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Proceedings

Spring 6-13-2013

Alcohol production from pyrolytic sugars obtained from selective fast pyrolysis of pretreated wood

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ALCOHOL PRODUCTION FROM PYROLYTIC SUGARS OBTAINED FROM SELECTIVE FAST PYROLYSIS OF PRETREATED WOOD

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Background

- Previous studies showed that feedstock demineralization increases levoglucosan (LG) yield (Oudenhoven, 2012)
- LG is the most abundant anhydrous sugar in demineralized pyrolytic oil
- If acid hydrolyzed it is transformed to glucose

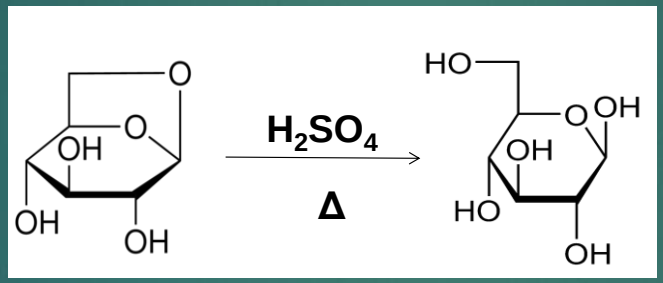


Figure 1. Levoglucosan hydrolysis to glucose

- Present among a pool of fermentation inhibitors
  - HMF
  - Phenolics: Lignin derived compounds

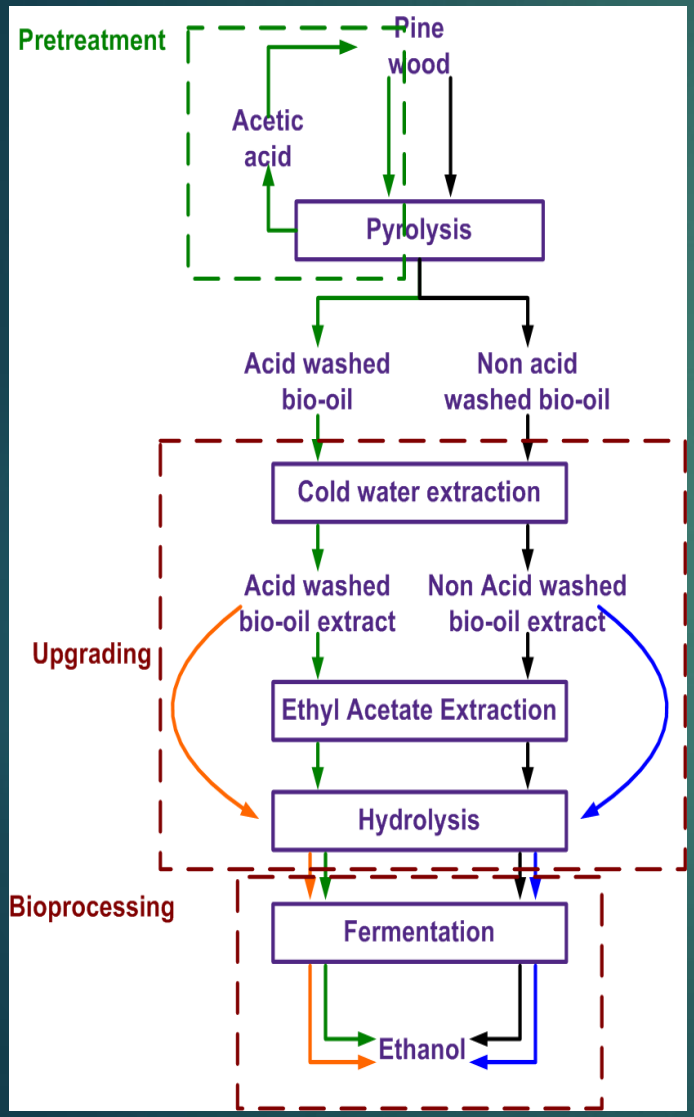
Background

- Detoxification with
  - Activated carbon
  - Polymers
    - XAD-4 XAD-7
- More steps that are avoidable

Objective

- Production of a fermentable substrate from demineralized (acid washed) biomass pyrolytic oil.
- Developing a high throughput analytical metodolody for pyrolysis oil fermentability assesment

Methodology



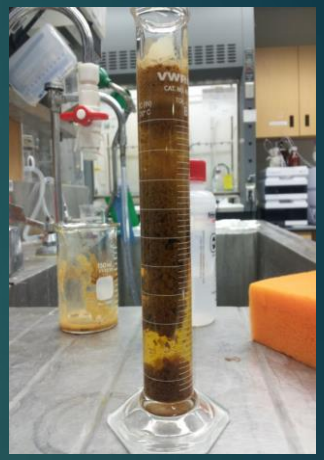
Demineralization (acid wash)
- Removing ion
- Increases LG yield
- Decreases water content

Cold Water extraction
- Precipitates insoluble lignin

Ethyl acetate extraction
- Removes soluble growth inhibitory compounds

Hydrolysis & Neutralization
- Precipitates any left acidic compounds

Fermentation
- Transforms pyrolytic sugar into ethanol



Results

Table 1. Non-Acid washed bio oil extractions

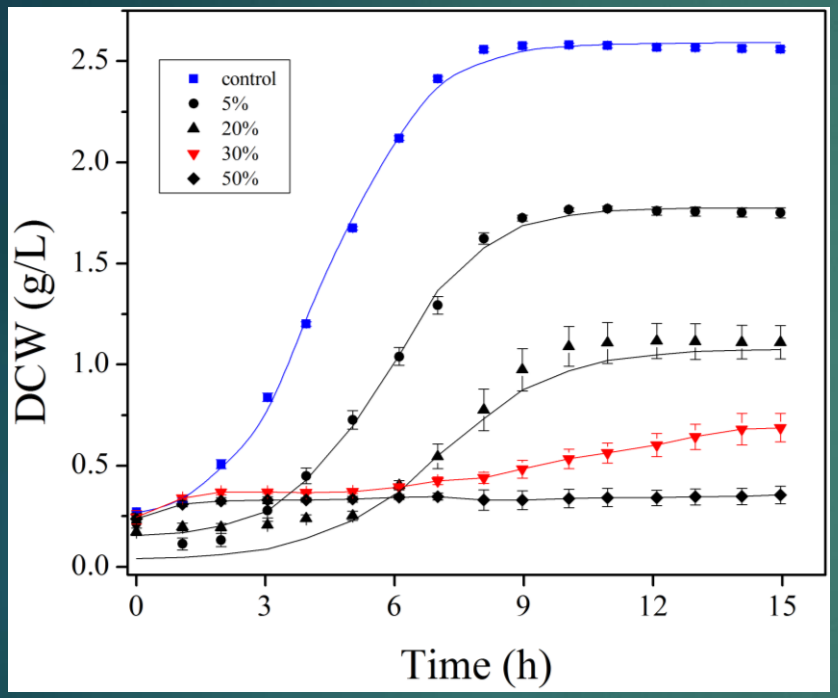
	NON ACID WASHED BIO-OIL									
	Cold Water Extraction					Ethyl Acetate Extraction				
	TOC (g/L)	Levoglucosan (g /L)	Glucose (g/L)	Levoglucosan carbon fraction	Glucose carbon fraction	TOC (g/L)	Levoglucosan (g /L)	Glucose (g/L)	Levoglucosan carbon fraction	Glucose carbon fraction
Bio-oil extract	17.225	7.9	0	0.20	0.00	8.9	7.15	0	0.36	0.00
Neutralized hydrolyzate	14.78	2.75	3.8	0.08	0.10	8.25	1.05	3.91	0.06	0.19
Molar Yield			0.43			Molar Yield		0.49		

Table 2. Acid washed bio oil extractions

	ACID WASHED BIO-OIL									
	Cold Water Extraction					Ethyl Acetate Extraction				
	TOC (g/L)	Levoglucosan (g /L)	Glucose (g/L)	Levoglucosan carbon fraction	Glucose carbon fraction	TOC (g/L)	Levoglucosan (g /L)	Glucose (g/L)	Levoglucosan carbon fraction	Glucose carbon fraction
Bio-oil extract	46.9	44.6	0.8	0.42	0.00	41.3	44.5	0	0.48	0.00
Neutralized hydrolyzate	38.5	1	41.8	0.01	0.43	36.7	1.32	43.4	0.02	0.47
Molar Yield			0.84			Molar Yield		0.88		

Results

After water extraction



After ethyl acetate extraction

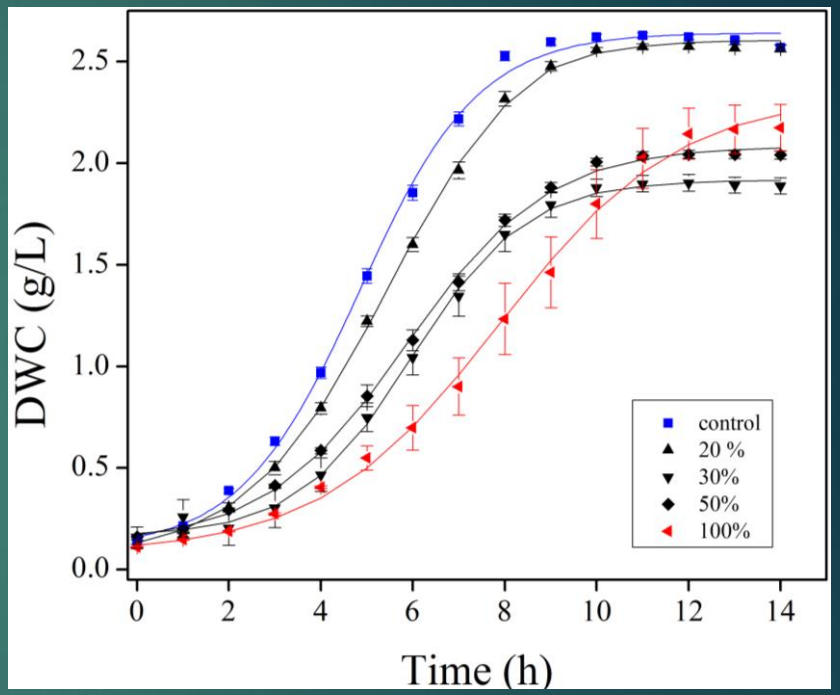


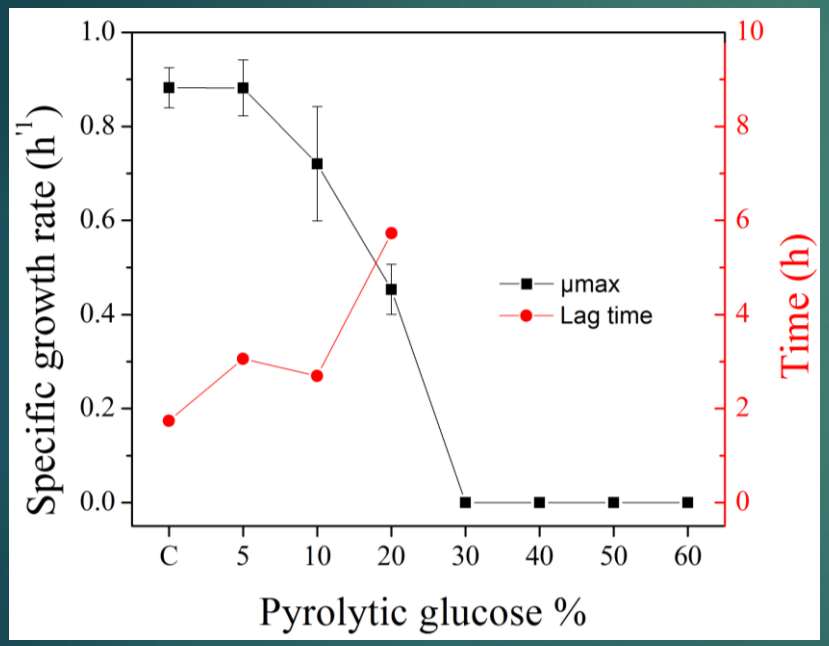
Figure 1. Fermentability test of the extracts obtained from acid washed bio-oil

- Water extraction is not sufficient to extract the soluble inhibitory compounds
- Further ethyl acetate extraction helps to increase cell density

Results

Fermentation Parameters

After water extraction



After ethyl acetate extraction

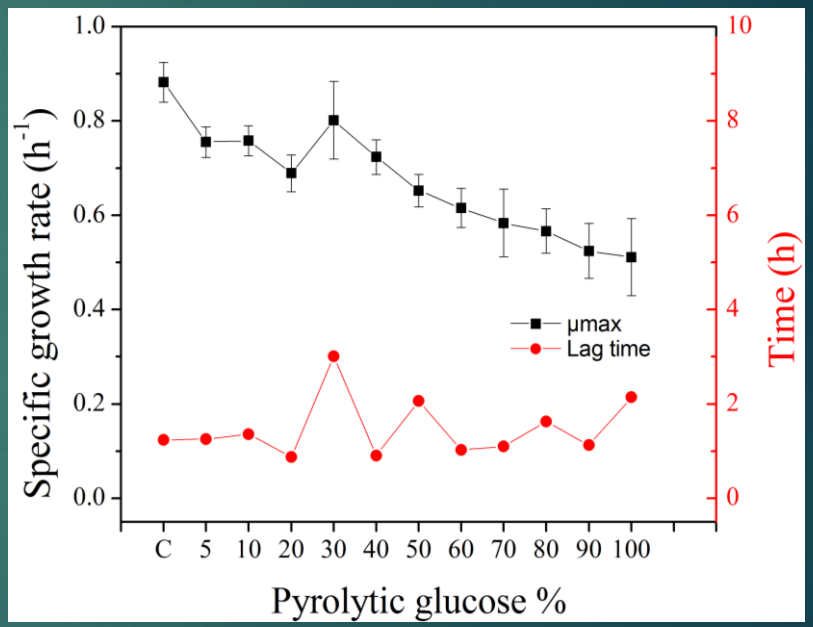


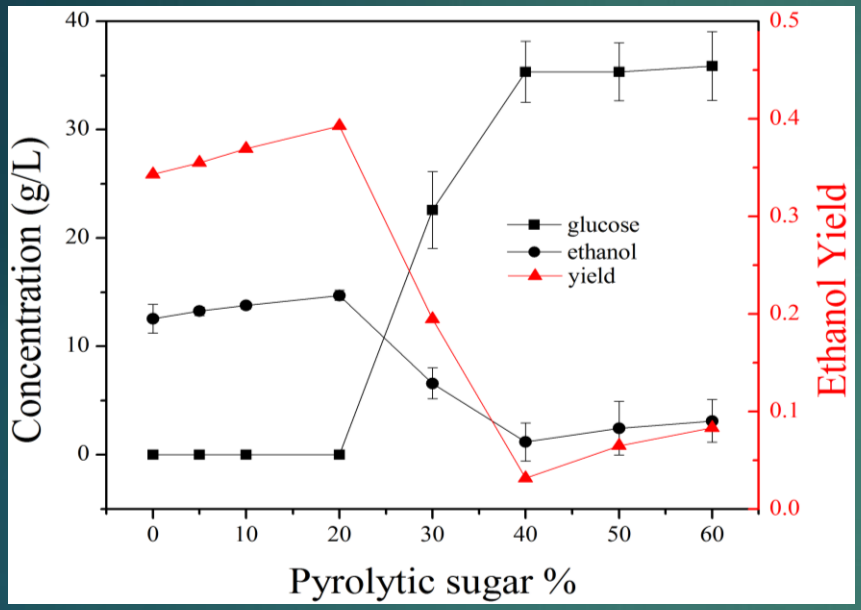
Figure 2. Lag time and specific growth rate in pyrolysis extract hydrolyzate fermentation

- Specific growth rate decreases with increasing pyrolytic sugar content.
- Lag time decreased in the ethyl acetate extracted fermentation

Results

Water extract fermentation products

Ethyl acetate extracted fermentation products



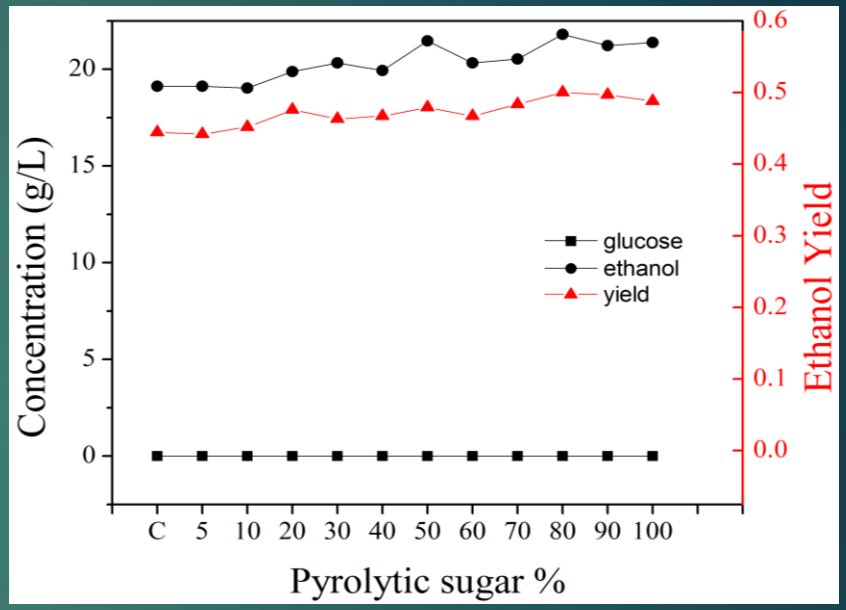


Figure 3. Glucose and ethanol concentration after fermentation is completed. Ethanol yield showed in red

- Increasing the pyrolytic sugar content impacts heavily cell growth hence the productivity.
- When water extract is fermented, only 20%of it can be co-feeded with fresh YPG media.

Conclusion

- Cell density is not directly correlated with ethanol yield
- Neutralization of the hydrolyzate helps removing inhibitory compounds
- Removing left over soluble phenolics via ethyl acetate extraction increases the fermentability of the extract to 100%
- Assay indicates to be a potential process to assess Pyrolysis oil fermentability
- Scale up
- Moving towards other fuels production, like butanol

Acknowledgements

University of Twente
Enschede - The Netherlands

Western Engineering

NSERC CRSNG

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Thank you for listening!

Questions?

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