Evaluation of Storage Effect on the Biomass Conversion to Sugars

Qian He[1], Ling Liang[1], Tina Luong[1], Lynn M. Wendt[2], William A. Smith[2], Chenlin Li[1,3], Todd R. Pray[1], and Ning Sun[1]

[1]Advanced Biofuels(and Bioproducts) Process Demonstration Unit, Lawrence Berkeley National Laboratory, Emeryville, CA;
[2]Biological and Chemical Processing Department, Idaho National Laboratory, Idaho Falls, ID, United States
[3]Department of Biofuels & Renewable Energy Technologies, Idaho National Laboratory, Idaho Falls, ID, United States

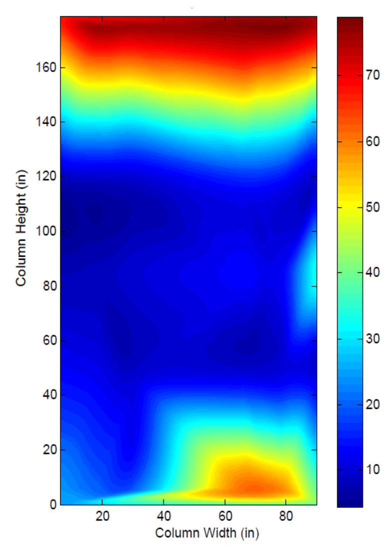
Introduction

Dry matter loss (DML) occurs in high-moisture storage conditions; it remains unclear how storage conditions and degradation impact sugar release and fermentation inhibitor production during conversion. Two feedstocks, switchgrass (SG) and corn stover (CS) were compared using compositional analysis, alkaline pretreatment, and enzymatic saccharification.

Materials and Methods

Feedstocks:

Set 1. Four switchgrass samples (SG) come from field bale storage (18 month storage)



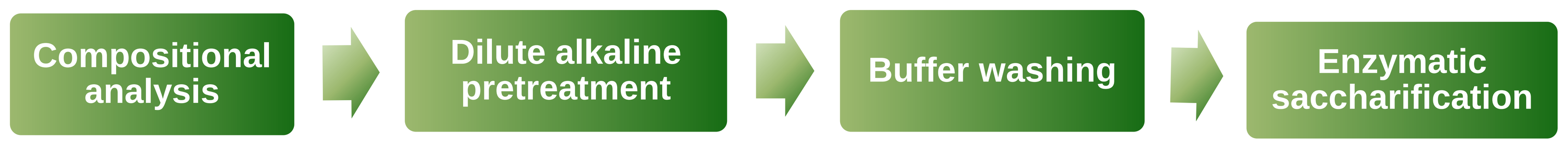
No.	Biomass Type 1	Description
1	SG Raw	before storage
2	SG Top	~30% DML and ~50% moisture content (MC)
3	SG Middle	<12% DML and <20% MC
4	SG Bottom	~20% DML and ~30% MC

Set 2. Corn stover (CS) samples were produced using laboratory storage reactors (3 month storage) ;

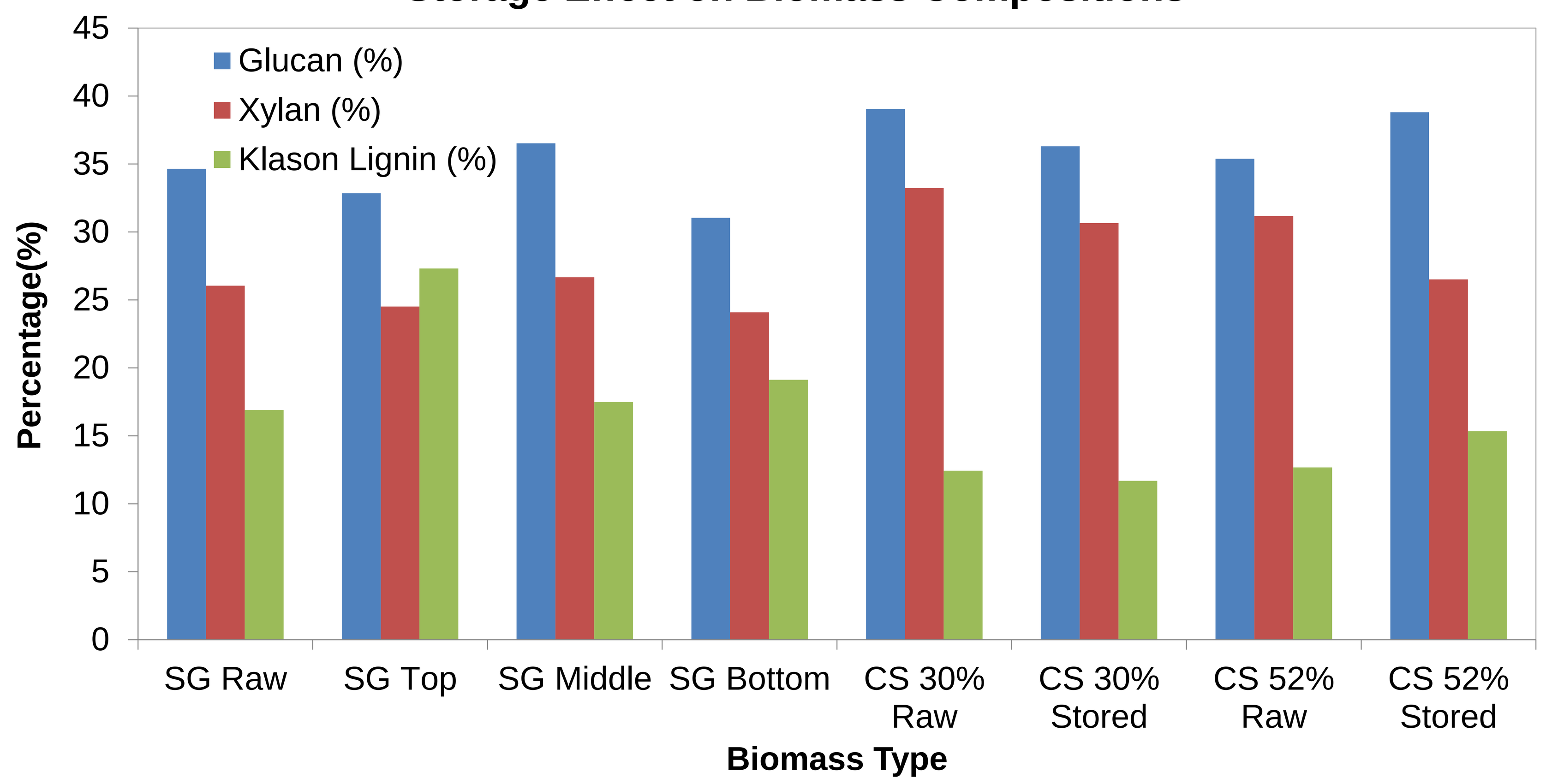

INL storage reactor

No.	Biomass Type 2	Description
5	CS 30% Raw	before storage, 20% MC
6	CS 30% Stored	3 months storage, 12% DML and 20% MC
7	CS 52% Raw	before storage, 52% MC
8	CS 52% Stored	3 months storage, 35% DML and 52% MC

Process Flow Diagram



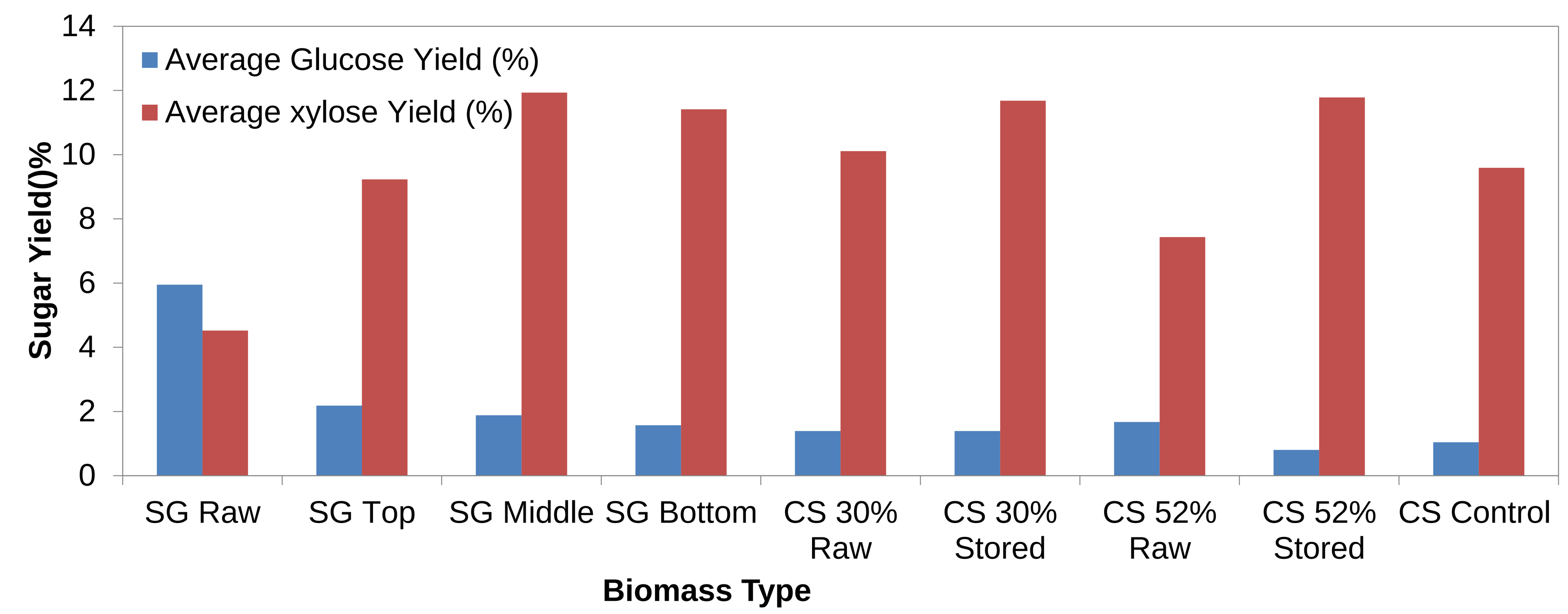
Compositional Analysis



Process Conditions & Results

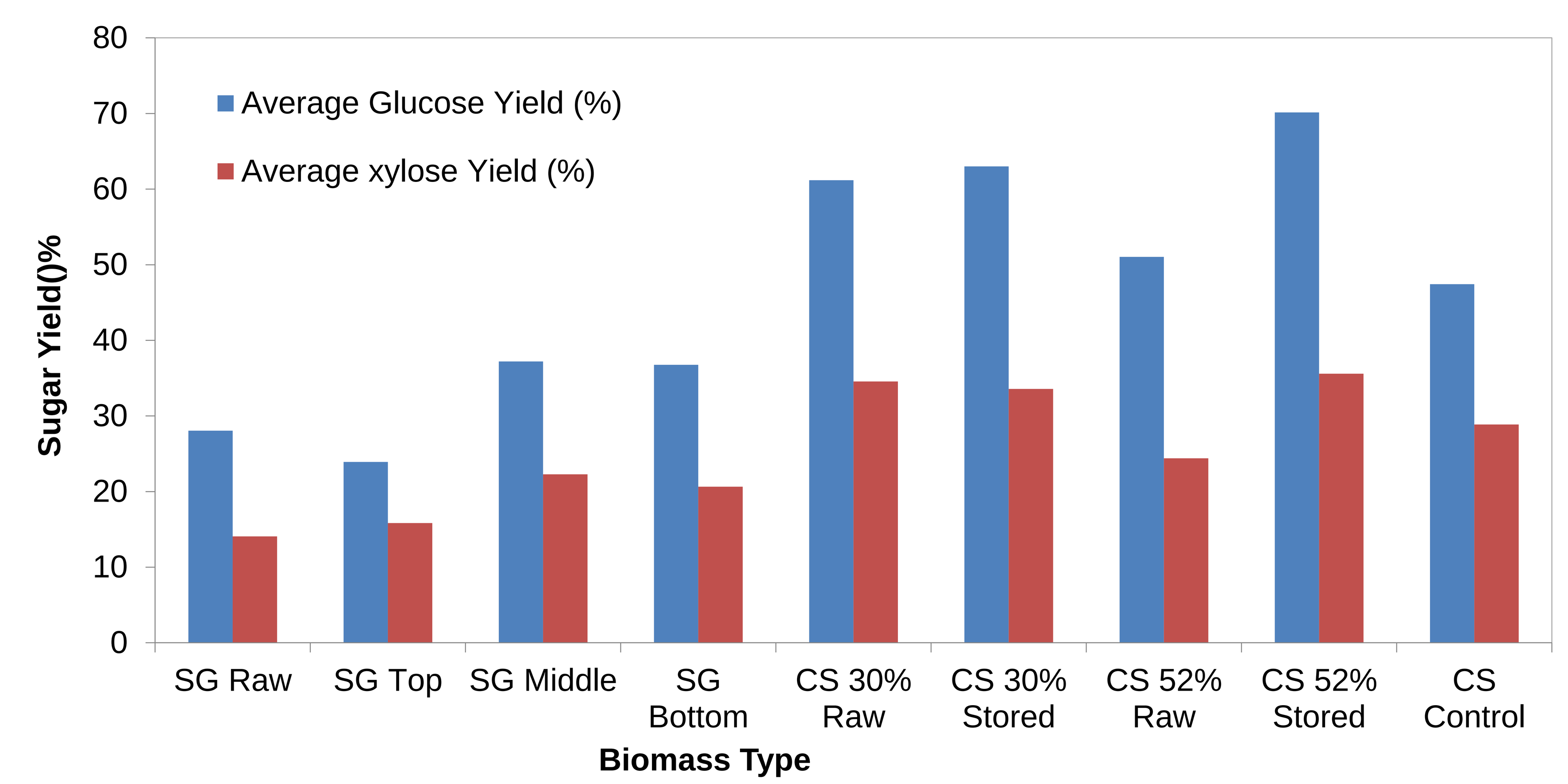
Pretreatment Conditions

Total weight	20 g
Solid loading (w/w)	10%, 2g biomass based on dry weight
Alkaline	0.05g NaOH/g biomass
severity factor	Log Ro=2.07
Temperature and Time	120 ˚ C and 30 min



Saccharification Conditions

Total weight	40 g
Solid loading (w/w)	5%, based on initial biomass (2 g)
Enzyme loading	CS: 20 mg CTec2/g biomass and 2 mg HTec2/g biomass. SG: 25 mg CTec2/g biomass and 2.5 mg HTec2/g biomass
Buffer	50 mM Citric Buffer, pH = 4.8
Sodium Azide (w/w)	0.02% final concentration (400 uL 2% Na_2S)
Temperature and Time	50 ˚ C and 120hr



Analytics

Sugar yields and degradation products such as furfural, HMF, acetic acid, formic acid, levulinic acid, etc in pretreatment liquors and enzymatic hydrolysates were tested using Thermo Ultimate 3000 HPLC Bio-Rad Aminex-87H column. The inhibitors' content is below the lowest detection range(<0.1g/L).

Conclusions

Switchgrass samples:

- Compositional analysis showed glucan and xylan losses were proportional to DML.
- Sugar release was decreased in samples from the top bales, which suffered the greatest DML relative to the starting materials and the other sampled locations.
- Switchgrass samples from the middle and bottom bales produced more sugars compared to the top bales after pretreatment and saccharification.

Corn stover Samples:

- After three months storage, CS with high MC (50% mc) was more reactive with increased glucose (from 51% to 70%) and xylose (from 24% to 35%) yields during saccharificiation.

Both feedstocks:

- Results show the impact of storage-related degradation on feedstock reactivity. Under the tested conditions, SG from the middle and lower bales (10% and 20% DML) and CS with high moisture content (30% DML) achieve higher sugar yields compared to the samples before storage.
- Results suggest that conversion conditions may require optimization to utilize degraded feedstocks efficiently.

Acknowledgements

This work is supported by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Bioenergy Technologies Office, under DOE Idaho Operations Office Contract DE-AC07-05ID14517

Contact:
Qian He
Senior Research Associate
510-495-8039
qianhe@lbl.gov

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy