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Enzyme-assisted extraction and modification of lignocellulosic biomasses for the production of functional oligosaccharides and other nutraceutical compounds

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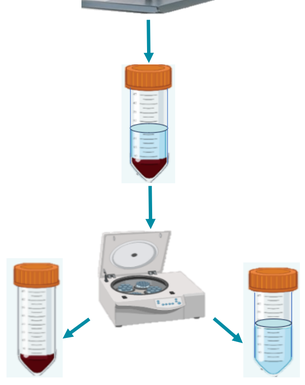
- Food industry generates vast amounts of lignocellulosic biomasses → fibers sources.
- Common fibers extraction processes involves strong conditions: high temperature, pressures, strong acids/basis → degradation compounds (not food-grade).
- Multiple purification steps required → high costs

Fostering matrix (hazelnut shells) disruption with physical pre-treatments and/or lignin remotion allowing fibers extraction under milder conditions.

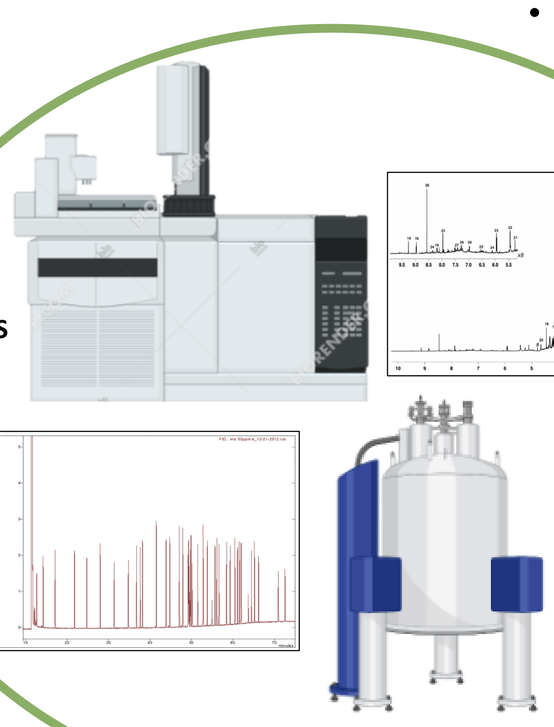
EFFECT OF TEMPERATURE

- Hydrothermal (**HT**) extraction.

HT EXTRACTION
125, 150, 175, 200°C,
1 h, 1/25 substrate-water ratio

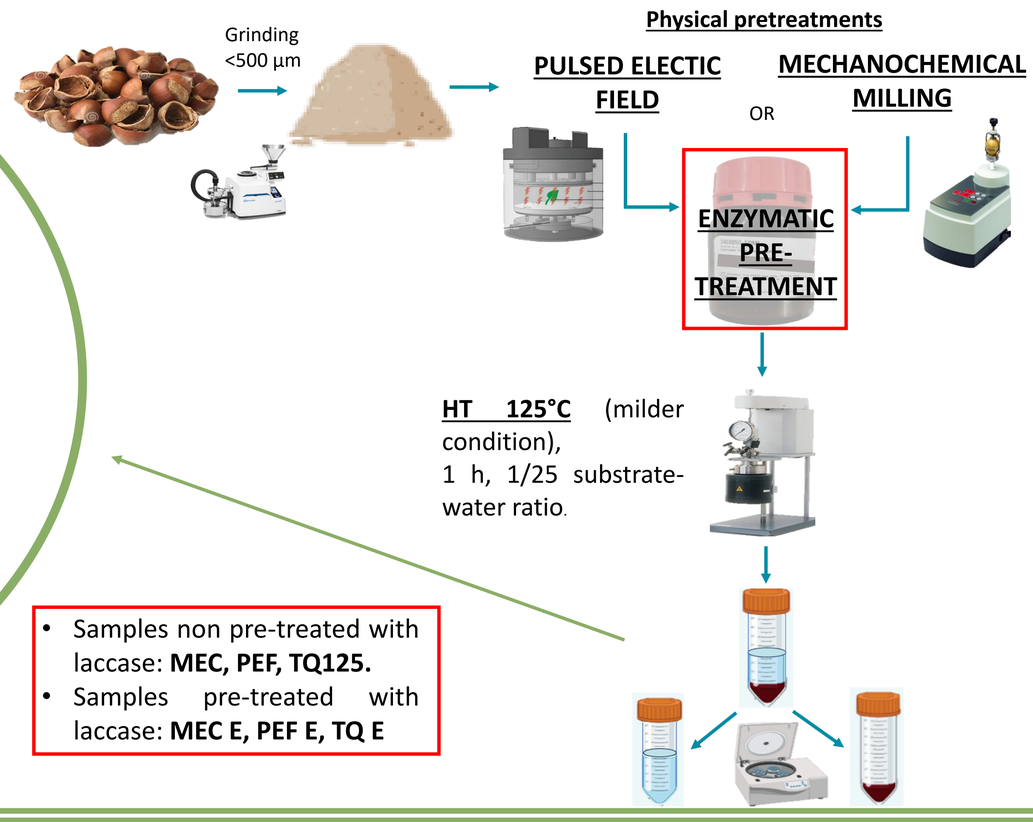


TQ 125; TQ 150; TQ 175; TQ 200



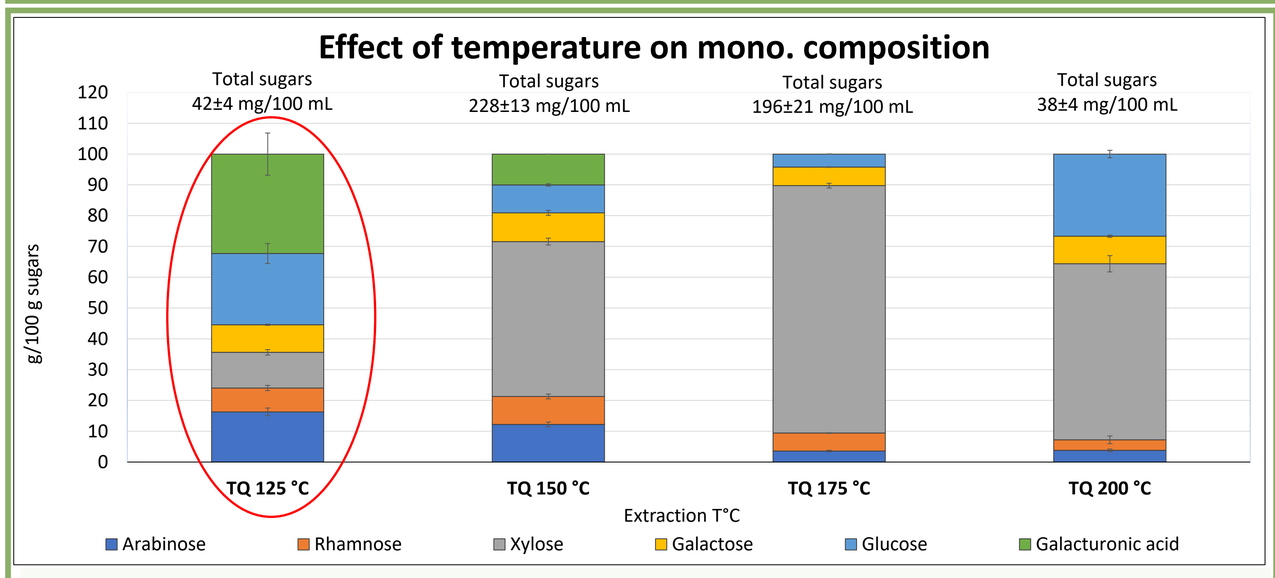
EFFECT OF PHYSICAL PRE-TREATMENTS AND/OR LIGNOLYTIC ENZYMES

- Pulsed electric field (**PEF**) and mechanochemical milling (**MEC**).
- Enzymatic pre-treatment (**E**): Laccase from *Aspergillus sp.* 24h; 40°C; pH 7.5; 300 U/mL; enz-sub ratio 1:40 (samples pre-treated and non- with laccase).
- Hydrothermal extraction: 125°C, 1 h, 1/25 substrate-water ratio.

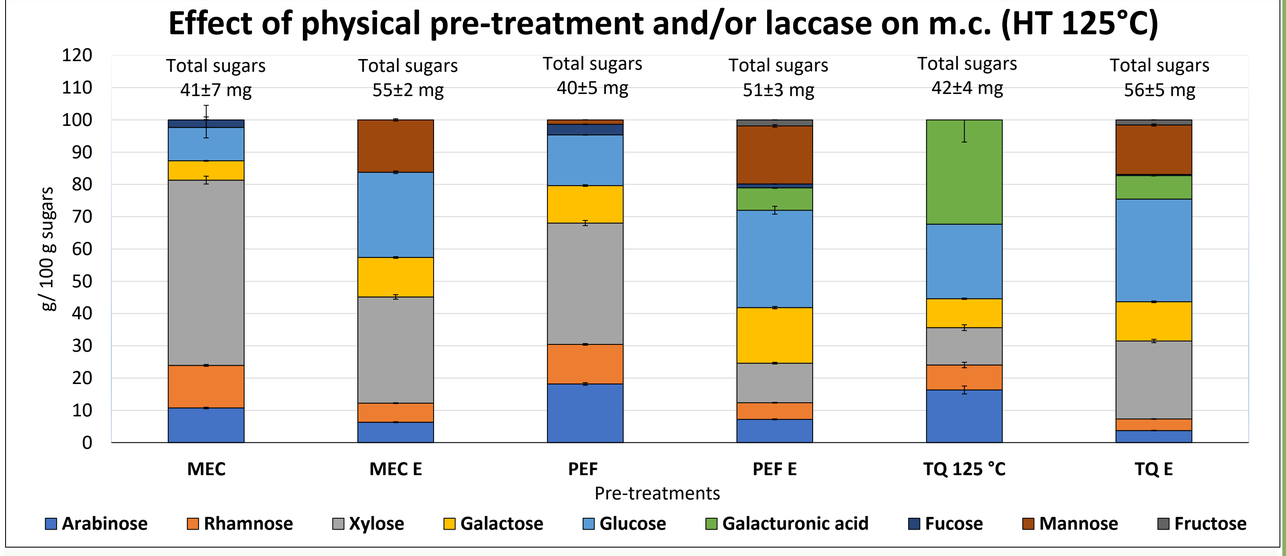


- Samples non pre-treated with laccase: **MEC, PEF, TQ125.**
- Samples pre-treated with laccase: **MEC E, PEF E, TQ E**

Effect of temperature on mono. composition



Effect of physical pre-treatment and/or laccase on m.c. (HT 125°C)



Degradation compounds (mg/100 mL extract)

Samples	Acetic acid	Methanol	Formic acid	HMF
TQ 125	3.94 ± 1.72	1.78 ± 0.40	2.41 ± 0.08	0.29 ± 0.35
TQ 150	24.69 ± 3.30	13.91 ± 1.31	11.17 ± 0.71	1.13 ± 0.75
TQ 175	45.55 ± 95.08	11.17 ± 1.00	11.25 ± 0.79	13.91 ± 0.26
TQ 200	81.40 ± 4.02	8.61 ± 0.19	17.13 ± 0.01	61.99 ± 1.23

Degradation compounds (mg/100 mL extract)

	Acetic acid	Methanol	Formic acid	HMF
TQ 125	3.94 ± 1.72	1.78 ± 0.40	2.41 ± 0.08	0.29 ± 0.35
TQ E	10.45 ± 3.30	1.95 ± 1.31	2.40 ± 0.71	/
MEC	6.79 ± 3.31	0.56 ± 0.32	2.16 ± 0.72	/
MEC E	8.88 ± 1.08	4.74 ± 1.00	3.12 ± 0.79	/
PEF	5.76 ± 9.09	0.45 ± 1.01	2.42 ± 0.80	/
PEF E	7.31 ± 2.02	4.74 ± 0.19	3.36 ± 0.01	/

CONCLUSIONS

Effect of temperature on HT extraction:

- Different fibers fractions obtained in function of the different temperatures.
- Sugar yields increased with T°C, with a drastic drop at 200°C (strong sugar degradation).
- Main detected monosaccharide:
  1. 125°C: Galacturonic acid → pectins
  2. >150°C: Xylose → hemicelluloses

Effect of physical pre-treatments and/or laccase on HT extraction at 125°C:

- Physical pre-treatments did not increase yields but affected the different fibers extractability
- Laccase pre-treatment increased the polysaccharides extraction yields of 37±3.0 % compared to the control treatment, independently on the physical pretreatments.
- Laccase introduced new fiber fractions compared to the specific control sample → mannose and galactose (only increased) in MEC and PEF sample: galacto-mannans, and galacturonic acid in PEF sample: pectins (various technological applications).

Future perspectives

- Optimization study to improve enzyme's application conditions (on going) → scale-up study and industrial perspective
- Optimize the extraction process to control and achieve specific molecular structures in the final extract, enhancing its desired functionalities →explore the potential of the extracted fibers to serve multiple roles within the food industry, both as bioactive ingredients and as technological additives.