Isolation of High Purity Lignin from Bio-Jet Biorefinery Hydrolysis Residue

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Introduction

Up to this point lignin research has mainly focused on lignin recovered directly from biomass. Our research has taken typical lignin research a step further to characterize high-purity lignin from biofrefinery pretreatment waste residuals.

What is Lignin?

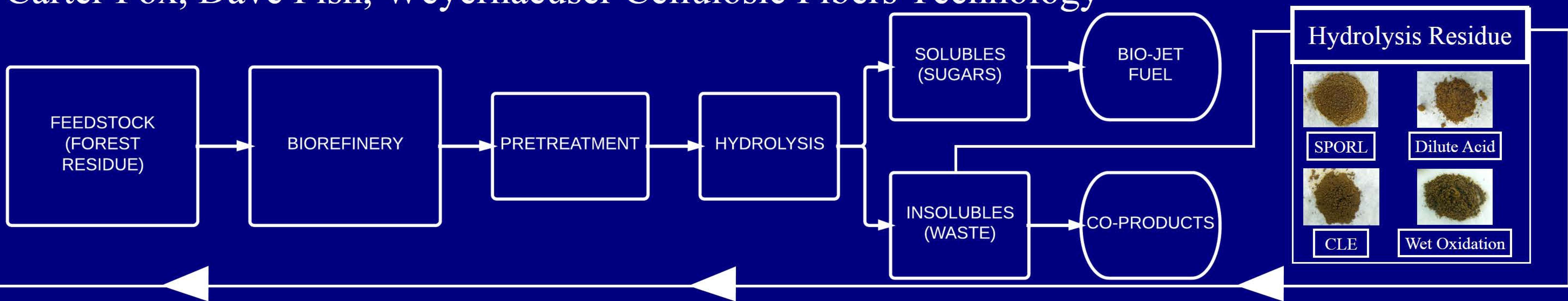
"A complex organic polymer deposited in the cell walls of many plants, making them rigid and woody.
-Oxford Dictionary

Purpose

Our motivation for this research is to characterize high-purity lignin from several different biorefinery pretreatment processes and to find economic ways to isolate high-purity lignin. This analysis will be utilized by the NARA co-product team for further development of co-products to help ensure the economic viability of bio-jet fuel. The additional sale of co-products will generate revenue from process waste products of the biorefinery creating value-added streams.

Methods

To perform this analysis we begin with the insoluble residual solids from four different biomass pretreatment processes: Wet Oxidation, Sulfite Pretreatment to Overcome Recalcitrance of Lignocelluloses (SPORL), Catchlight Energy (CLE) and Dilute Acid. Each pretreatment residual retains its own characteristics within the lignin such as lignin, carbohydrates and ash which is representative in the analysis data. The residuals are then treated with a dioxane/dilute acid and/or aqueous sodium hydroxide process to isolate the high-purity lignin within the residual. The high-purity lignin is then precipitated, collected, dried and weighed. Then analyzed by three techniques discussed in the results.



Isolation Process

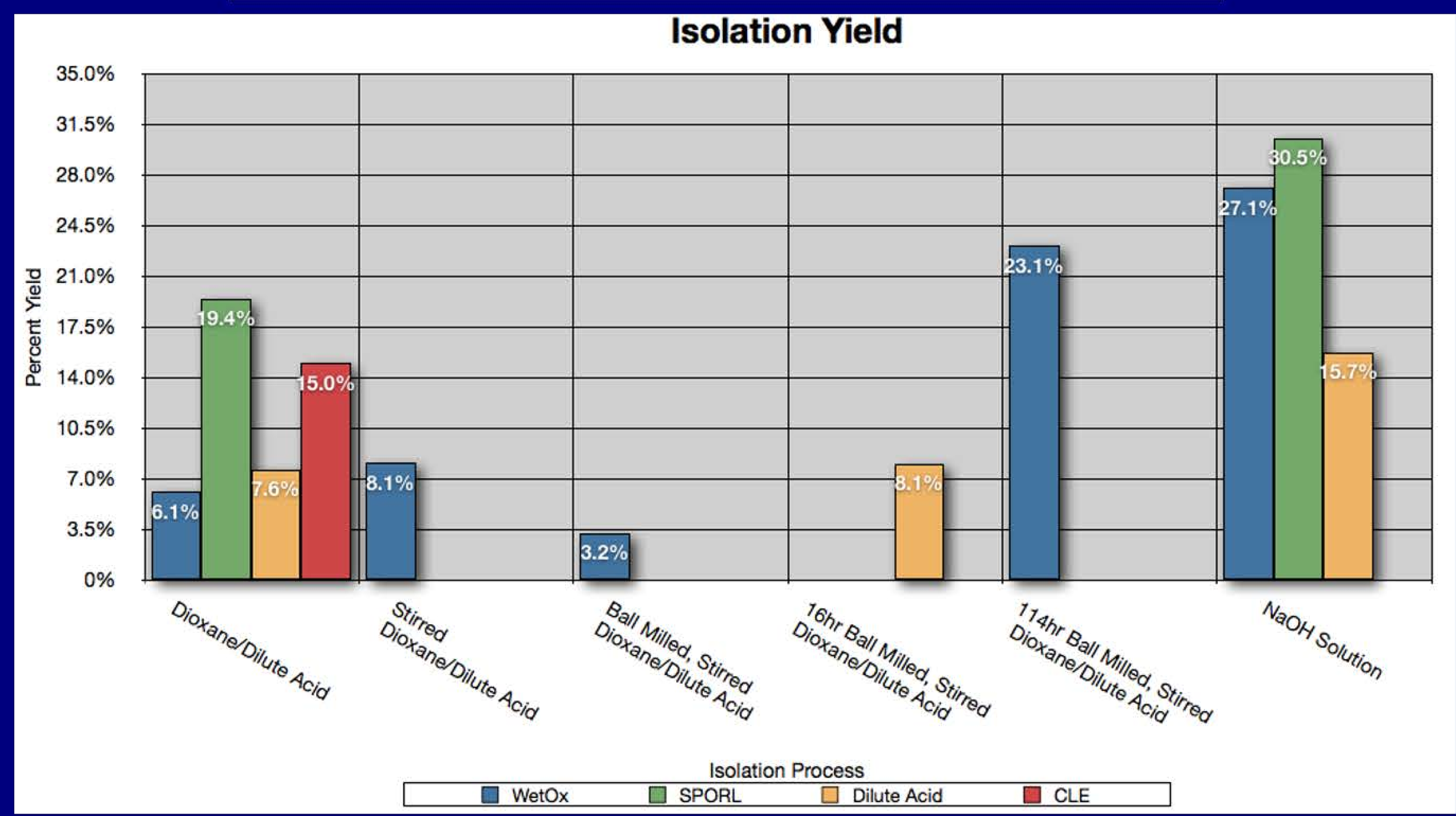
Precipitated Lignin

Analysis Techniques

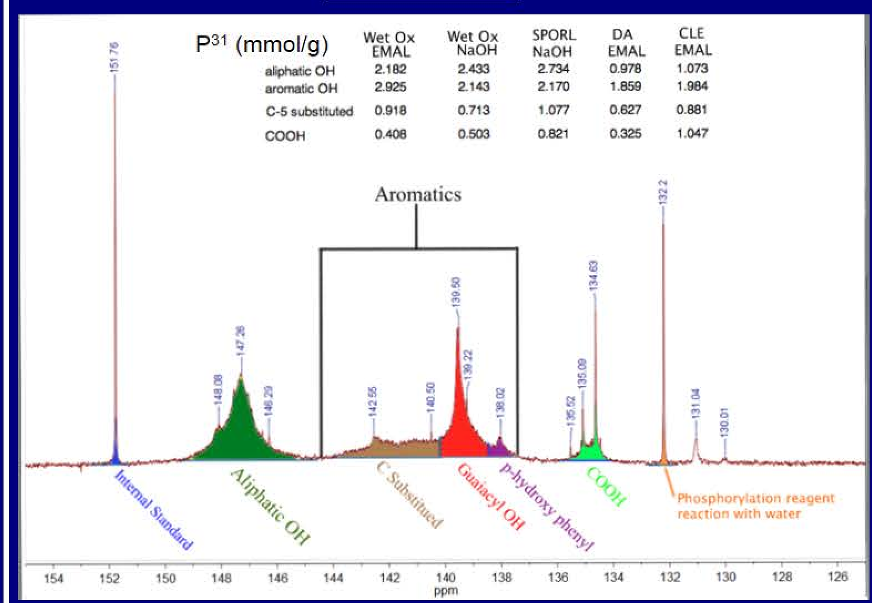
Results

The three major analytical techniques used for characterization of the lignin are Nuclear Magnetic Resonance (NMR), Gel Permeation Chromatography (GPC), and Fourier Transform Infrared Spectroscopy (FTIR). The NMR and FTIR are tools to identify specific chemical functional groups in the lignin, while the GPC determines the molecular weight. This data will be particularly useful in determining which co-products can be economically developed from a biorefinery. The isolation data is important in determining which methods are viable for isolating high-purity lignin.

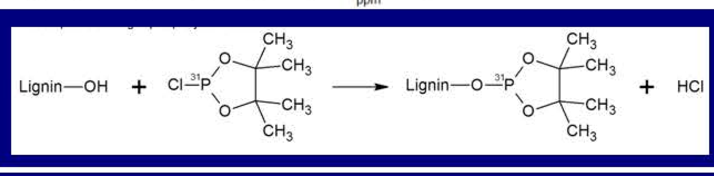
High-Purity Lignin Isolation Data



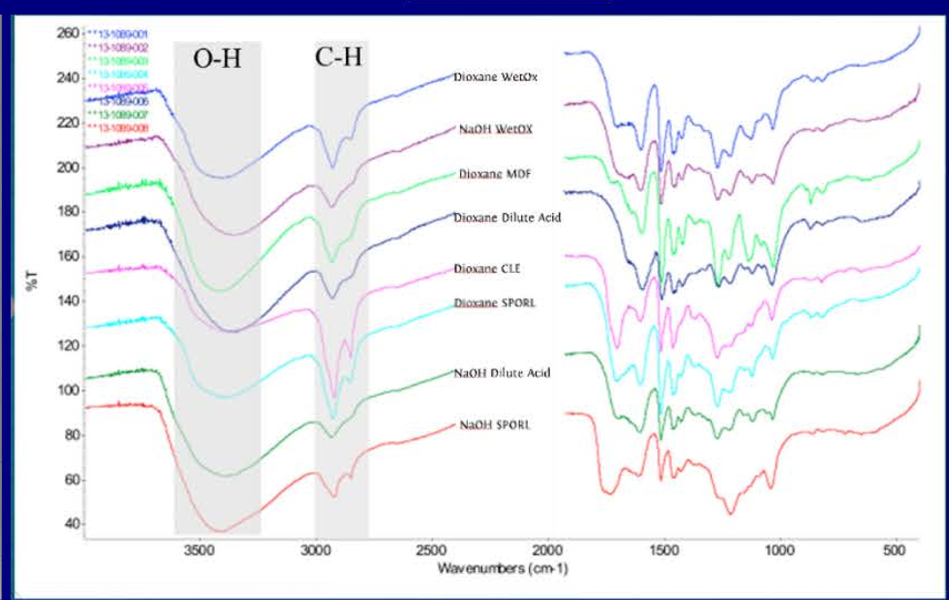
NMR



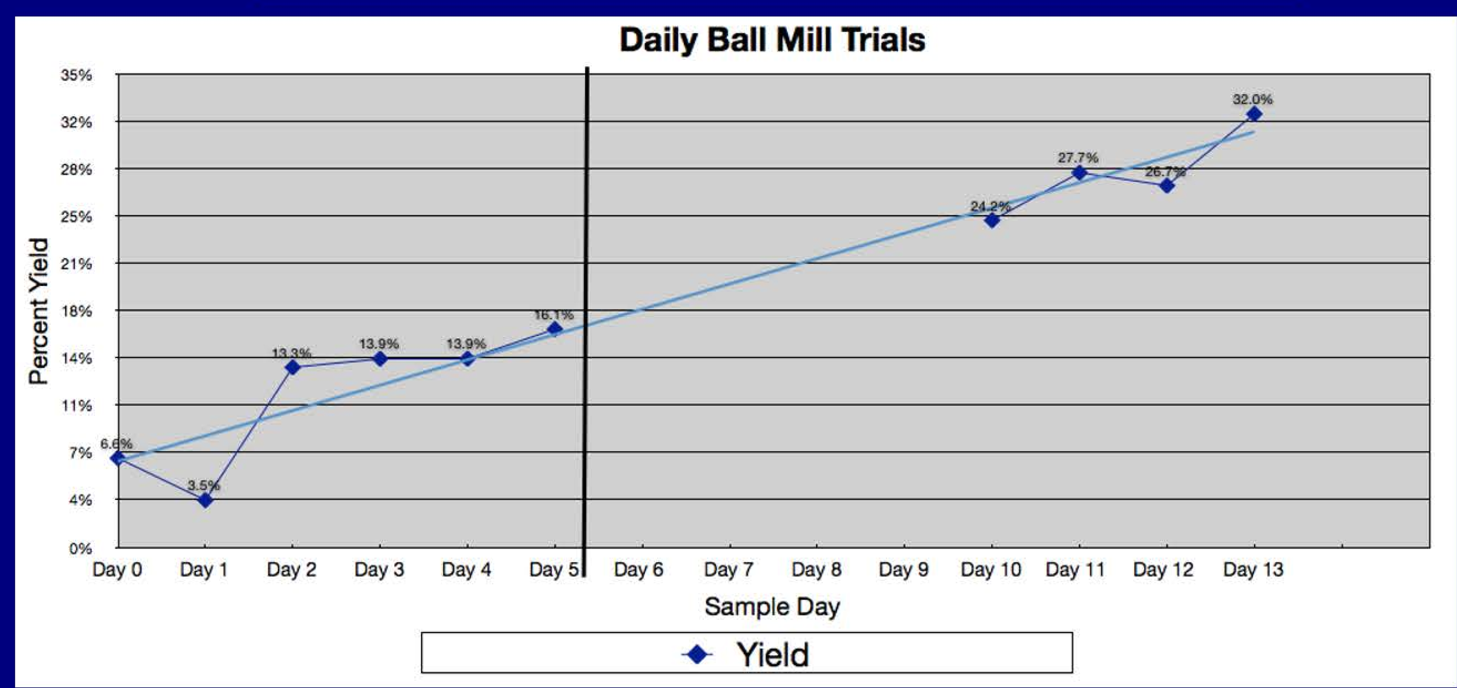
P^{31} (mmol/g)	Wet Ox EMAL	Wet Ox NaOH	SPORL NaOH	DA EMAL	CLE EMAL
aliphatic OH	2.182	2.433	2.734	0.978	1.073
aromatic OH	2.925	2.143	2.170	1.859	1.984
C-5 substituted	0.918	0.713	1.077	0.627	0.881
COOH	0.408	0.503	0.821	0.325	1.047



FTIR



Ball Milling Isolation Data



Future Work

Experiments will be continued by Carter Fox to further characterize high-purity lignin.

Conclusion

- Pretreatment processes change the chemistry of the lignin
- Not all hydrolysis residuals produce high-purity lignin with certain isolation processes
- Further refinement of hydrolysis residue, through ball milling, increases high-purity lignin yield
- Dioxane and NaOH proves to be viable methods for extracting high purity lignin

Acknowledgments

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Weyerhaeuser

NARA Northwest Advanced Renewables Alliance