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

![Levoglucosan hydrolysis to glucose](image)

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 methodology for pyrolysis oil fermentability assessment
Methodology

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

**Upgrading**
- Cold Water extraction
  - Precipitates insoluble lignin
- Ethyl acetate extraction
  - Removes soluble growth inhibitory compounds
- Hydrolysis & Neutralization
  - Precipitates any left acidic compounds

**Bioprocessing**
- Fermentation
  - Transforms pyrolytic sugar into ethanol
Results

Table 1. Non-Acid washed bio oil extractions

<table>
<thead>
<tr>
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<th>Cold Water Extraction</th>
<th>Ethyl Acetate Extraction</th>
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<tbody>
<tr>
<td></td>
<td>TOC (g/L)</td>
<td>Levoglucosan (g/L)</td>
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<tr>
<td>Bio-oil extract</td>
<td>17.225</td>
<td>7.9</td>
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<tr>
<td>Neutralized hydrolyzate</td>
<td>14.78</td>
<td>2.75</td>
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<tr>
<td>Molar Yield</td>
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<td></td>
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</table>

Table 2. Acid washed bio oil extractions

<table>
<thead>
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<th>Cold Water Extraction</th>
<th>Ethyl Acetate Extraction</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>TOC (g/L)</td>
<td>Levoglucosan (g/L)</td>
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<tr>
<td>Bio-oil extract</td>
<td>46.9</td>
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<td>Neutralized hydrolyzate</td>
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<td>Molar Yield</td>
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<td>0.84</td>
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</table>
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-fed with fresh YPG media.
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
Thank you for listening!

Questions?

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References


