6-20-2016

Influence of pre-treatment on grass pyrolysis for high value products

Chiara Barbiero
Western University, Canada, cbarbier@uwo.ca

Charles Greenhalf
Western University

Franco Berruti
Western University, Canada

Cedric Briens
Western University, Canada

Influence of pre-treatment on grass pyrolysis for high value products

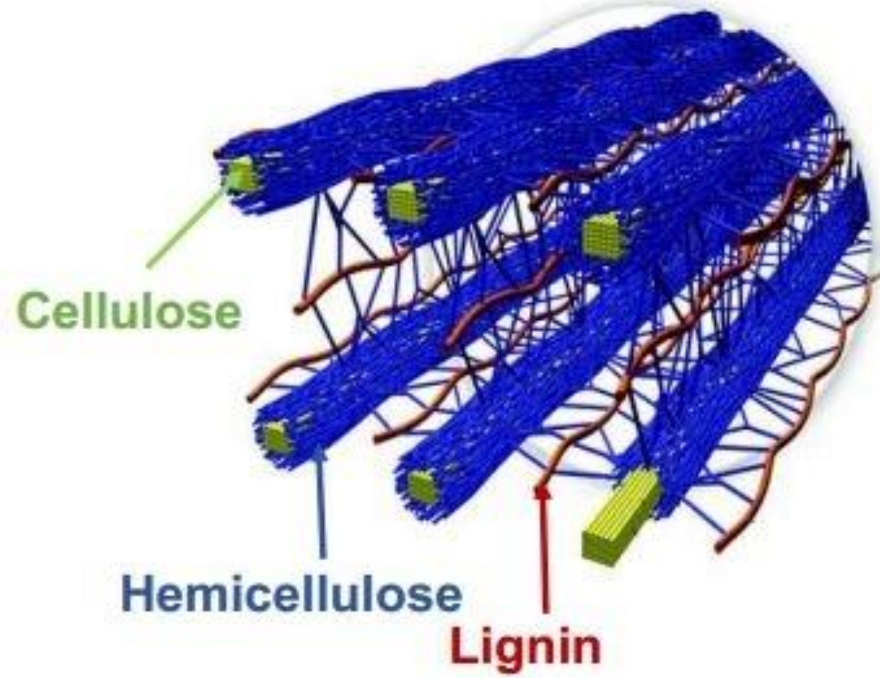
Chiara Barbiero, Charles Greenhalf, Franco Berruti, Cedric Briens

Major Biomass components:

Cellulose glucose polymer
- long chain polysaccharide
- Tightly packed and organized

Hemicellulose complex polymeric network
- 5- and 6- carbon sugar
- connect cellulose and lignin fibers

Lignin amorphous polymer of aromatic compounds
- Composed of phenolic alcohols
- Gives support, resistance and impermeability to the plant
- Holds together hemicellulose and cellulose



Upon rapid heating, the carbohydrates (cellulose and hemicellulose) break down to provide low molecular weight volatile products.

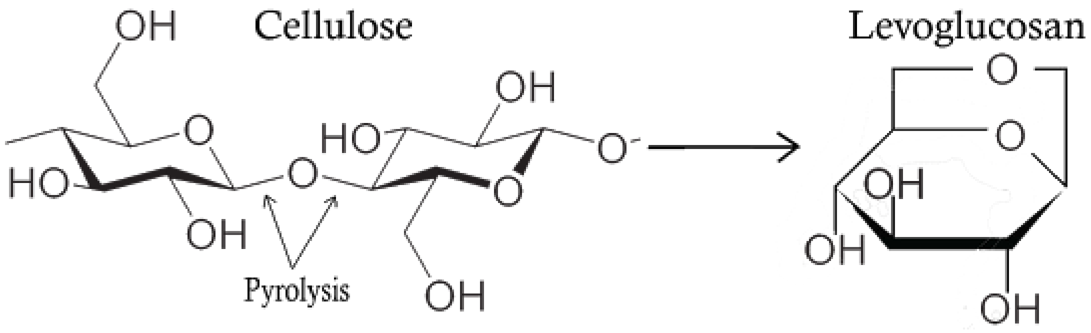
Pyrolysis thermal decomposition of fuel into liquids, gases, and char (solid residue) in the absence of oxygen.

- Gases (non-condensable vapors)
- Liquids (condensable vapors)
- Solids: char and ash

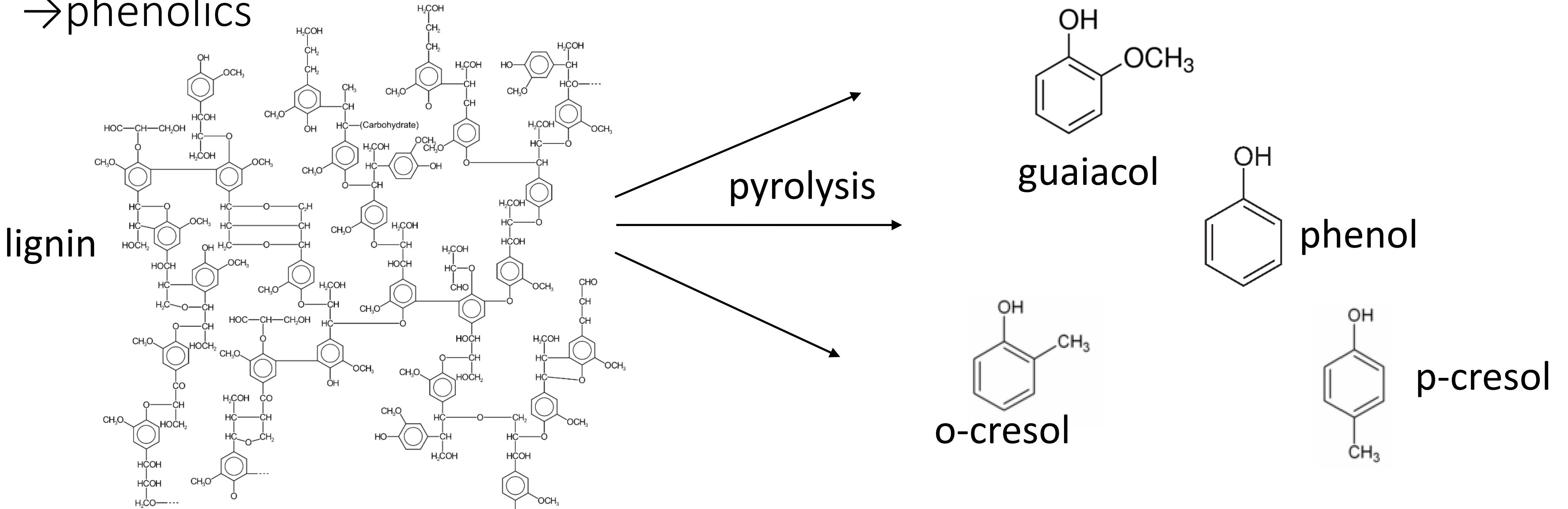
Objectives:

Develop pre-treatment process to maximize valuable products:

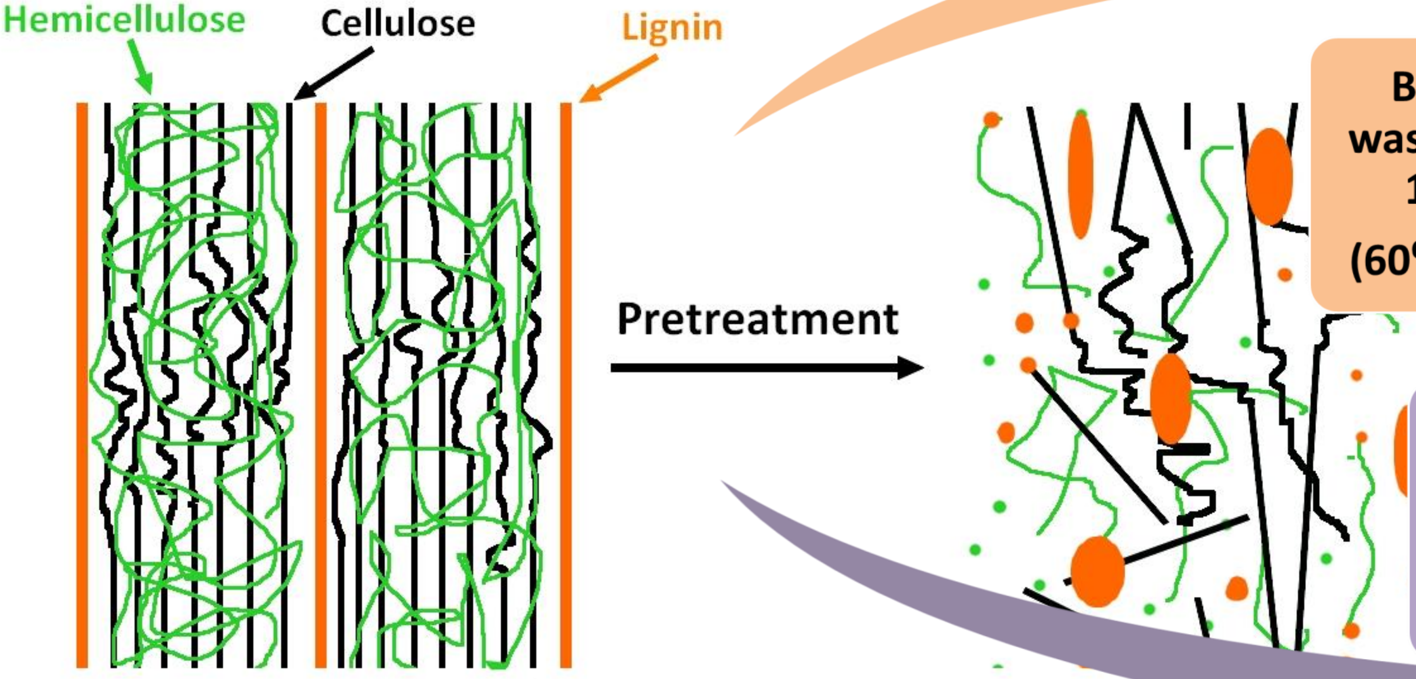
→sugars



→phenolics



Pretreatments process



Acid wash

Biomass washed with 1% HCl (60°C for 1h) → Biomass rinsed with deionized water → Drying 105°C for 16h

Alkali impregnation

Biomass impregnated with 1% NaOH (60°C for 1h) → Drying 105°C for 16h

Biomass: Phragmites Australis

Invasive species that has been damaged Ontario biodiversity for decades.

Impact of Invasive Phragmites:

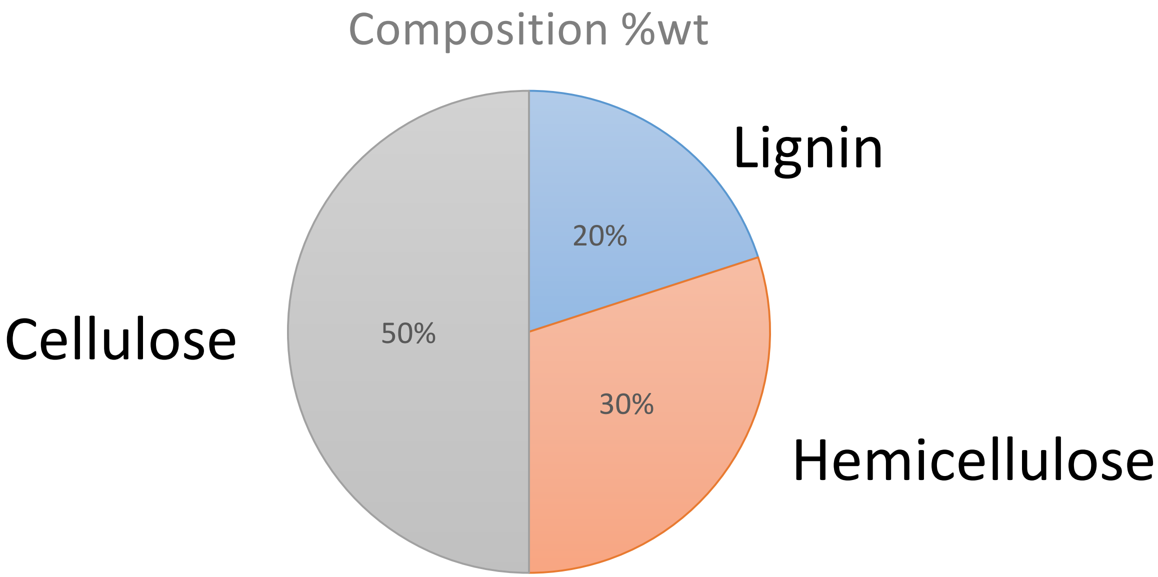
crowds out native vegetation

→ Increases fire hazard

→ grows in stands that can be extremely dense

→ can reach heights of up to 5 metres

We harvested the Phragmites in November.



Experimental setup

Technology: Slow Pyrolysis

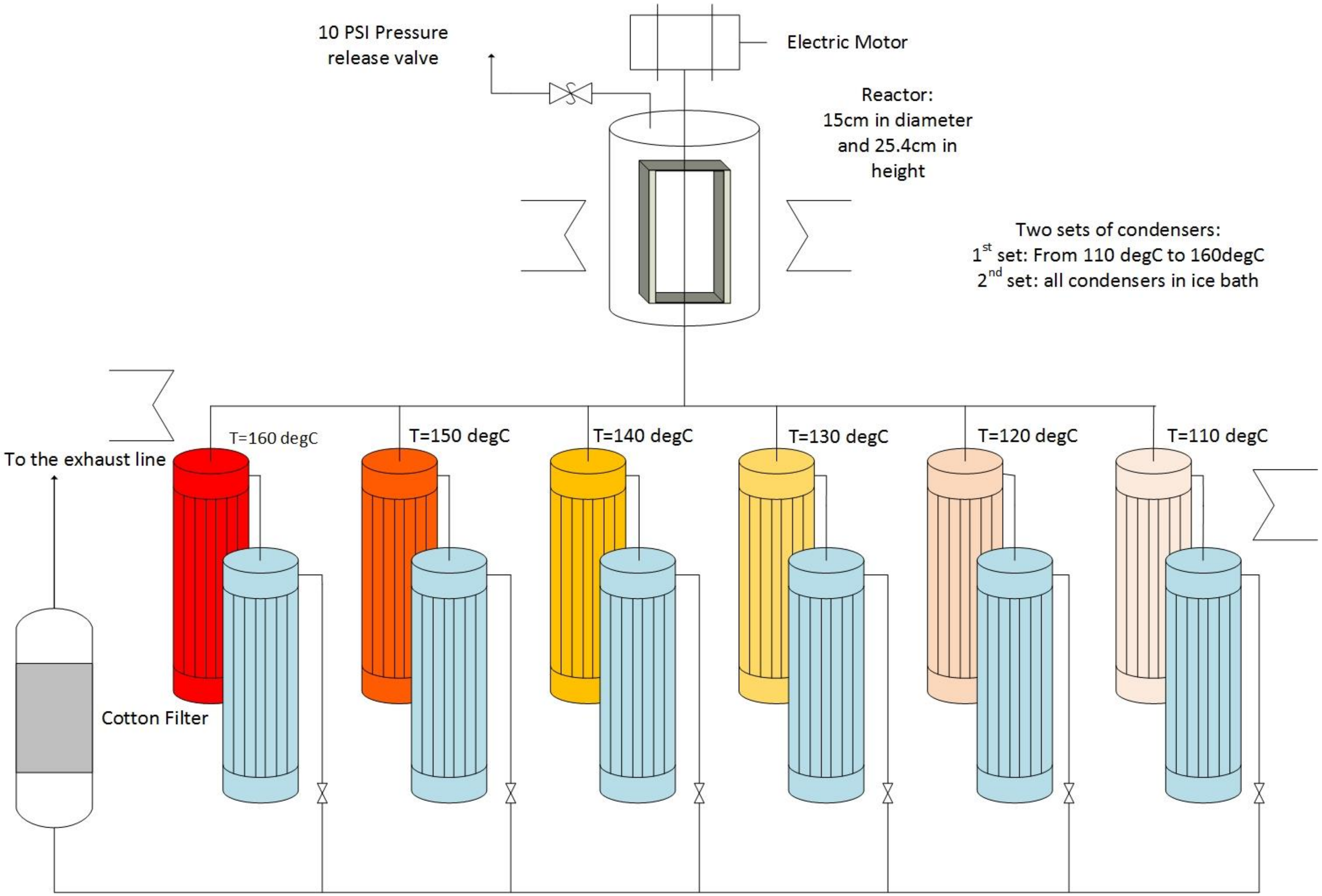
Mechanical Fluidized Bed (MFR)

Pyrolysis conditions:

→Reactor Temperature = 550 ^{o}C

→ Heating rate = 8 ^{o}C/min

→ Biomass = 200 g

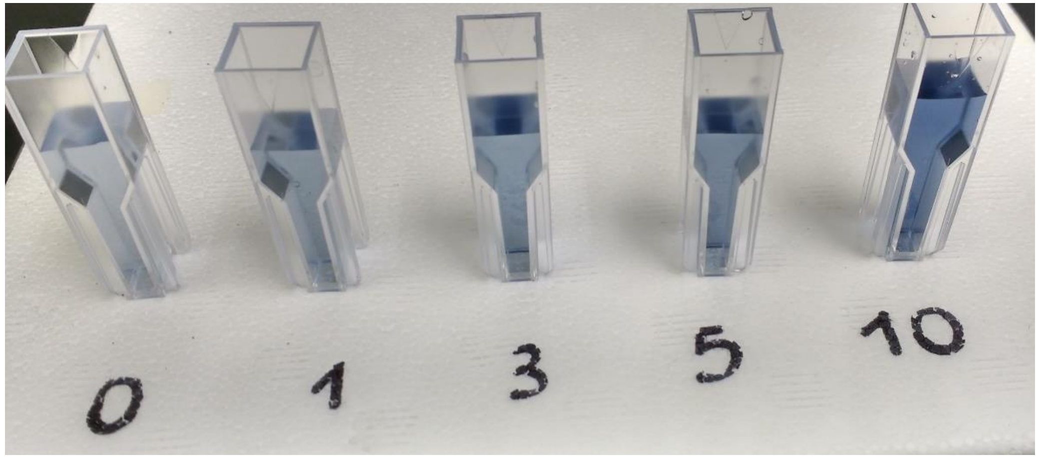


Front

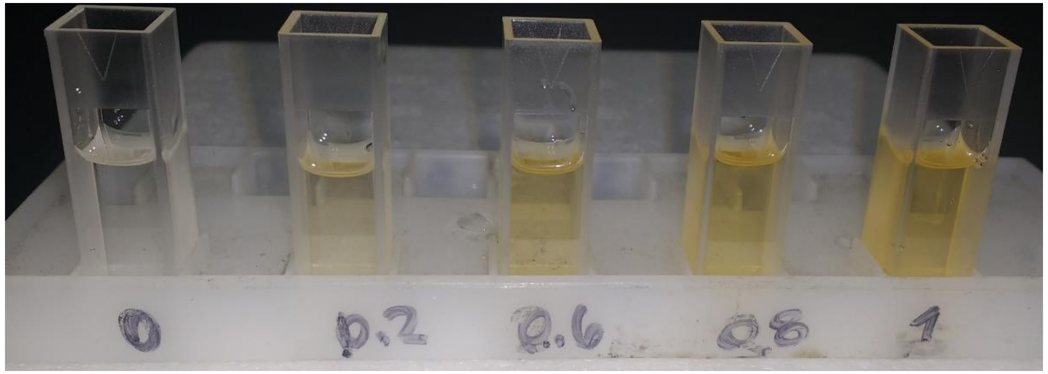
Back

Characterizations performed:

Total Phenolics:
Folin-Ciocalteau method



Total Carbohydrate Analysis:
phenol–sulfuric acid assay



Results and conclusion

	Effects of the pre-treatment	
	Total phenolics recovered/ untreated	Total carbohydrates recovered/ untreated
HCl	0.57	1.20
NaOH	1.31	1.12

Total Phenolics:110ºC <T condenser < 160ºC

- Small variations in yield and concentration of phenolics → try higher condenser temperature
- With NaOH pretreatment concentration of phenolics in dry bio-oil ≈ 30 wt%

Total carbohydrates:110ºC <T condenser < 160ºC

- Much better yield with 120 ºC condenser and 130 ºC condenser→ try lower condenser temperature
- with HCl pretreatment, concentration of carbohydrates in dry bio-oil ≈ 11wt%

Thanks!