Enhancing Biocrude Production from Catalytic Fast Pyrolysis of Preprocessed Corn Stover

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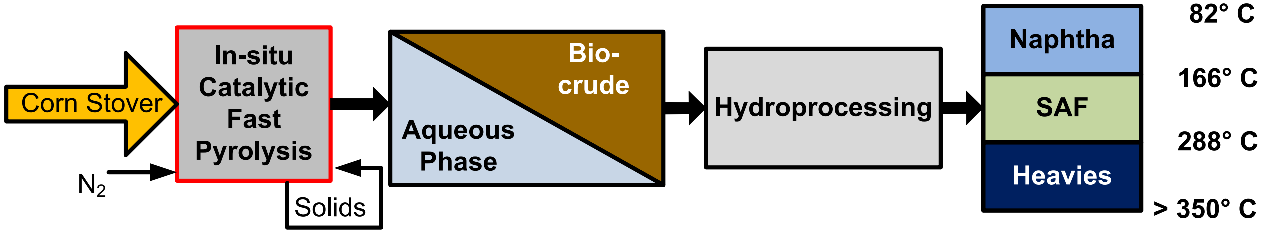
Our mission is to improve the human condition by turning knowledge into practice.

Project Overview

Objective: Validate the performance and yields of pretreated corn stover vs raw corn stover in bench-scale catalytic pyrolysis.

Reducing alkali and alkaline earth metals (AAEMs) in biomass has shown to enhance biocrude quality and improve yields.



R. Kumar, V. Strezov, H. Weldekidan, J. He, S. Singh, T. Kan, B. Dastjerdi,
Lignocellulose biomass pyrolysis for bio-oil production: A review of biomass pre-treatment methods for production of drop-in fuels,
Renewable and Sustainable Energy Reviews, Volume 123, 2020, 109763, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2020.109763.

Corn Stover Pretreatment

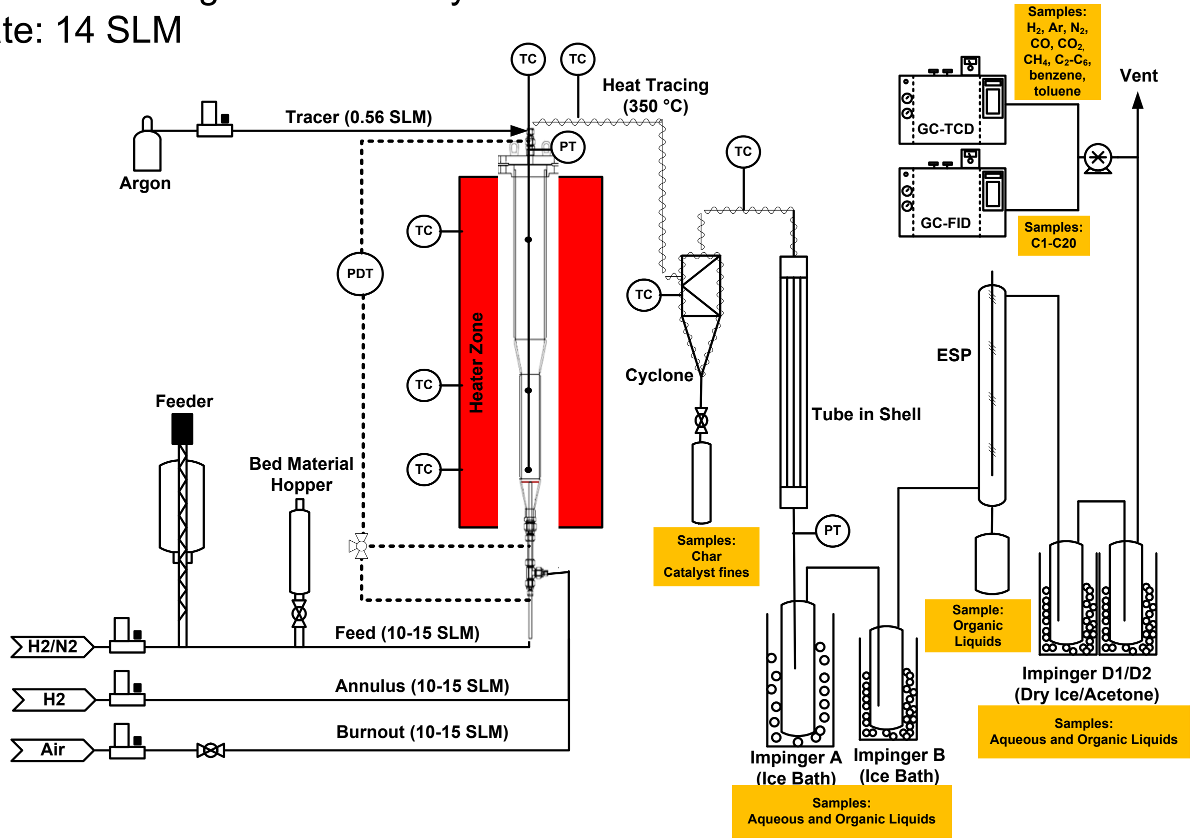
POET's pretreatment results in a 45% reduction in ash content and 70% reduction in AAEM.

Component	Unit	Pine Shavings	Raw Corn Stover	Preprocessed Corn Stover
Ash content	% w/w	0.4	6.6	3.6
Calcium	ppm	821	3,938	2,719
Magnesium	ppm	186	1,349	1,547
Phosphorus	ppm	80	1,005	328
Potassium	ppm	656	10,384	373
Sodium	ppm	15	10	49
AAEM	ppm	1,678	15,680	4,689

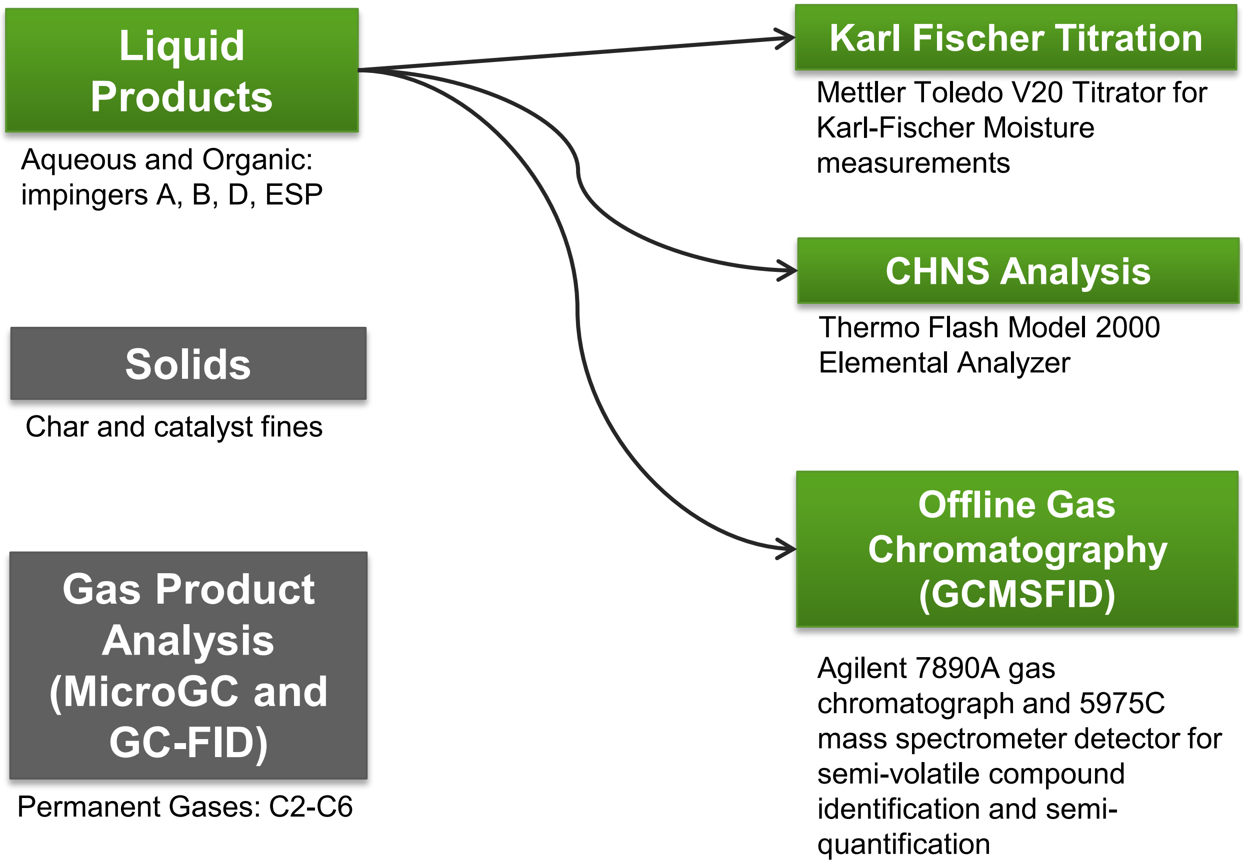
2.5" CFP Reactor

Feedstock: Corn stover
Catalyst: γ-alumina
Biomass Feed Rate: 4-6 g/min
Gas Flow Rate: 14 SLM

Pyrolysis Temp: 450°C
Oxidation Temp: 500 - 550°C
System Pressure: Ambient



Biomass Pyrolysis Analytical Methods



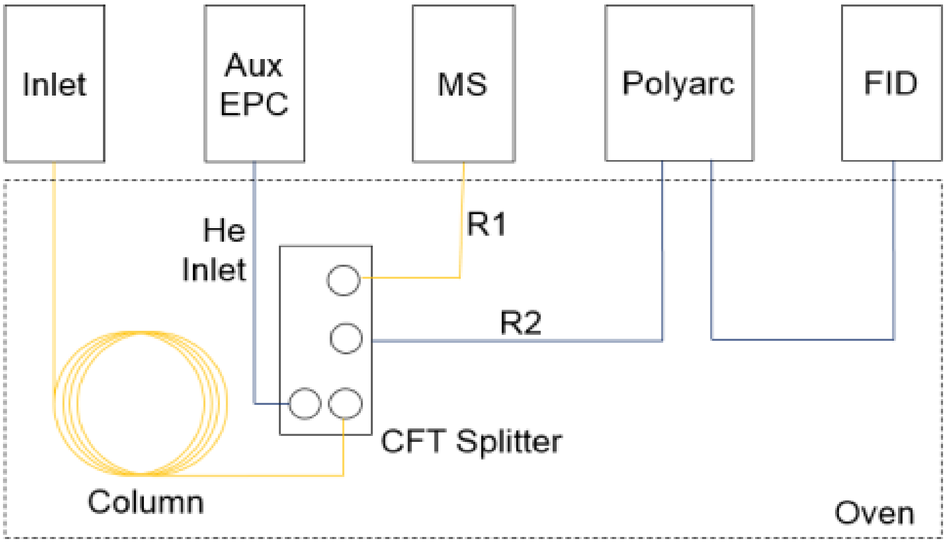
CFP Results – Carbon Yields

(grams C)	Pine	Raw	Pre-processed
Sample ID	**Average**	**Average**	**Average**
Biocrude (g-C/g-C)	**15.4%**	**14.2%**	**21.9%**
Imp A	*6.5%*	*6.7%*	*10.3%*
Imp B	*0.3%*	*0.0%*	*0.0%*
ESP	*8.6%*	*6.6%*	*11.1%*
Imp D	*0.0%*	*1.0%*	*0.5%*
Aqueous (g-C/g-C)	**4.1%**	**3.0%**	**9.3%**
Imp A	*3.7%*	*2.2%*	*7.7%*
Imp B	*0.2%*	*0.4%*	*0.6%*
ESP	*0.0%*	*0.0%*	*0.0%*
Imp D	*0.1%*	*0.5%*	*1.1%*
Solids (g-C/g-C)	**42.2%**	**53.6%**	**45.3%**
Total Gas (g-C/g-C)	**25.3%**	**30.4%**	**28.4%**
C_1-C_3 gas	*4.7%*	*5.1%*	*4.3%*
C_4^+ Gas	*3.7%*	*5.1%*	*4.6%*
CO	*12.7%*	*10.4%*	*11.5%*
CO_2	*4.2%*	*9.9%*	*7.2%*
"Uncondensed"	**1.2%**	**1.8%**	**1.7%**
Ceff	**20.4%**	**21.1%**	**28.1%**
Carbon Balance	**88.3%**	**103.0%**	**105.6%**
Mass Balance	**90.7%**	**98.2%**	**99.4%**
Biocrude wt%O-dry	**28.4%**	**16.7%**	**21.5%**

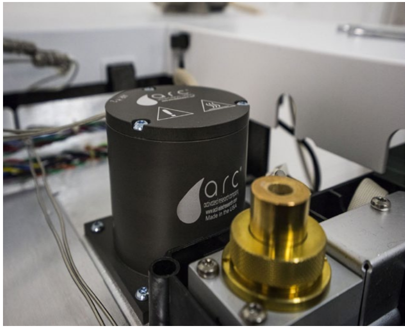
54% increase in organic biocrude yield

15% reduction in solids production

Polyarc™-FID Technology (PA-FID)



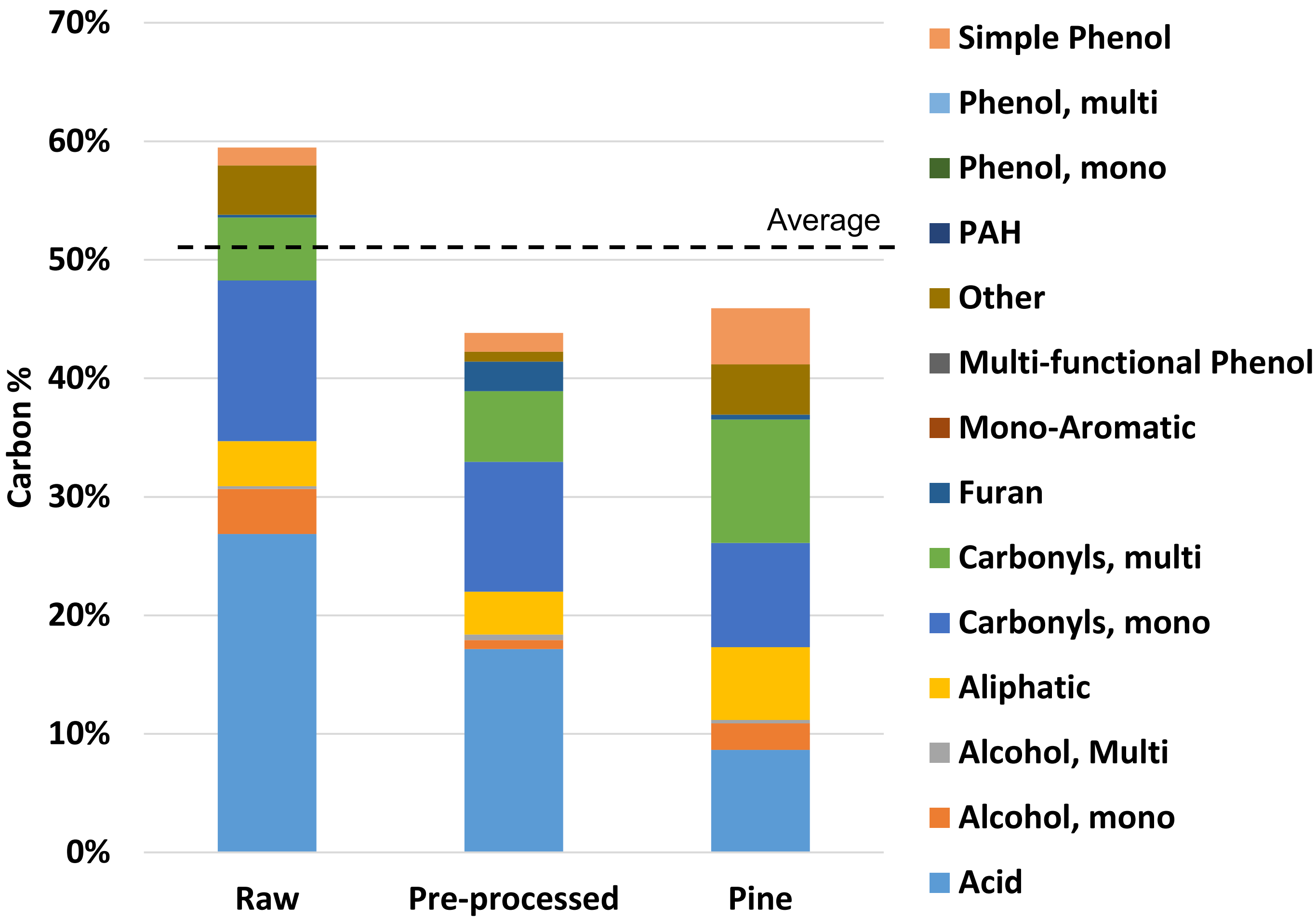
Split configuration with Polyarc/FID - MS



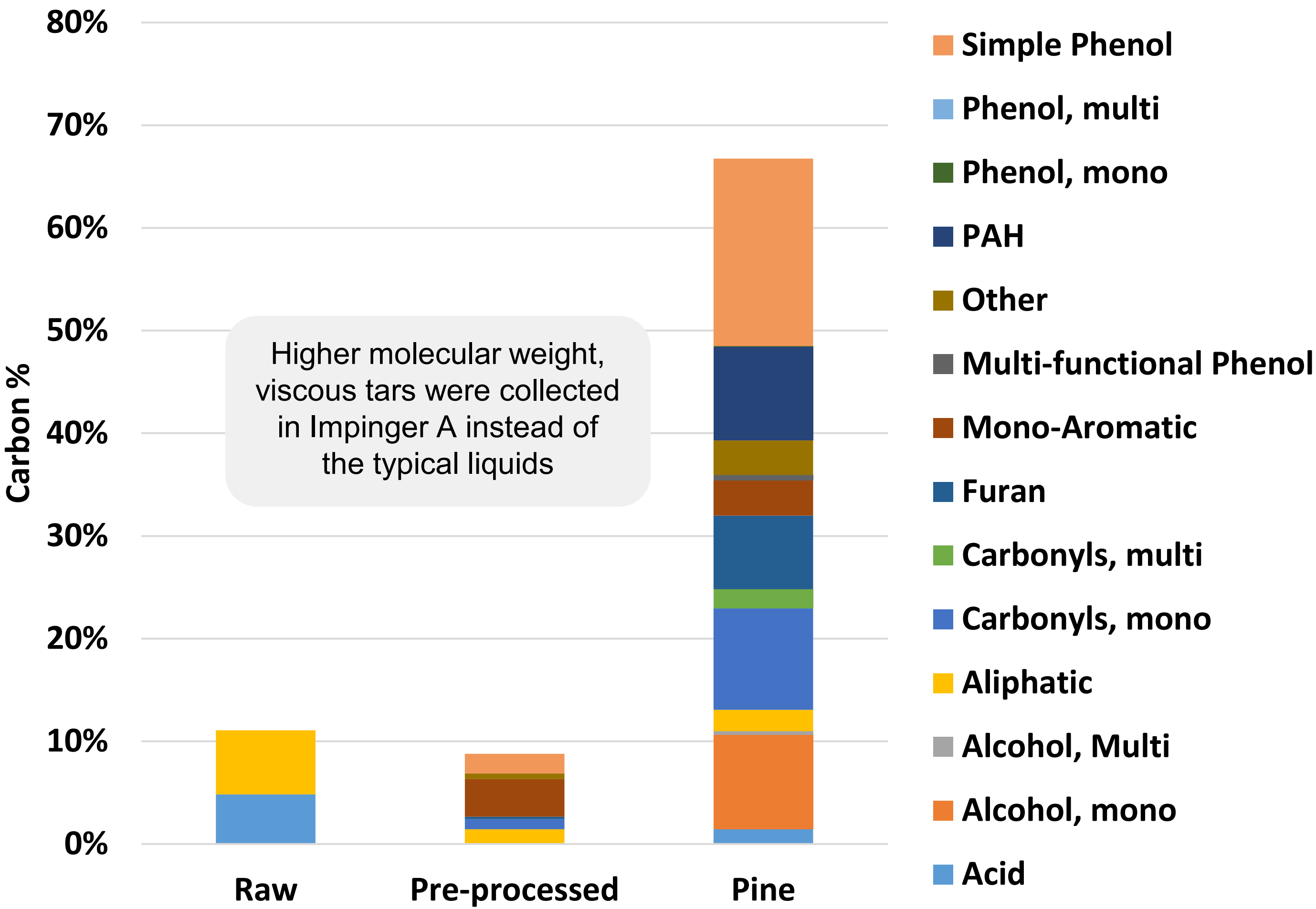
Catalytic Methanation Reactor converts carbon containing species to methane so there is a uniform detector response to quantify volatile organic compounds.

[Polyarc® System | Products | Activated Research Company]

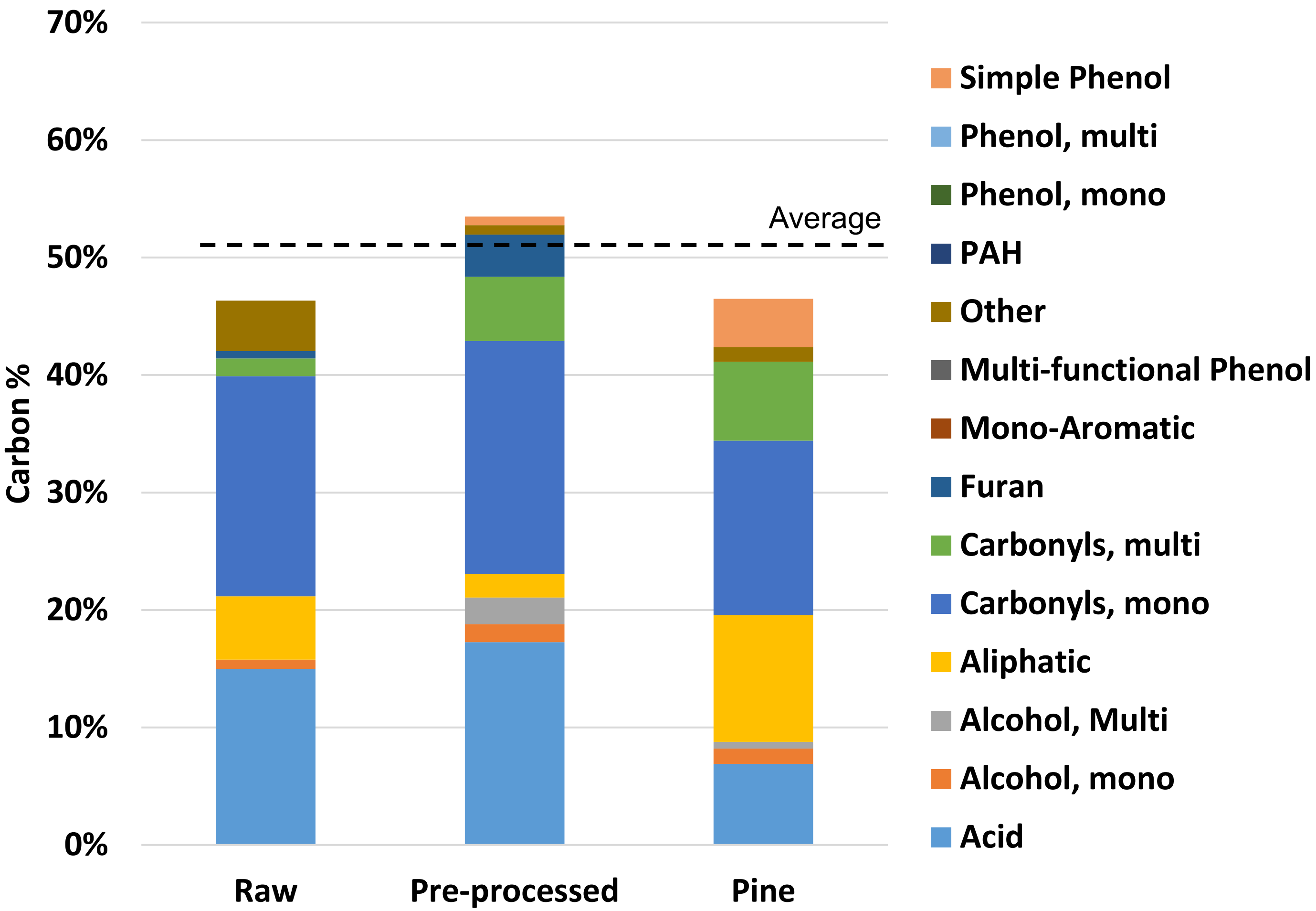
CFP Results – A Aqueous GCMSFID Product Analysis



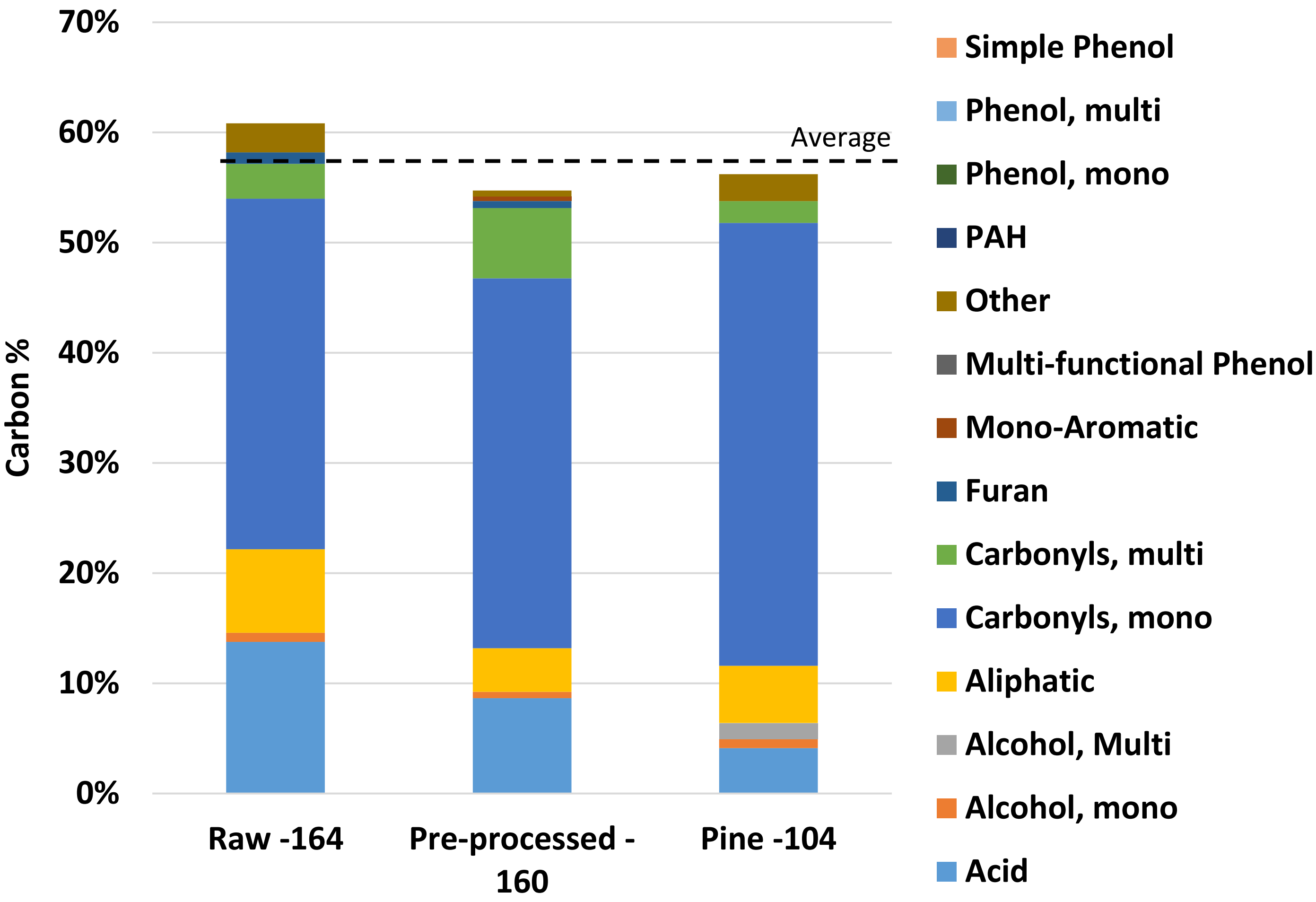
CFP Results – A Organic GCMSFID Product Analysis



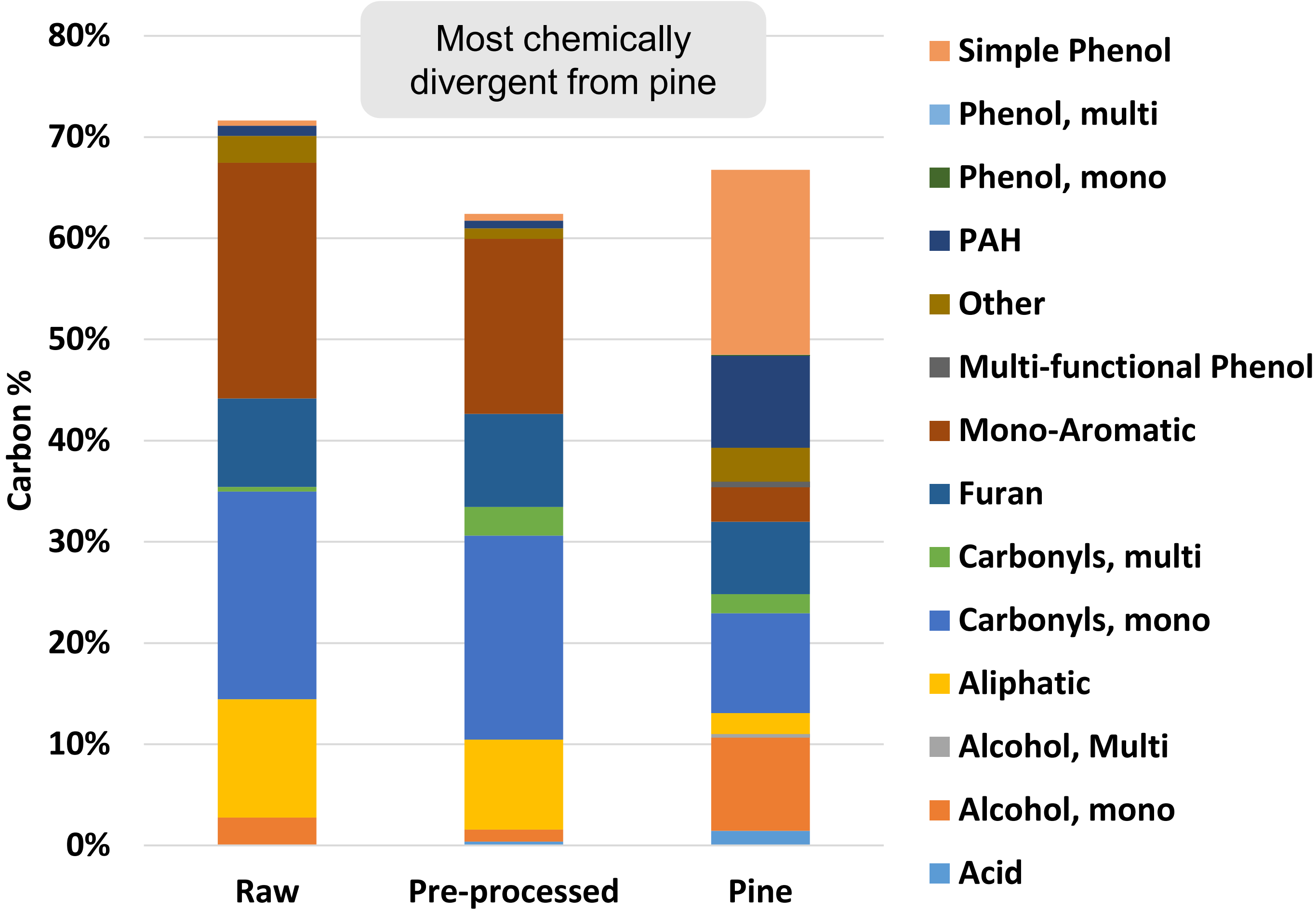
CFP Results – B Aqueous GCMSFID Product Analysis



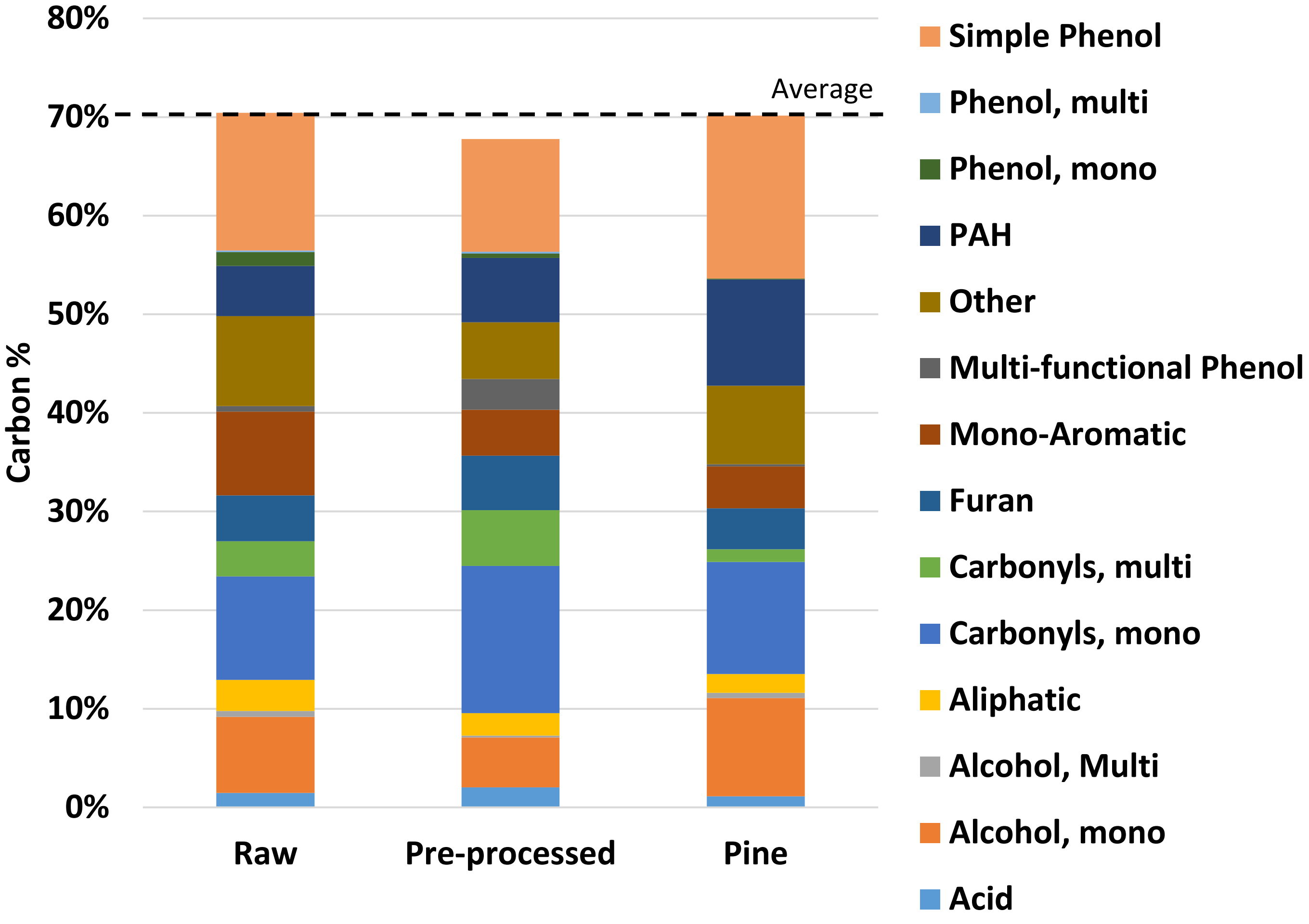
CFP Results – D Aqueous GCMSFID Product Analysis



CFP Results – D Organic GCMSFID Product Analysis



CFP Results – ESP GCMSFID Product Analysis



GCMSFID Product Analysis Summary

Comprehensive GC-MS analysis of biomass CFP liquids is difficult for:

- Low Volatility
- High MW
- Polar Compounds
- Organic Acids

On average, only 50% of the carbon in liquids collected from Impingers A and B is accounted for:

- Higher MW
- Low Volatility

On the contrary, 70% or more of the carbon in the liquids collected from Impinger D and the ESP is accounted for:

- Lower MW
- Higher Volatility

Organic products tend to contain mono-aromatics and phenols

Aqueous products tend to contain mono-carbonyls and acids

Summary and Next Steps

Pre-processed corn stover performance validated in bench-scale testing:

- Increases organic biocrude yield by **54%**
- Decreases ash production by **15%**

Next Steps:

1 TPD Testing → Hydrotreatment → SAF Product

Acknowledgements

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