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Production of bio-coal from biomass in a Mechanically Fluidized Reactor (MFR)

Anastasia Colomba
ICFAR

Franco Berruti
ICFAR

Cedric Briens
ICFAR

Institute for Chemicals and Fuels from Alternative Resources
Western University

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Anastasia Colomba, Franco Berruti and Cedric Briens

Institute for Chemicals and Fuels From Alternative Resources (ICFAR)
Western University, London, Ontario
CANADA

Objectives

Explore the extent to which biomass can be upgraded to bio-coal:

- Biologically stable
- Hydrophobic behavior
- Higher calorific value
- Friable for use in pulverized coal boilers

Objectives of this study

- Create a database of biomass and products characteristics
- Comparison of different torrefaction technologies
- Identify potential feedstocks for fuel production

Biomass selection

Energy crops	Crop residues	Energy crops seeds	Milling residues
Willow	Wheat Straw	Sorghum	Olive Residue
Miscanthus	Corn Stover	Sunflower Husks	Bagasse
Switchgrass	Canola Straw		

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Feedstocks used in this work

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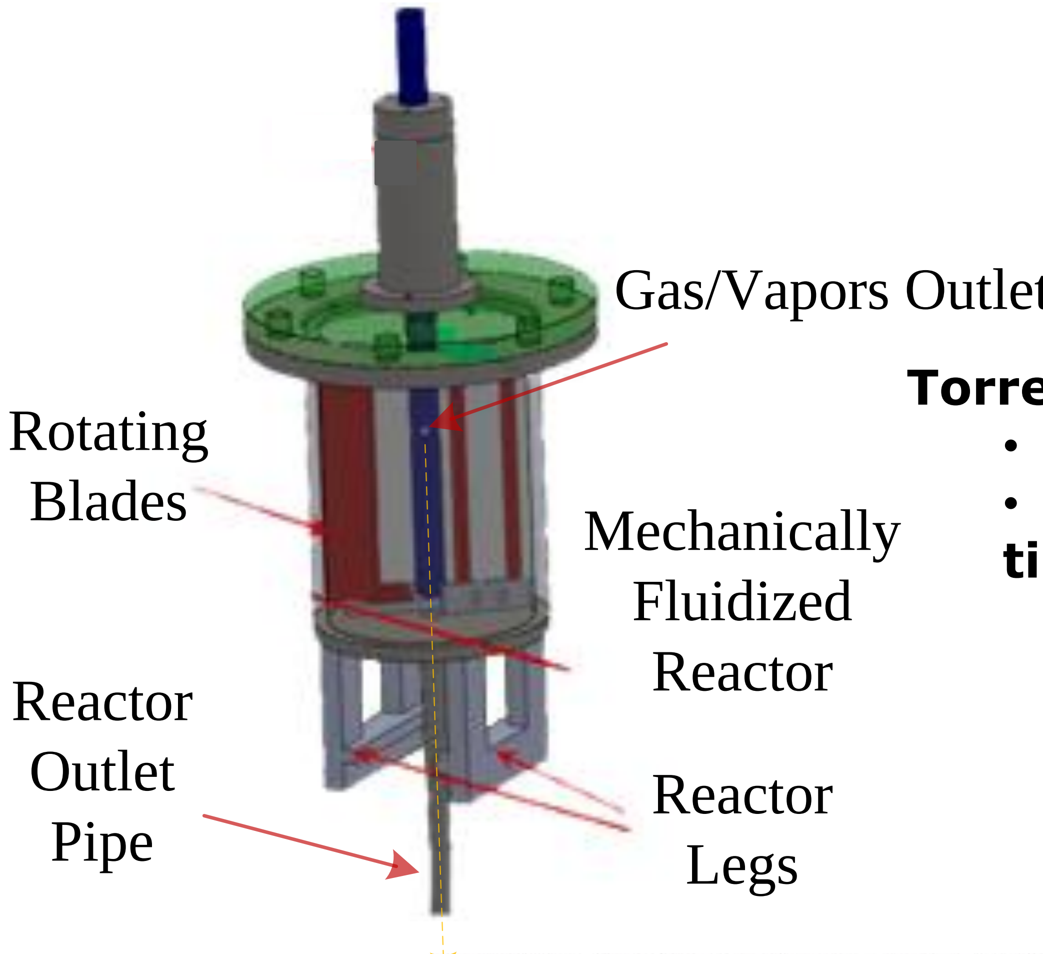
ICFAR Mechanically Fluidized Reactor (MFR)



Torrefaction experiments:

- **260 °C and 300 °C**
- **15 minutes residence time**

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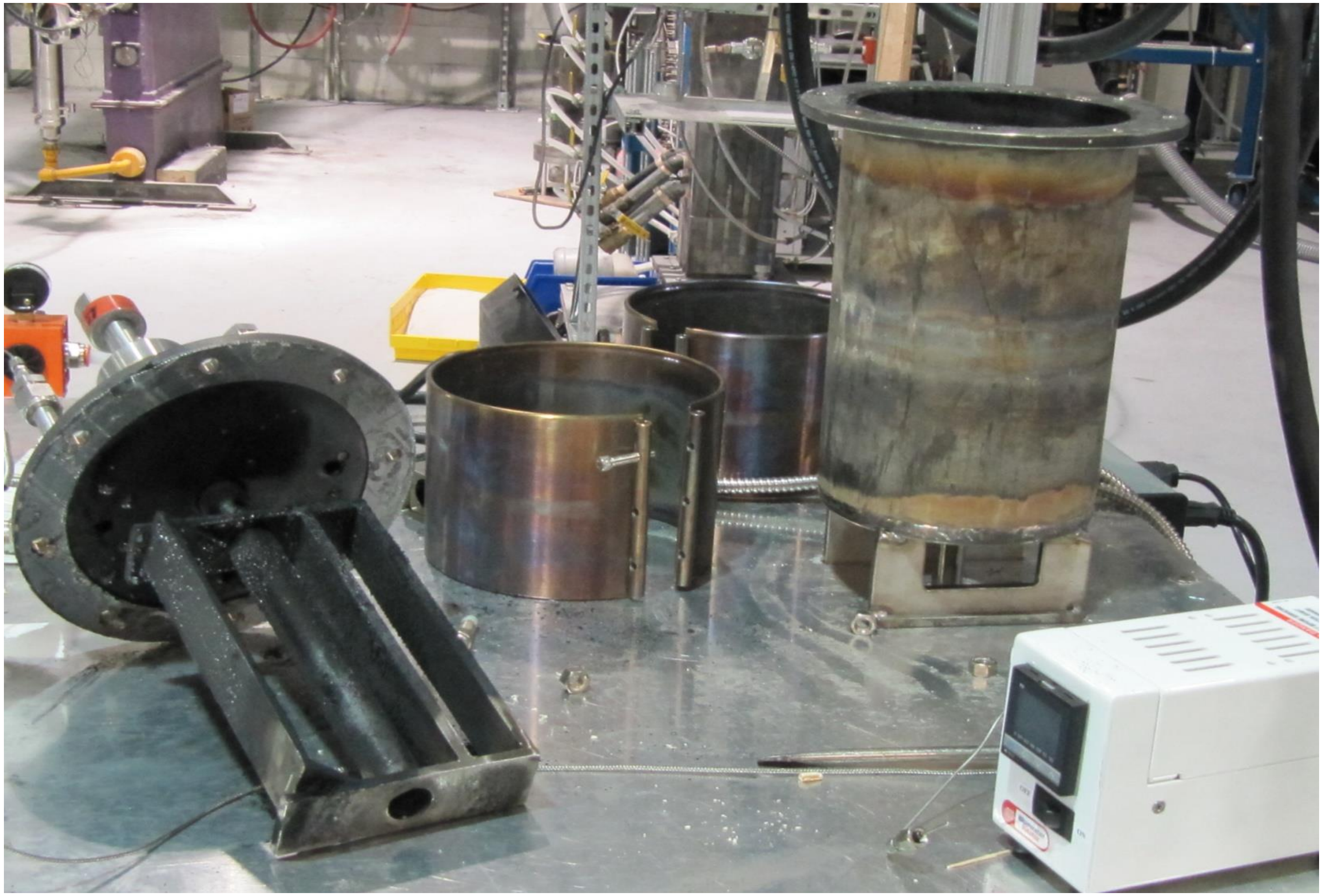
ICFAR Mechanically Fluidized Reactor (MFR)



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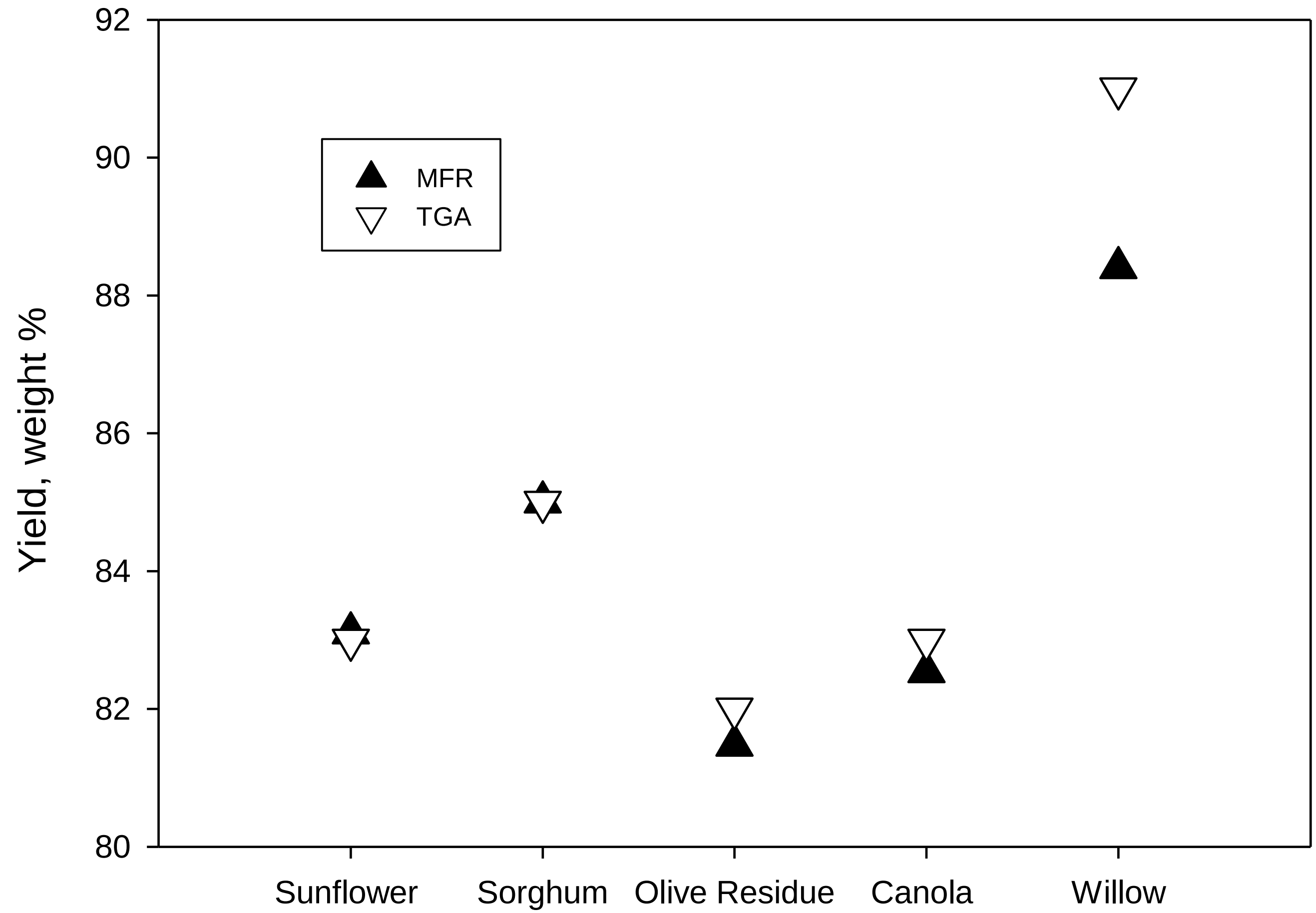
Yields– comparison with different reactors at 260 °C



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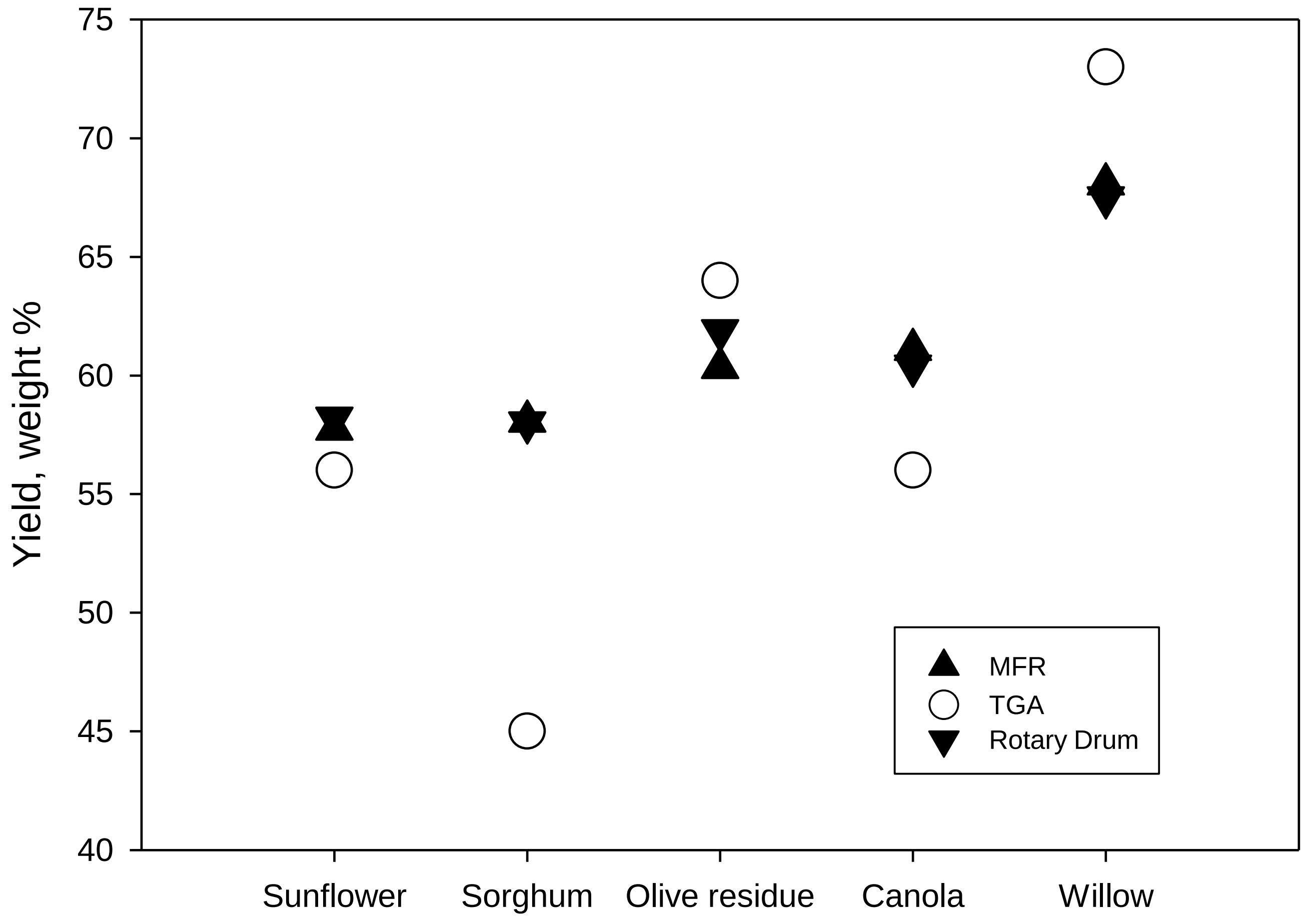
Yields– comparison with different reactors at 300 °C



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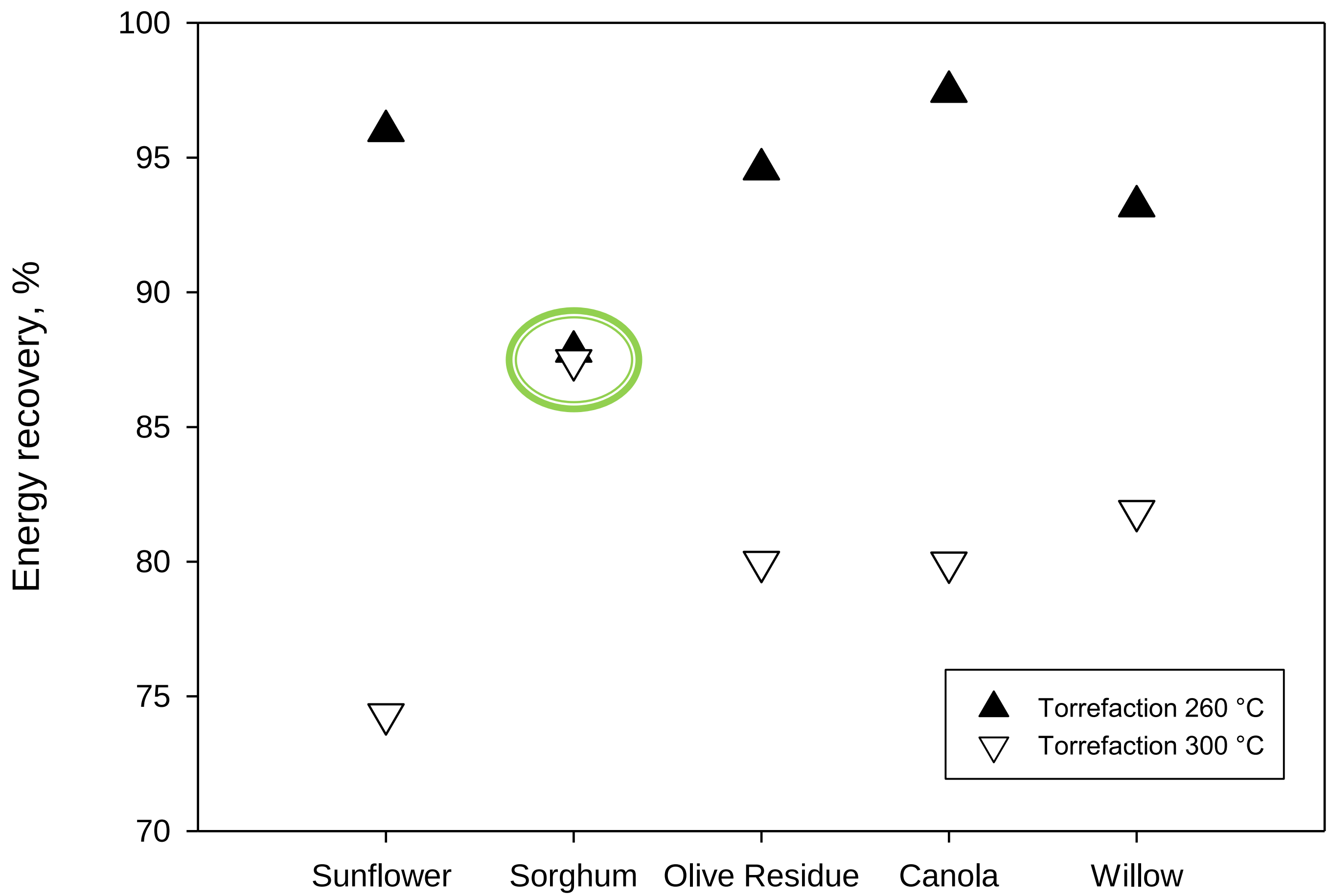
Energy recovery



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Interesting observations

Sorghum seeds "pop" at higher temperatures ⟹ problems with the stirrer

Raw sorghum seeds

Torrefied at 260° C

Torrefied at 300° C

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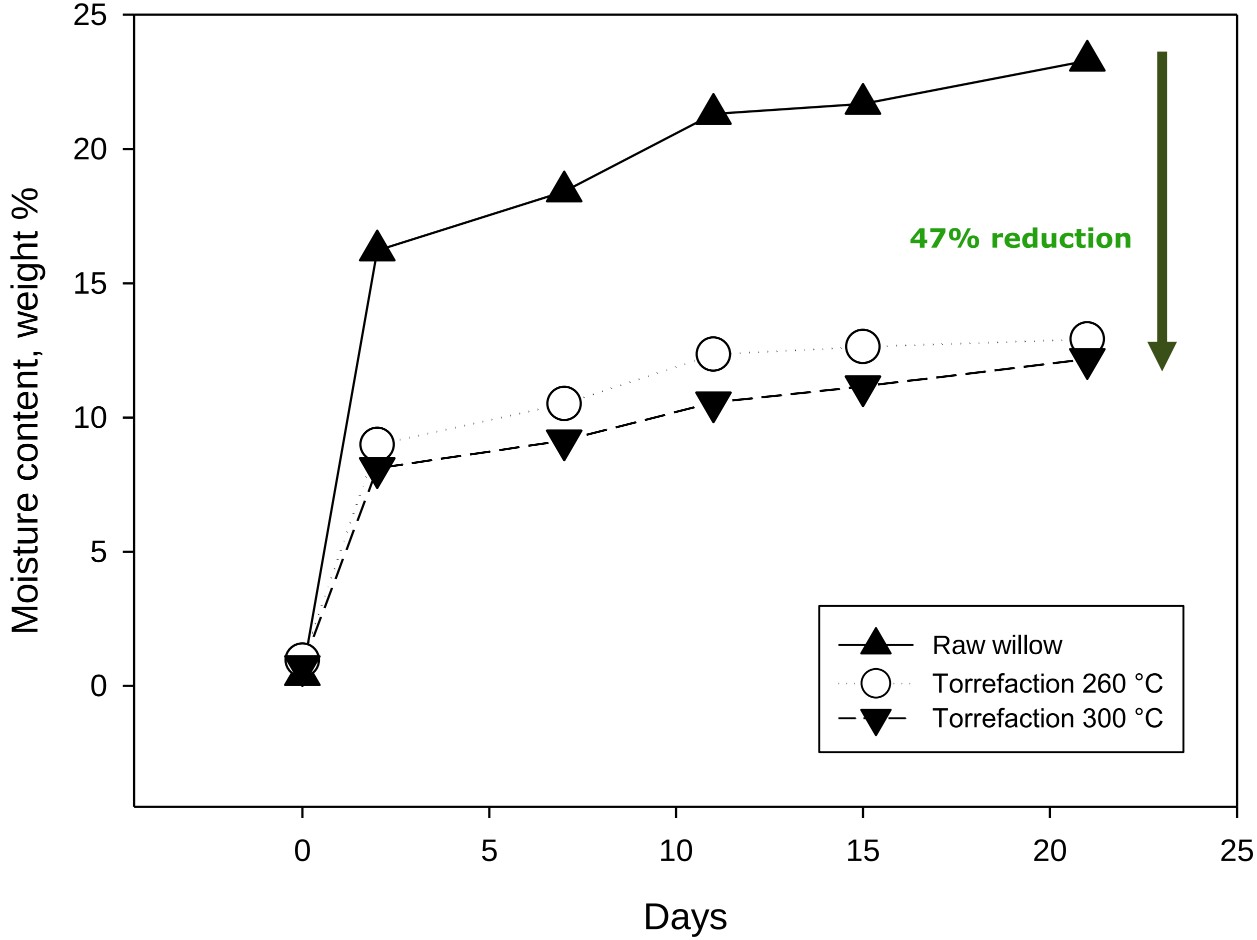
Hygroscopicity



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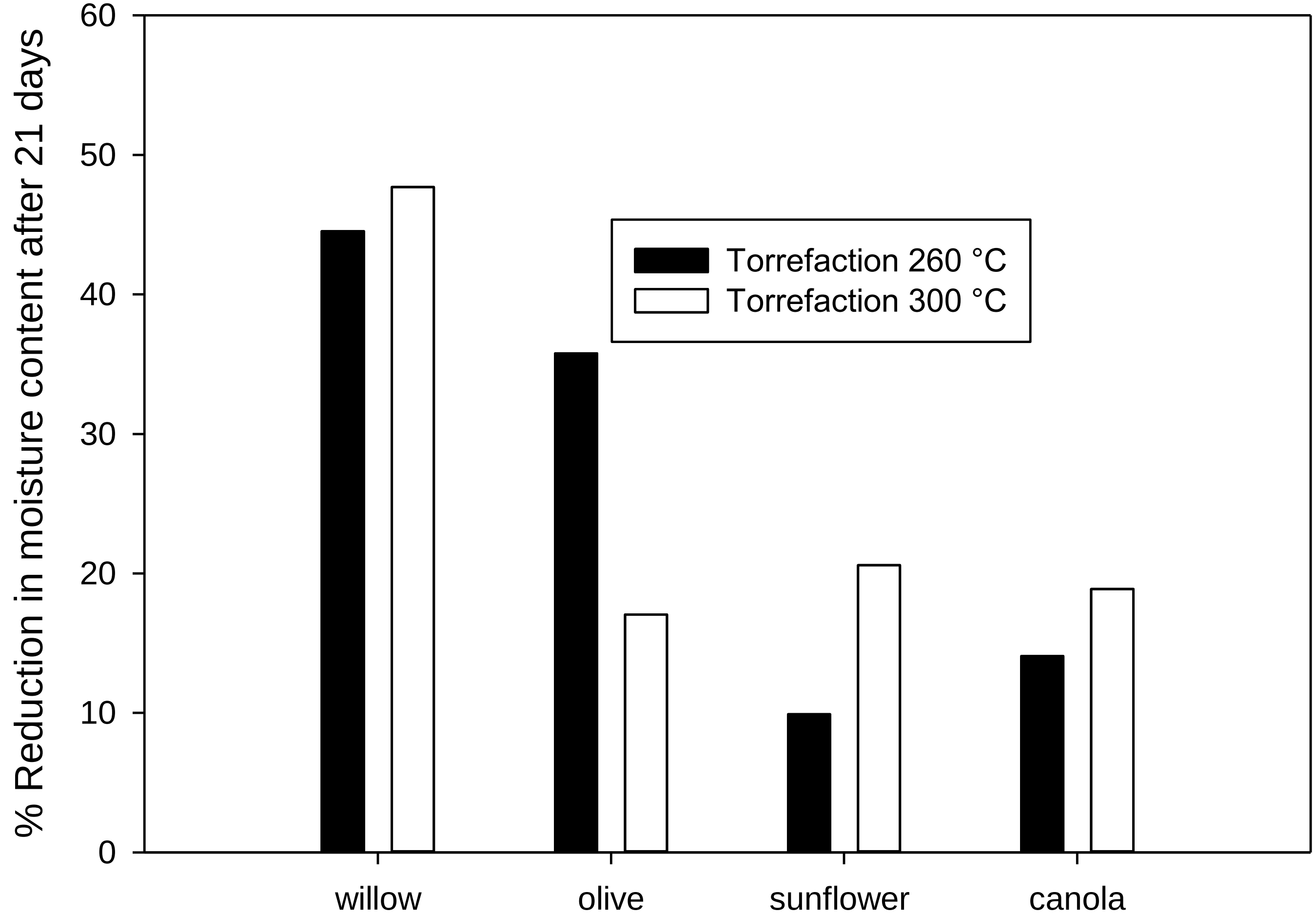
Hygroscopicity

Evaluated after 21 days in a saturated atmosphere at 15°C



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Interesting observation– Hygroscopicity

Bacteriological activity after 21 days in a saturated atmosphere:

- raw sunflower husks
- raw sorghum seeds

Prevented with torrefaction !

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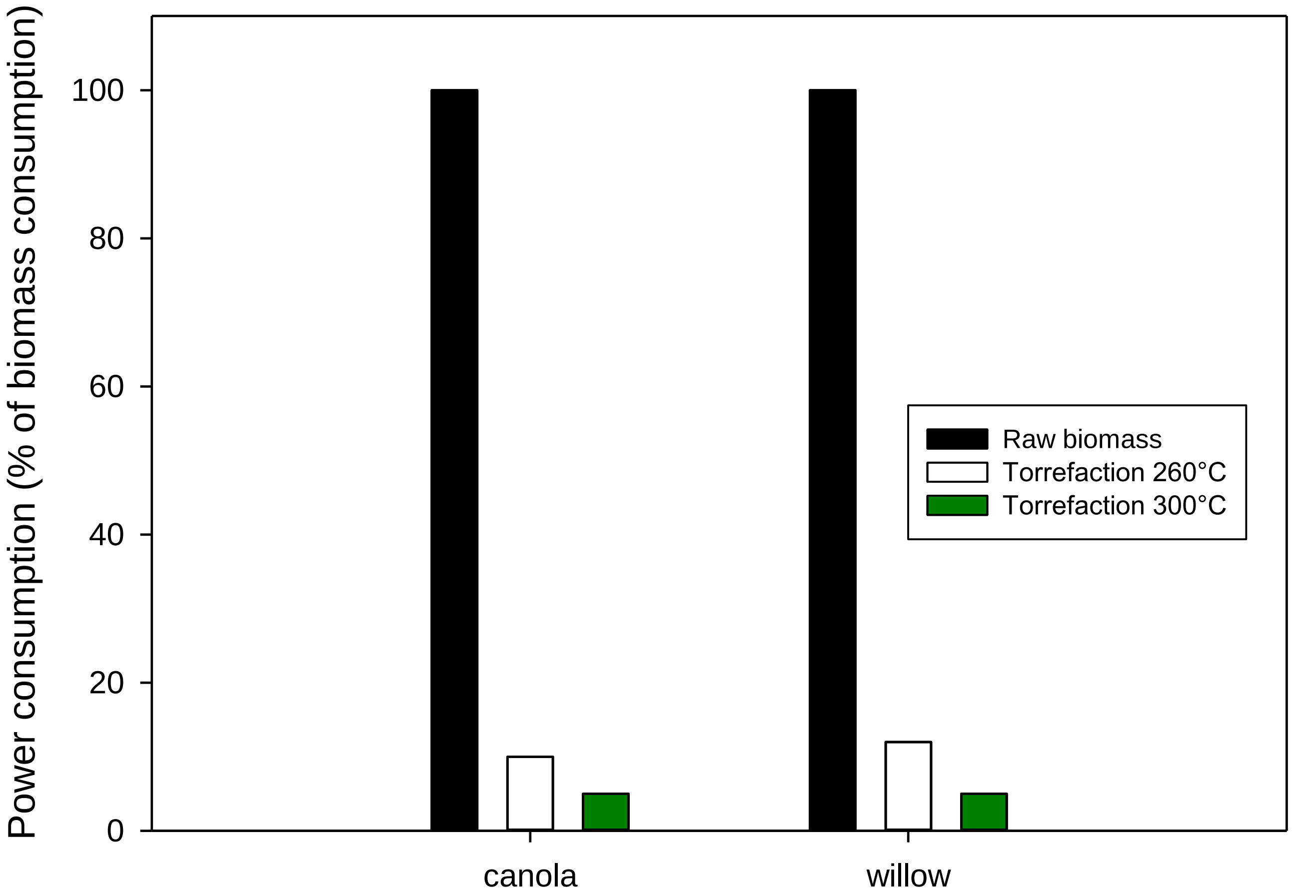
Grindability



Reduction up to 90% in the power consumption for grinding after torrefaction

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Grindability

Raw sunflower husks

Torrefied at 260° C

Torrefied at 300° C

Destruction of sunflower husks at higher temperature
→ no need for further grinding?

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Key conclusions

- Suitability of the MFR for torrefaction
- Torrefaction for 15 minutes at 300 ^{o}C
  - Upgrades biomass in terms of hygroscopicity, biological stability and grindability
  - Removes the hemicellulose (confirmed by re-hydrolyzing the sample and FT-IR spectra)

Future work

- Bio-coal:
  - Comparison with bio-coal produced in continuous MFR
  - Production of large quantities of bio-coal for combustion testing
  - Predictive correlations in terms of product performance
- Production and testing of bio-char for:
  - Soil amendment
  - Activated carbon

Acknowledgments

RÉSEAU BIOFUELNET CANADA

NSERC CRSNG

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