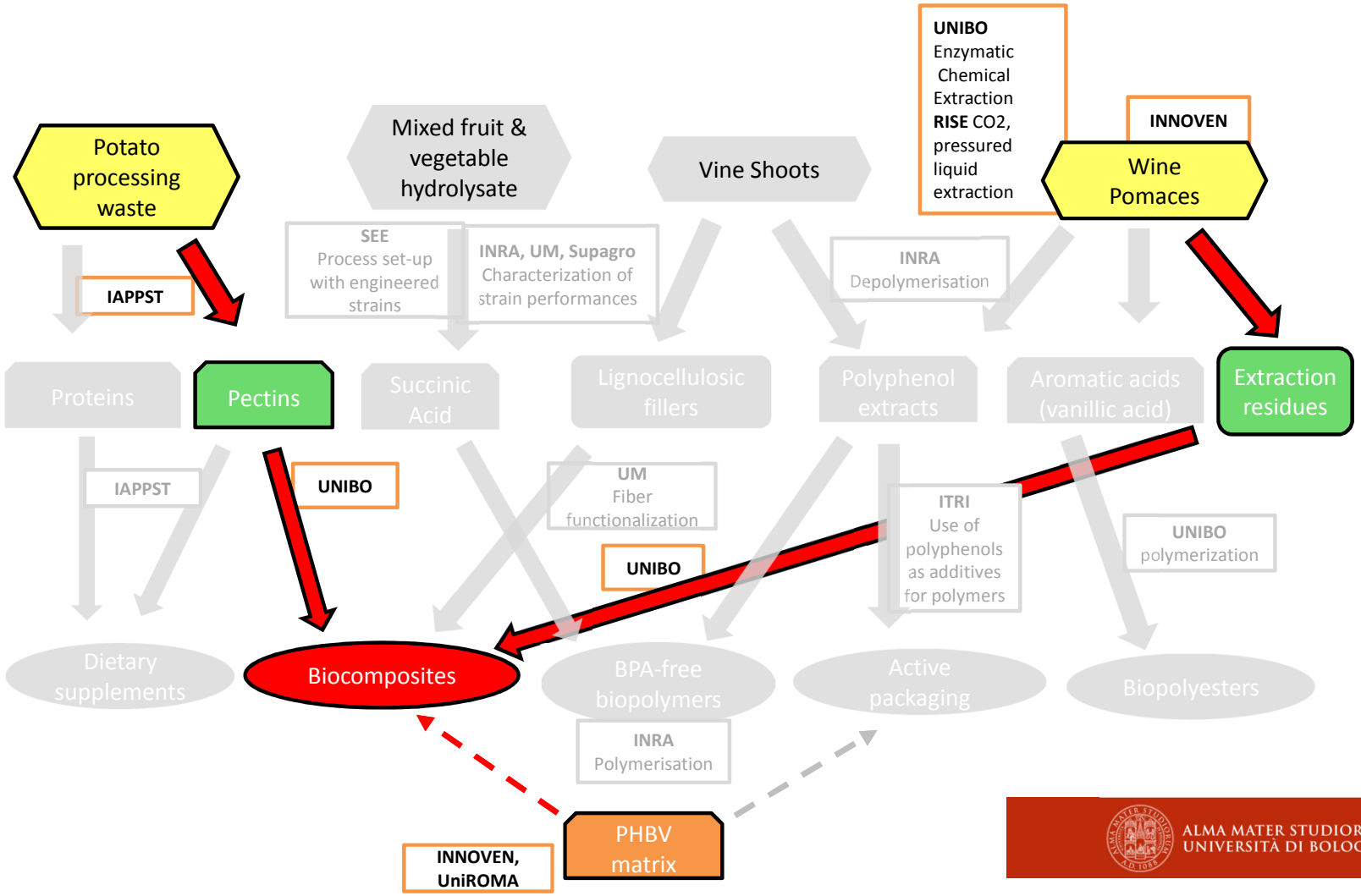
WP4 Task 1



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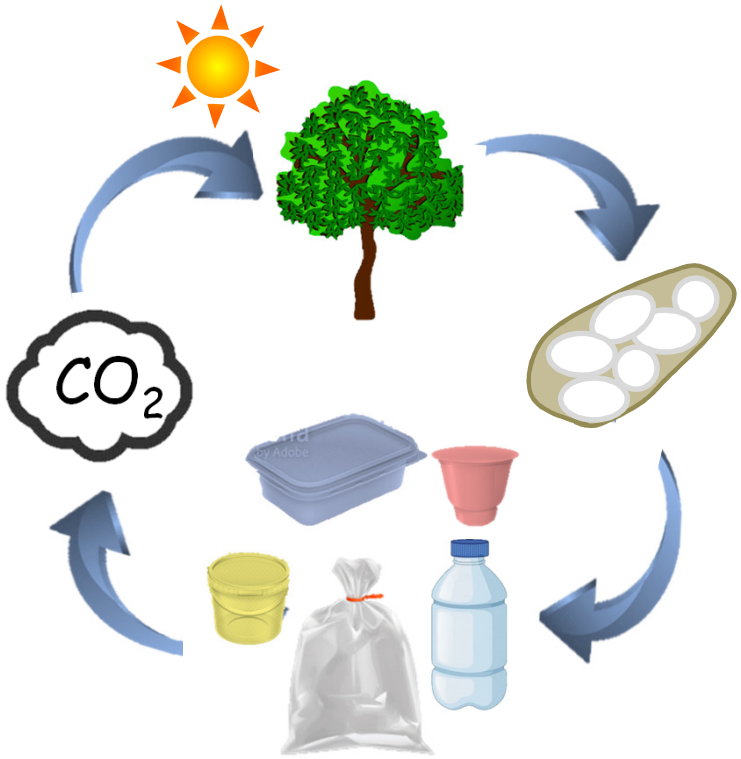
Choice of polymeric matrix

Poly(hydroxyalkanoate)s **(PHA)s** are a family of microbial biopolymers.

They have excellent biocompatible and biodegradable properties

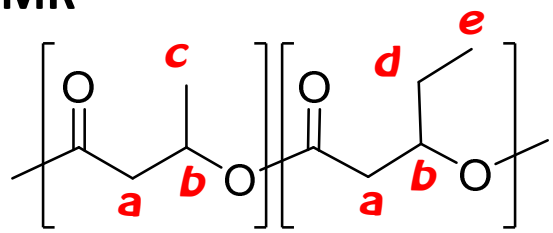
The PHAs are particularly **expensive**

and lack **mechanical properties**.



PHBV: poly(3-HydroxyButirate-co-Valerate)

^{1}H NMR



PHB/PHV: 98/2 (mol/mol)

PHBV thermal properties:

T_{onset}: 288°C
T_D: 302°C

T_m: 172°C, ΔH_m: 78 J/g
T_c: 114°C, ΔH_c: 73 J/g

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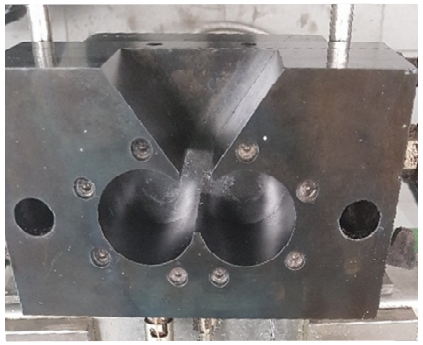
Composites preparation

The composites are prepared by melt mixing in a **Brabender microcompounder**.



load: 45–50 g
screw speed: 50 rpm
temperature: 200 °C
mixing time: 5 min

For each fiber residue, different blends were prepared containing

5, 10 or **20 wt%** of residue.

Extractions of polyphenols from wine pomaces

INNOVEN
INNOVATION FOR THE ENVIRONMENT

Merlot

Garganega

Two methods:

Solvent-based extractions

Best conditions: Acetone/Water 75/25 (vol/vol)

Pressurized liquid extractions (only on red pomaces)

RI. SE

Best conditions:
Ethanol/Water 50/50
(vol/vol)

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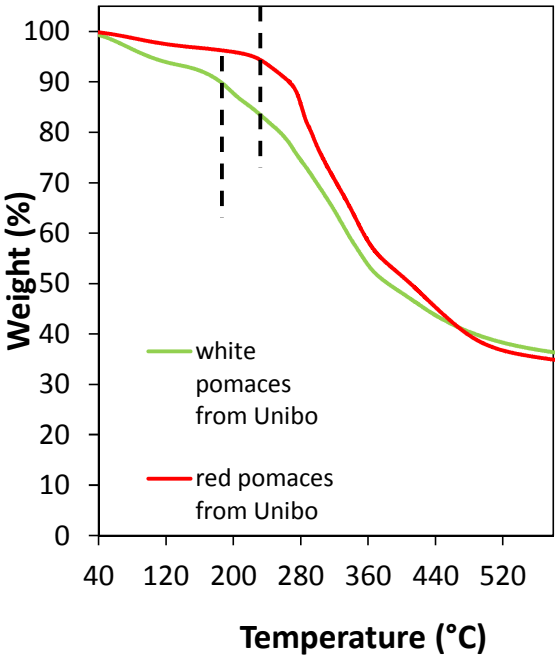
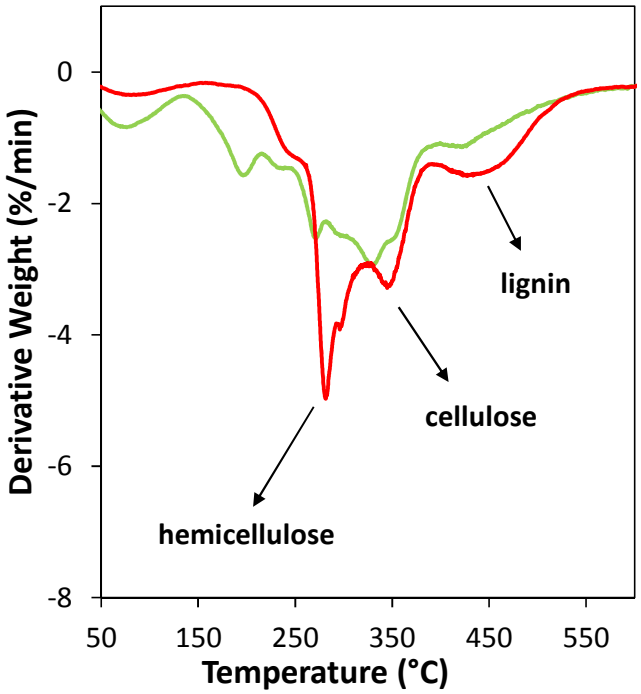
Characterization of chemically extracted residue (UNIBO)

Garganega (WHITE) residue

Merlot (RED) residue

Thermogravimetric analyses





white pomaces from Unibo

red pomaces from Unibo

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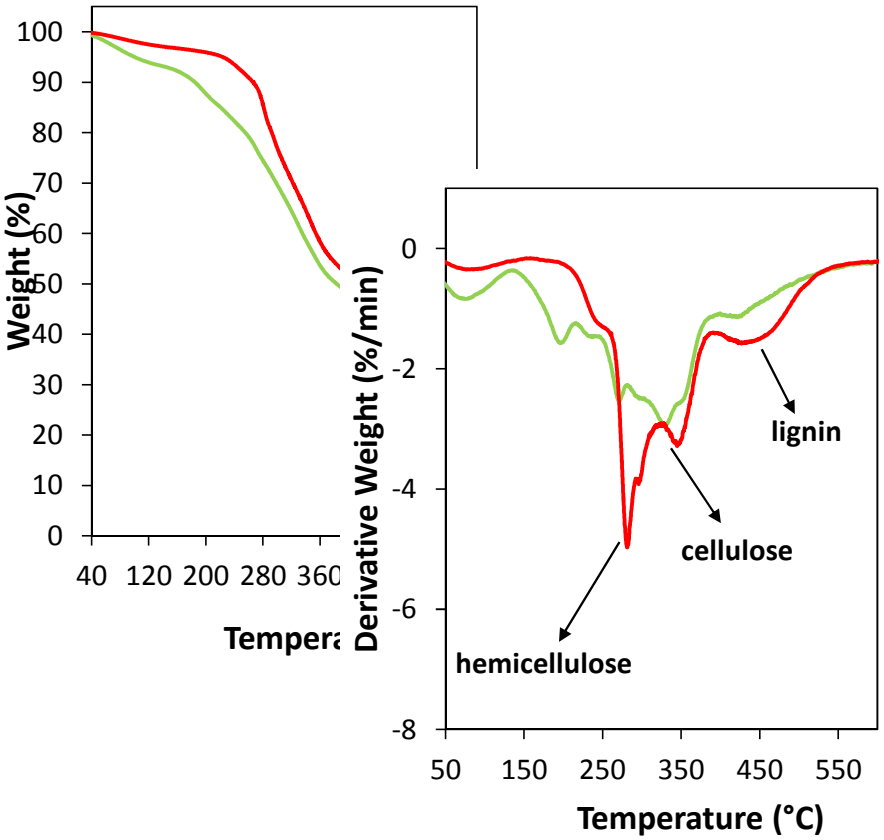
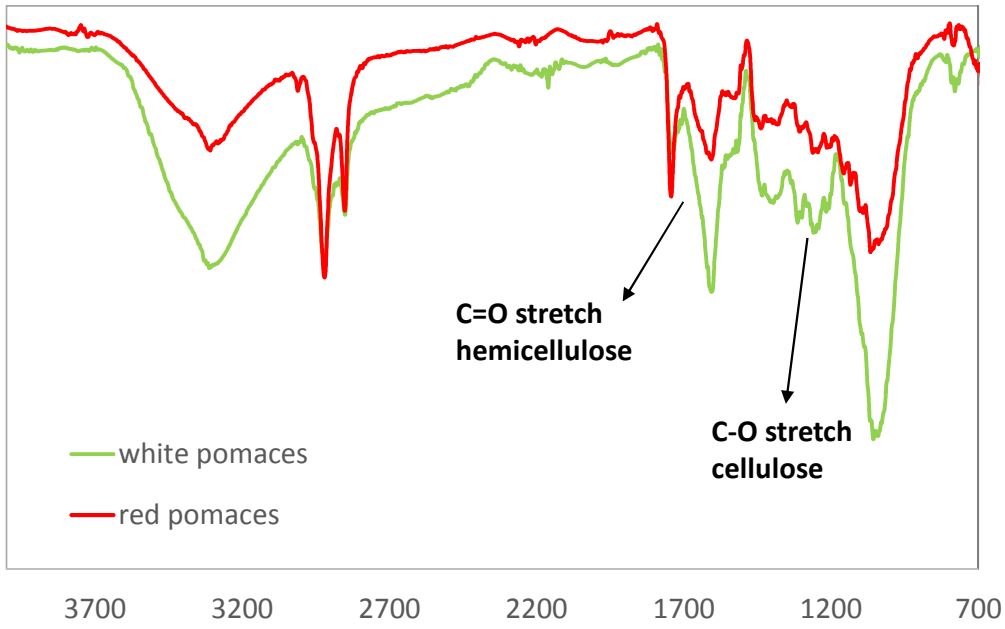
Characterization of chemically extracted residue

Thermogravimetric analyses



FT-IR spectra



Bio-composites with residue from solvent extracted red and white pomaces

Sample code	1° heating scan		cooling scan		2° heating scan	
	T_m (°C) [b]	ΔH_m (J/g) [b]	T_c (°C) [c]	ΔH_c (J/g) [c]	T_m (°C) [d]	ΔH_m (J/g) [d]
PHBV	172	78	114	73	168	82
PHBV-W-5CE	171	78	111	72	168	80
PHBV-W-10CE	170	71	111	67	168	78
PHBV-W-20CE	169	63	109	57	167	66
PHBV-R-5CE	170	72	112	68	168	77
PHBV-R-10CE	169	74	110	65	168	74
PHBV-R-20CE	170	64	108	57	168	66

First scan, from 30 to 210°C at 20°C/min; 1 min at 210°C; cooling scan, from 210°C to 0°C at 20°C/min; 1 min at 0°C; second scan, from 0 to 210°C at 20°C/min.

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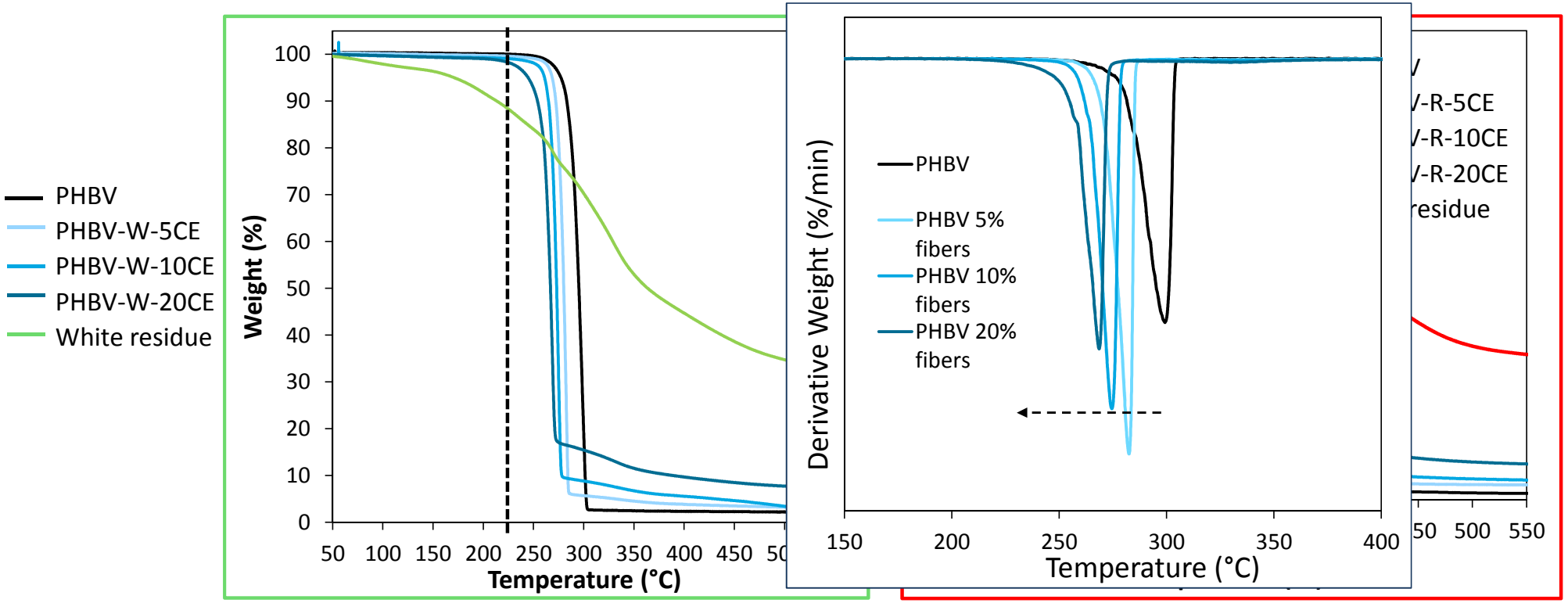
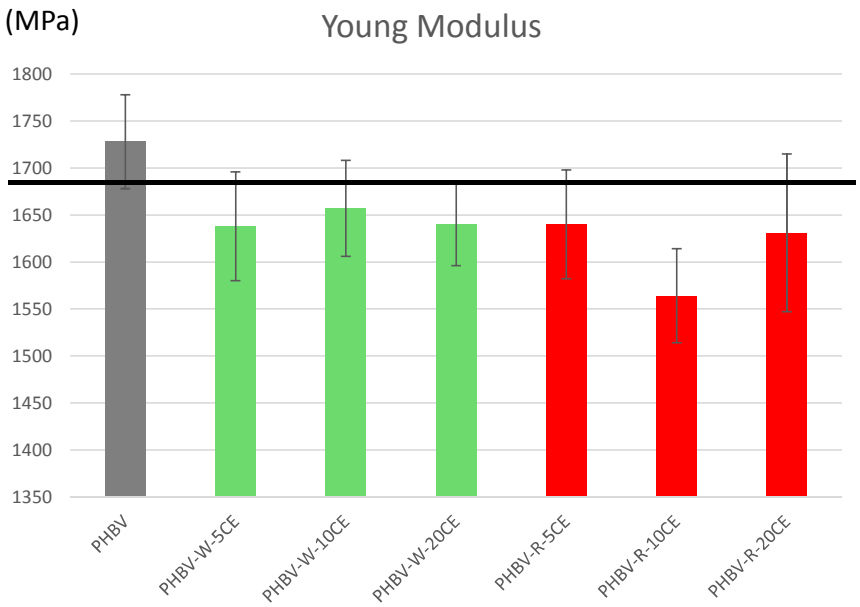
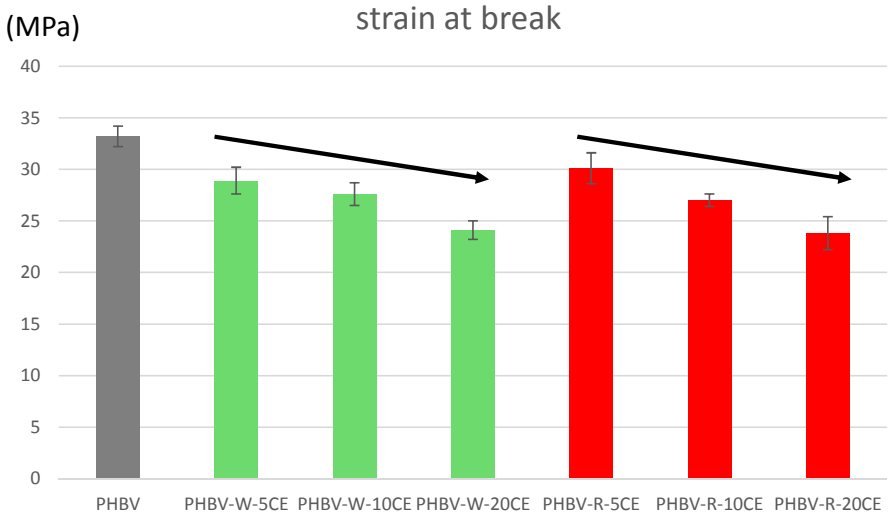
Thermal stability

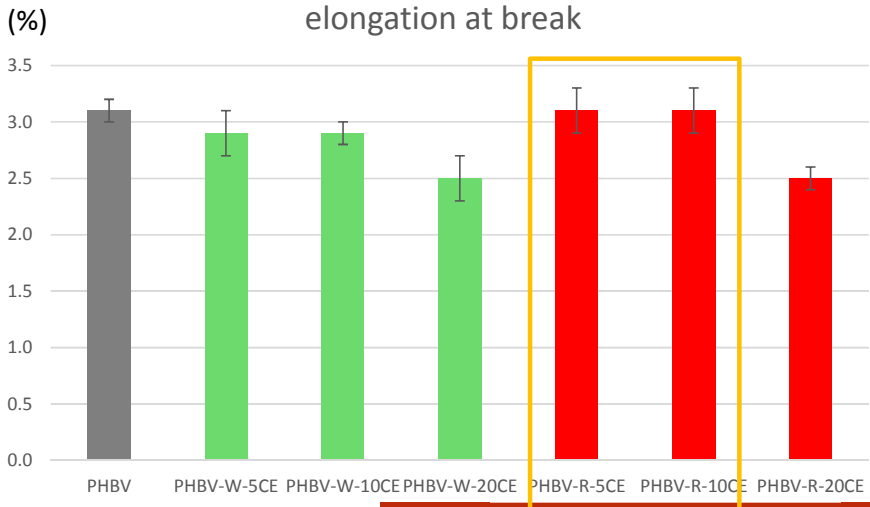


All the composites are stable over 230°C.
The thermal stability slightly decreases with the filler content.

Tensile tests







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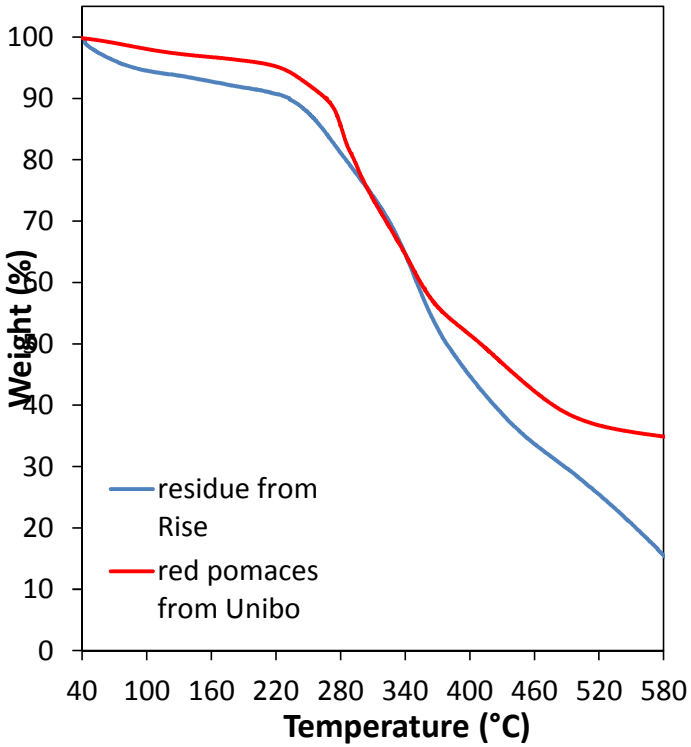
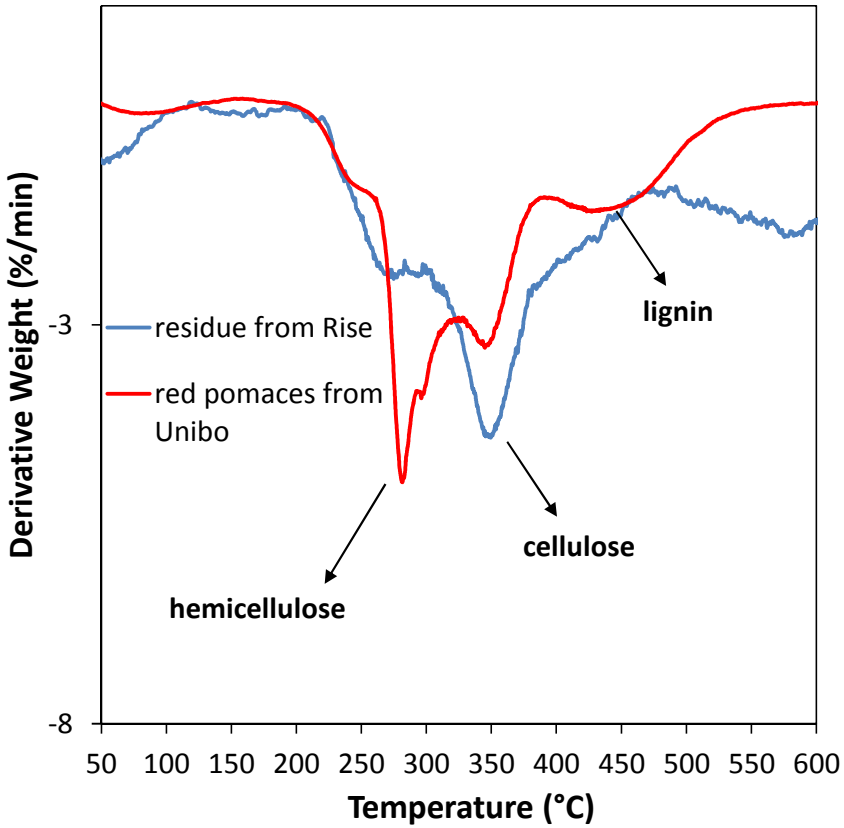
Characterization of pressurized extracted residue-comparison between the methods





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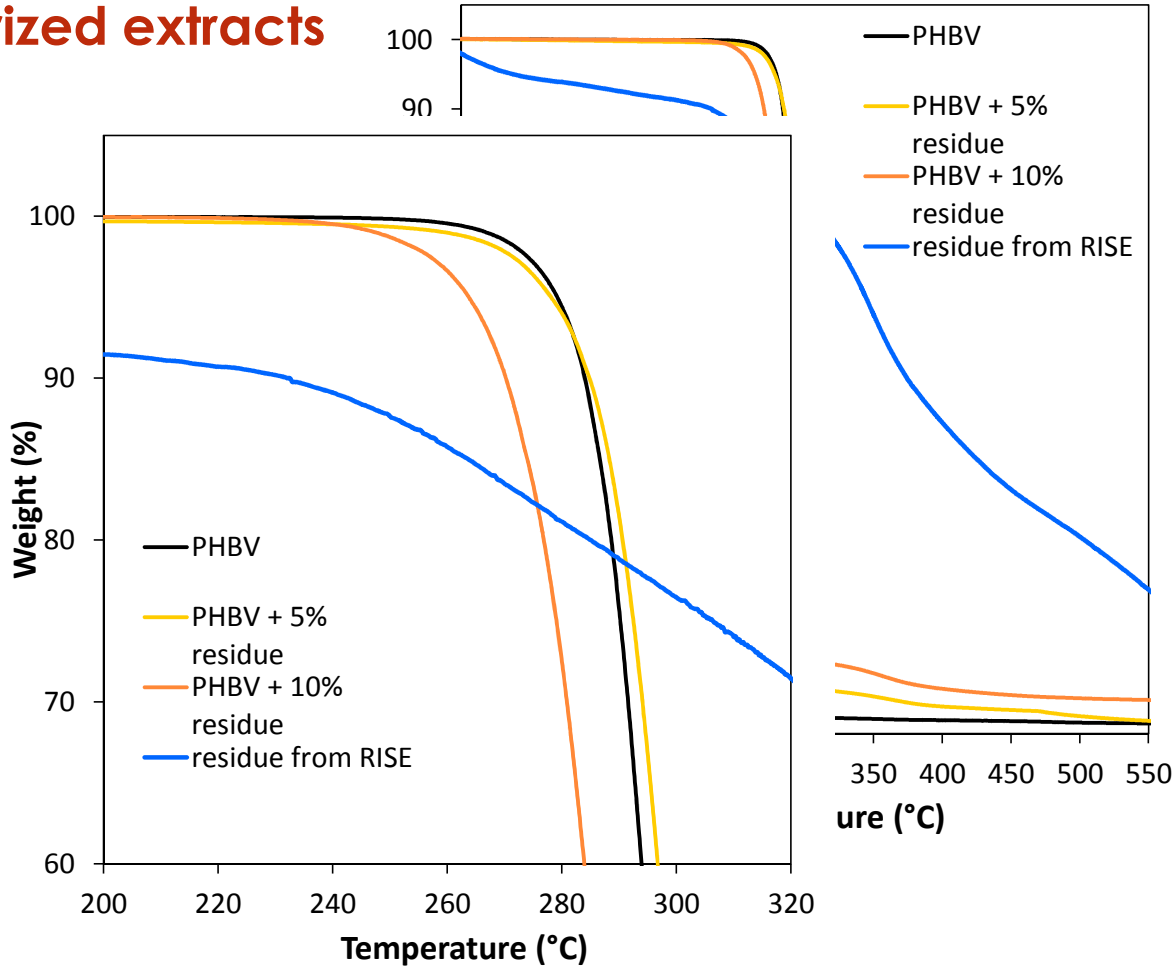
Bio-composites with red-pressurized extracts

Thermal Properties

Sample code	1° heating scan T_m (°C) [b]	1° heating scan ΔH_m (J/g) [b]	cooling scan T_c (°C) [c]	cooling scan ΔH_c (J/g) [c]
PHBV	172	78	114	73
PHBV-5PE	171	77	112	71
PHBV-10PE	171	73	110	66

First scan, from 30 to 210°C at 20°C/min; 1 min at 210°C; cooling scan 20°C/min; 1 min at 0°C; second scan, from 0 to 210°C at 20°C/min.

The thermal stability of PHBV and the composite containing 5 wt% of RISE extracts are comparable.



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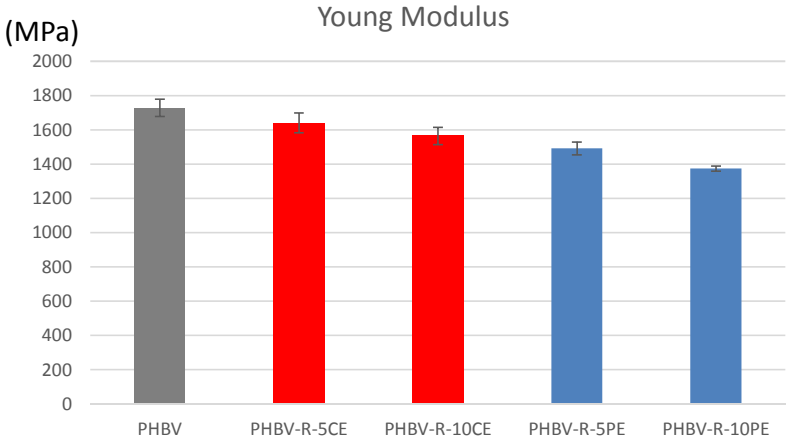
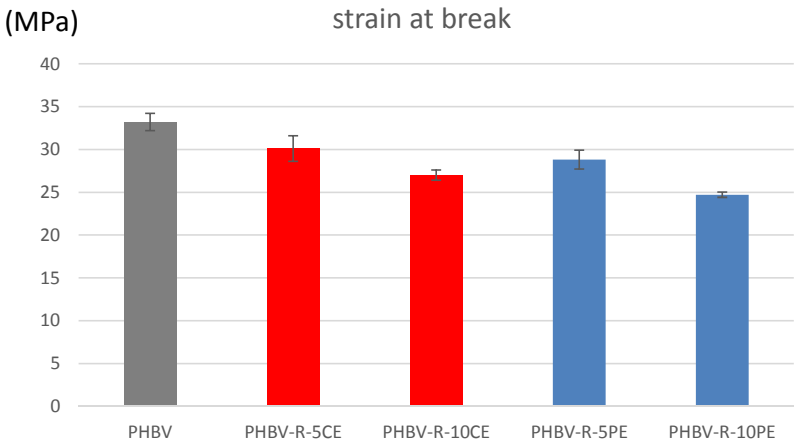
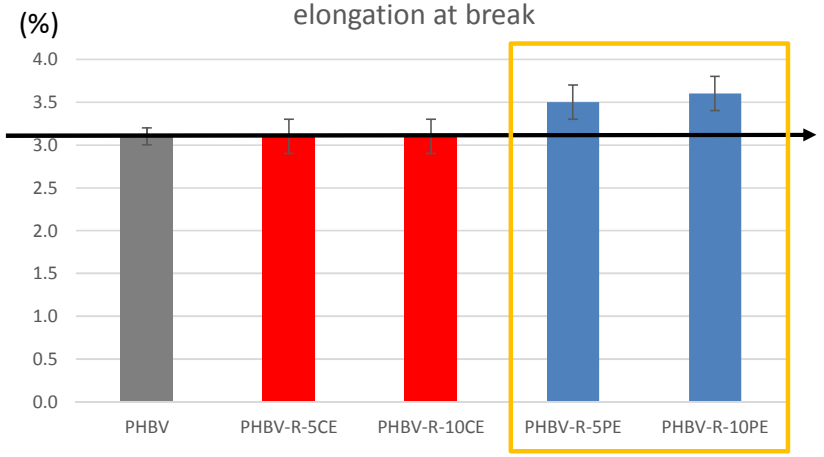
Tensile tests on bio-composites based on red pomaces residues







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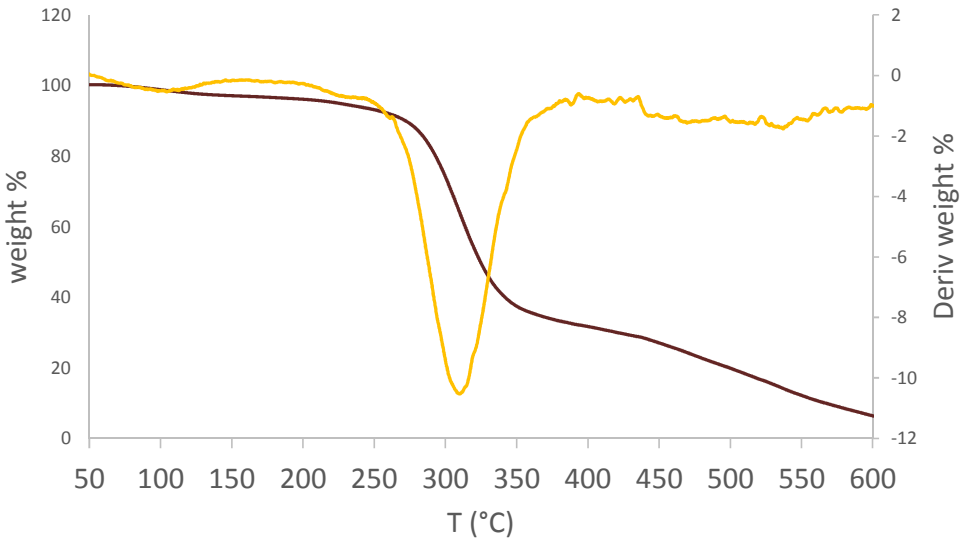
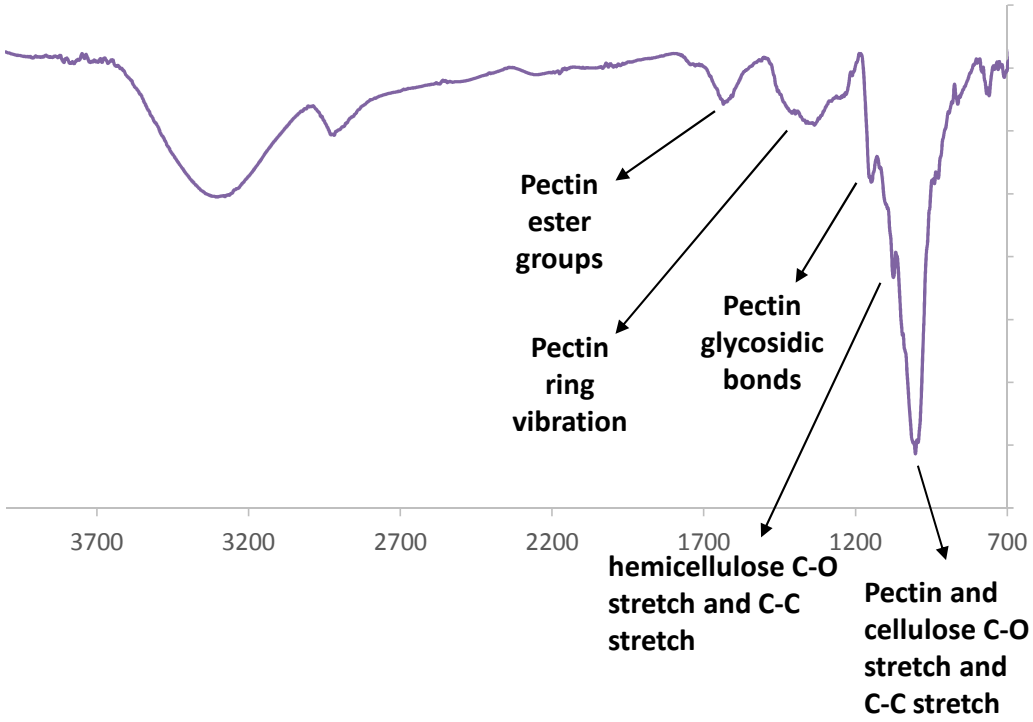
Characterization of potato's residue

Thermogravimetric analysis



FT-IR spectrum



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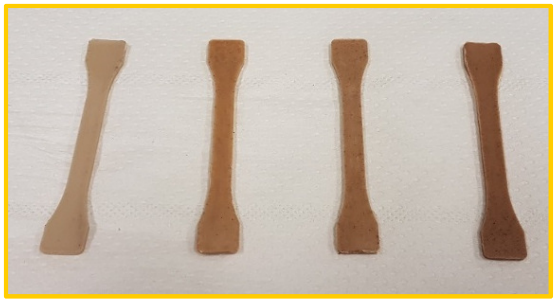
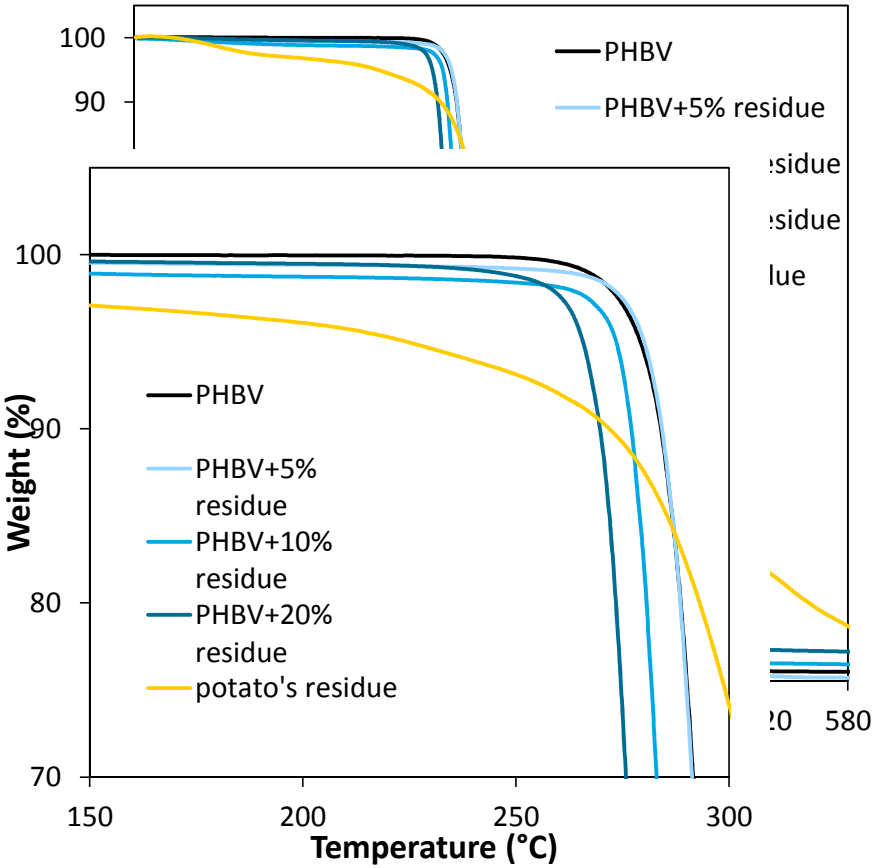
Bio-composites with potato's residue

Thermal properties

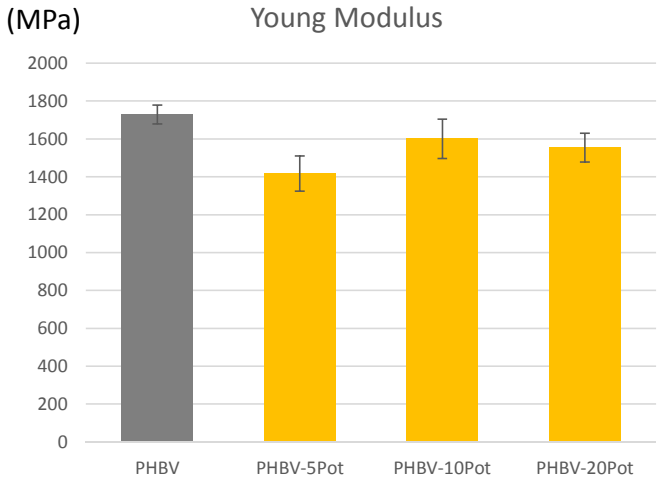


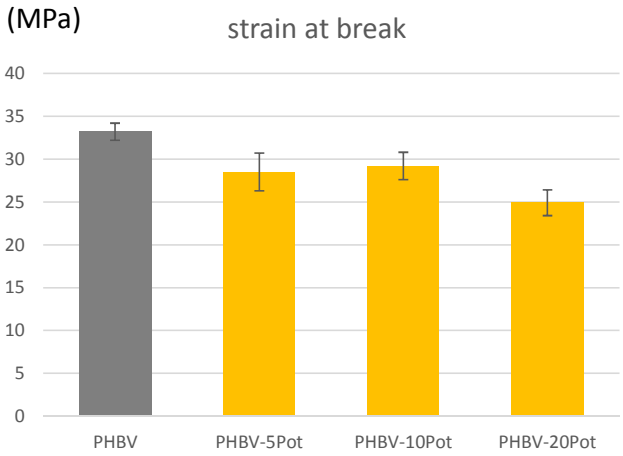
Sample code	1° heating scan		cooling scan		2° heating sca	
	T_m (°C) [b]	ΔH_m (J/g) [b]	T_c (°C) [c]	ΔH_c (J/g) [c]	T_m (°C) [d]	ΔH_m (J/g) [d]
PHBV	172	78	114	73	168	82
PHBV-5Pot	170	75	114	71	169	81
PHBV-10Pot	172	73	114	66	169	76
PHBV-20Pot	171	63	113	59	169	68

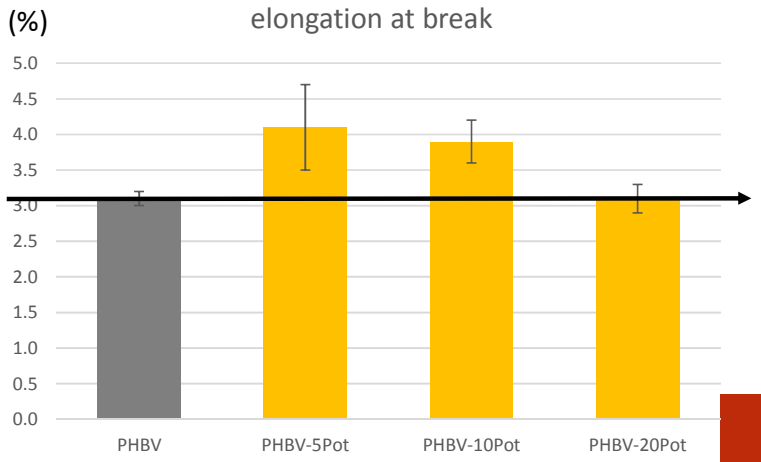
First scan, from 30 to 210°C at 20°C/min; 1 min at 210°C; cooling scan, from 210°C to 0°C at 20°C/min; 1 min at 0°C; second scan, from 0 to 210°C at 20°C/min.



Tensile tests on bio-composites based on potato residues







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Conclusions

- New bio-composites based on PHBV have been prepared by melt compounding.
- The content of filler has been **5, 10** or **20** wt%.
- The filler is deriving from **potatoes** and **pomaces**. In particular, the filler is the residue after further valorization of wastes of potato and pomaces processing.
- The bio-composites are thermally stable and easily processable.
- The Young Modulus remains fairly constant whereas the strenghth and the elongation slightly decrease meanwhile the material cost decreases.

- In some cases, the elongation has been maintained (**red UNIBO pomaces**) or improved (**red RISE pomaces** and potatoes).
- The filler-matrix interface compatibility will be studied by SEM.
- The use of a compatibilizer will be evaluated and tested in the future.

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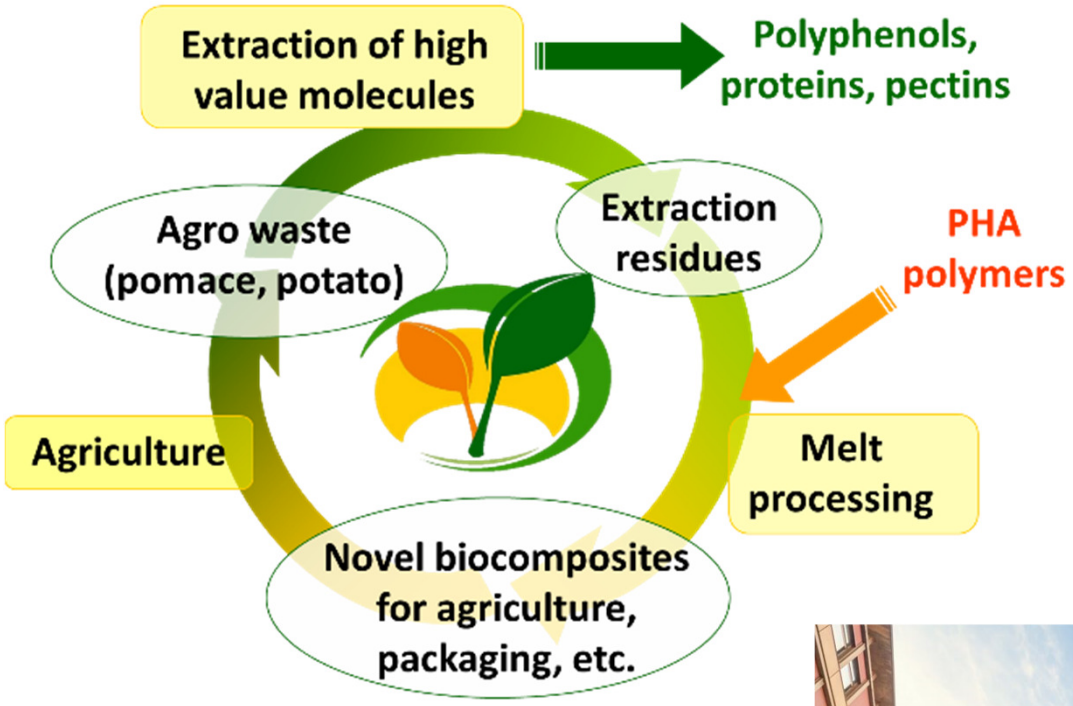

Thank you for your at tention!

***Bologna**: le 2 Torri and la fontana del Nettuno.*

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