Sugar Production from Recycled Wood Wastes via Enzymatic Hydrolysis

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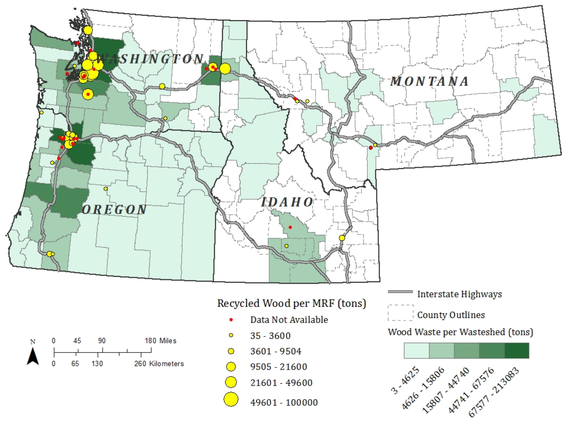
Introduction

Within our MSW, wood wastes from construction and demolition (C&D) streams offer a significant amount of consistent feedstock for a biorefinery operation. However, for this material to be considered, the yield of sugars and the potential for enzymatic inhibitors need to be addressed.

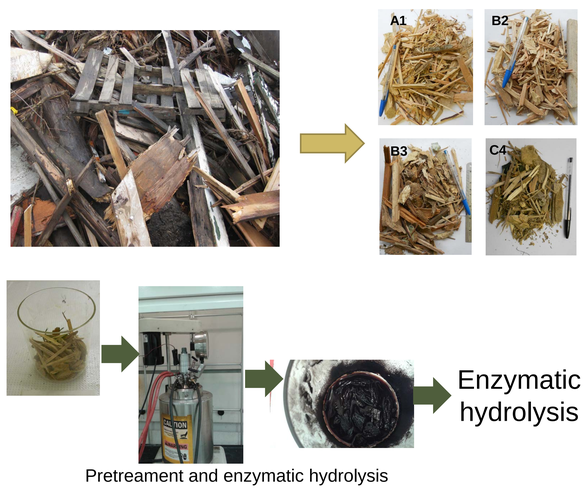
Current markets for these materials are often hog fuel and other low-value applications. Where wood composite and paper mills are within



Objective

Our objectives were to collect representative wood waste samples from NARA regional Material Recycling Facility's (MRFs) and determine their sugar yield and identify potential contaminants that may hinder the Biojet fuel process.

The SPORL pretreatement process was used, followed by enzymatic hydrolysis to sugars using CTec2 and HTec2 enzymes.



Pretreament and enzymatic hydrolysis

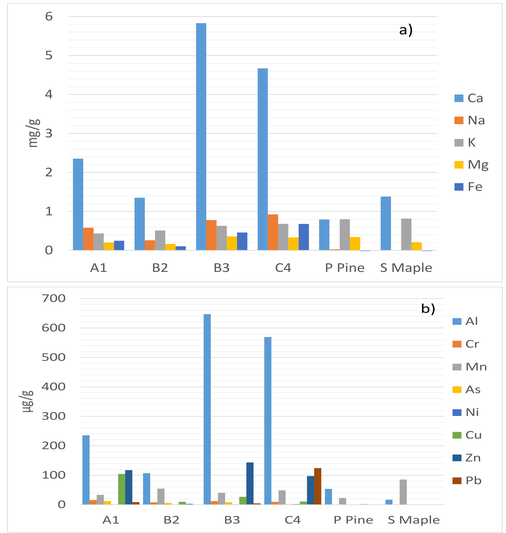
Feedstock Characterization

- *Inductively Coupled Plasma – Mass Spectometry (ICP-MS)* – Alklines and metal concentrations
- Ash content through *ASTM D1102 (550C)*
- *Thermal Gravimetric Analysis (TGA)* - volatiles and fixed carbon

Proximate composition of the incoming materials

Sample	Ash (%)	Volatiles (%)	Fixed Carbon (%)
A1	1.21±0.10	79.38	19.46
B2	0.83±0.14	81.22	18.14
B3	10.08±1.69*	79.94	16.67
C4	2.01±0.18	78.44	19.03
Ponderosa pine	0.51	77.76	21.73
Sugar maple	0.55	83.32	16.13

* Ash content for B3 reduced to 3.3% after screening



ICP-MS results showing content of alkalines and metals in the WWR samples (as received). Ponderosa pine and sugar maple have been added for comparison purposes only.

Preparation for pretreatment

- Materials screened for metals and large contaminates
- Screened fractions passing through 25mm and retained in 12.5mm screens utilized

Pretreatment procedure

- Acid solution to wood: 3:1
- SPORL process – 165C for 75min
- Solution pH 1.73

Enzymatic Hydrolysis

- Pretreated solids washed and dried (70 ºC for 24 hrs) and knife milled through 40 mesh screen
- Treated biomass mixed in solution with HTec-2 and CTec-2 enzymes, shaken at 200rpm and 50C for 72 hrs

Analytical methods of Ion Chromotography (IC) and high performance liquid chromatography (HPLC) were used to assess sugars and contaminants (furans), respectively

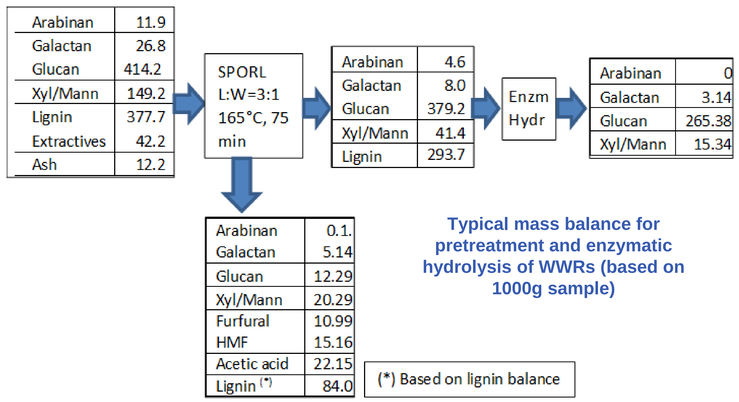
Carbohydrate levels of pretreated biomass

	A1 (%)	B2 (%)	B3 (%)	C4 (%)
Arabinan	0.80 (38.5) (**)	0.00	0.00	0.00
Galactan	1.40 (29.7)	0.44 (9.8)	1.23 (38.1)	1.22 (35.9)
Glucan	66.66 (91.5)	58.80 (85.1)	58.53 (82.3)	58.47 (78.5)
Xylan/Mannan	7.28 (27.8)	6.67 (25.7)	8.82 (35.7)	8.29 (32.2)
Total carbohydrates	**76.1**	**65.9**	**68.6**	**68.0**
Total carbohydrates recovery (%) (*)	95.4	82.4	87.3	82.5
Lignin	28.1	27.8	25.4	27.3

(*) Refers to the ratio, in percent, of the carbohydrates in pretreated materials to the carbohydrates in the corresponding feedstocks.
(**) The value in parenthesis refers to the percentage recovery of the corresponding sugar.

Sugar and inhibitor levels in the hydrolysate (pretreatment liquor)

Sugar	A1 (%)	B2 (%)	B3 (%)	C4 (%)
Arabinose	1.1	1.9	1.8	1.1
Galactose	19.2	7.0	9.0	19.6
Glucose	3.0	1.0	1.2	2.1
Xylose/Mannose	13.6	11.6	14.0	10.3
% Recovery in prehydrolysate	**6.29**	**5.33**	**6.11**	**6.21**
Furfural (g/L)	3.67	5.36	3.30	4.31
HMF (g/L)	5.05	7.25	1.74	10.90
Acetic acid (g/L)	7.38	8.30	8.40	8.95
Total furan and AA (g/L)	16.10	20.91	13.43	24.16



Typical mass balance for pretreatment and enzymatic hydrolysis of WWRs (based on 1000g sample)

(*) Based on lignin balance

Conclusions

Technically viable use of C&D waste wood feedstocks for Biojet fuel

- Sugar yields were slightly lower than virgin-clean wood
- Carbohydrate concentrations in pretreated material ranged from 66-76%
- Total sugar yield was 49-60%
- Potential for low costs $20-50/bdt, make C&D waste wood feedstocks very attractive

NARA
Northwest Advanced Renewables Alliance

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