

# Wheat Straw

REFERENCE MATERIAL

## Pedigree

Location: Jefferson County, ID  
 Class: Classic Hard White  
 Harvested: 2014

Received at INL: 2015  
 Sample Preparation: Ground to pass through a 2-inch sieve using a Vermeer BG480 grinder followed by a 1-inch sieve using a Bliss Hammermill

## Composition

**Table 1.** Chemical composition<sup>a</sup> of Reference Wheat Straw (mean of analyses completed 6/2015 & 7/2015)

%Structural Ash	%Extractable Inorganics	%Structural Protein	%Extractable Protein	%Water Extracted Glucan <sup>b</sup>
5.50	3.37	3.07	1.19	1.56
%Water Extracted Xylan <sup>b</sup>	%Water Extractives Others	%EtOH Extractives	%Lignin	%Glucan
0.92	4.76	2.76	16.27	32.24
%Xylan	%Galactan	%Arabinan <sup>c</sup>	%Acetate	%Total
16.95	1.60	3.17	1.70	95.05

<sup>a</sup>Determined using NREL “Summative Mass Closure” LAP (NREL/TP-510-48087)

<sup>b</sup>Determined by HPLC following an acid hydrolysis of the water extractives

<sup>c</sup>%Arabinan value includes %mannan, because arabinose and mannose co-elute on the HPLC column

## Proximate, Ultimate & Calorimetry

**Table 2.** Proximate, ultimate, and calorific values for Reference Wheat Straw (reported on a dry basis; completed 5/2015)

Proximate <sup>a</sup>			Ultimate <sup>b</sup>					Calorimetry <sup>c</sup>	
%Volatile	%Ash	%Fixed Carbon	%Hydrogen	%Carbon	%Nitrogen	%Oxygen	%Sulfur	HHV	LHV
77.04	9.07	13.89	5.90	45.02	1.06	38.82	0.12	7742	6333

<sup>a</sup>Proximate analysis was done according to ASTM D 5142-09

<sup>b</sup>Ultimate analysis was conducted using a modified ASTM D5373-10 method (Flour and Plant Tissue Method) that uses a slightly different burn profile. Elemental sulfur content was determined using ASTM D4239-10, and oxygen content was determined by difference

<sup>c</sup>Heating values (HHV, LHV) were determined with a calorimeter using ASTM D5865-10

## Elemental Ash

**Table 3.** Elemental ash composition<sup>a</sup> of Reference Wheat Straw (completed 7/2015)

%Al as Al <sub>2</sub> O <sub>3</sub>	%Ca as CaO	%Fe as Fe <sub>2</sub> O <sub>3</sub>	%K as K <sub>2</sub> O	%Mg as MgO	%Mn as MnO	%Na as Na <sub>2</sub> O	%P as P <sub>2</sub> O <sub>5</sub>	%Si as SiO <sub>2</sub>	%Ti as TiO <sub>2</sub>	%S as SO <sub>3</sub>
2.77	10.83	2.99	15.45	2.69	0.07	1.16	2.15	58.16	0.11	2.34

<sup>a</sup>Determined as described in ASTM standards D3174, D3682 and D6349

## Lignin Chemistry

**Table 4.** Lignin chemistry of Reference Wheat Straw (completed 9/2015)

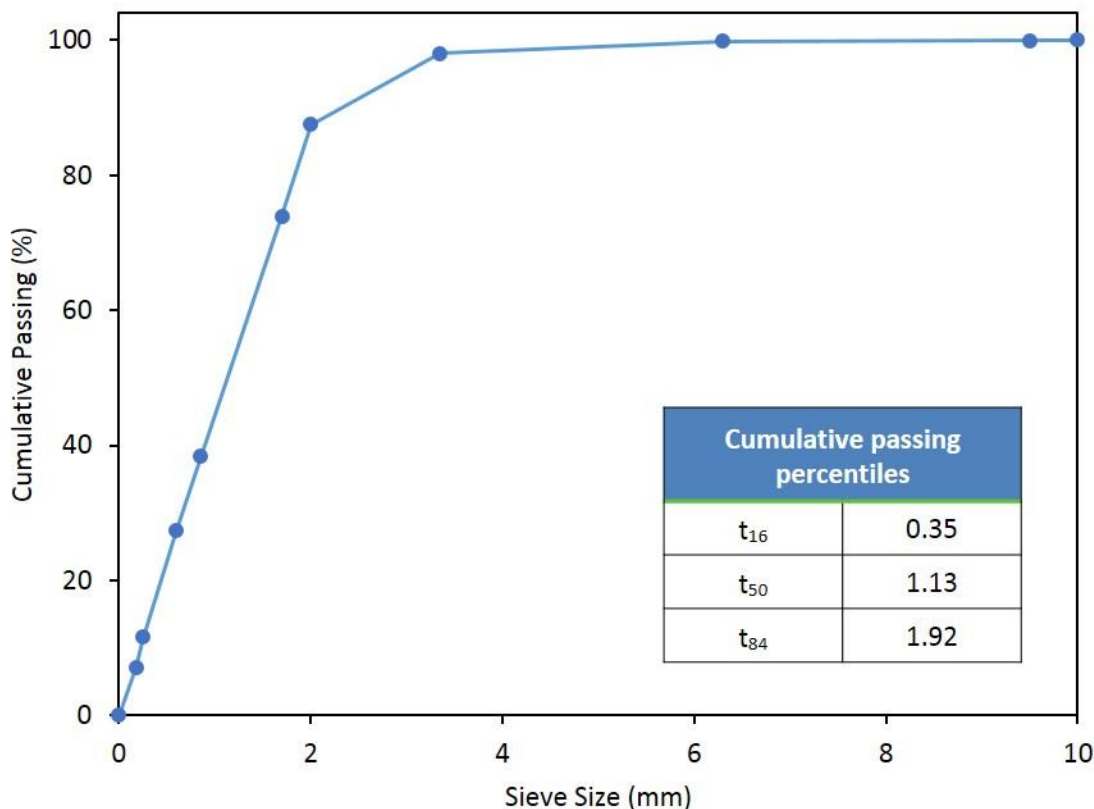
Monolignol Composition <sup>a</sup>			Linkage Analysis <sup>b</sup>				Cinnamate Content <sup>a</sup>	
p-Hydroxyphenyl (H) content (% of total H+G+S)	Guaiacyl (G) content (% of total H+G+S)	Syringyl (S) content (% of total H+G+S)	$\beta$ -aryl ether ( $\beta$ -O-4) (fraction of total) <sup>c</sup>	Phenylcoumaran ( $\beta$ -5/a-O-4) (fraction of total)	Resinol ( $\beta$ - $\beta$ ) (fraction of total)	Dibenzodioxocin (5-5/4-O- $\beta$ ) (fraction of total)	Ferulate content (% of total cinnamates)	p-Coumarate (% of total cinnamates)
3	58	39	89	10	1	0	84	16

<sup>a</sup>Determined by integration of peak volumes of ball-milled whole cell wall samples, swelled in 4:1 DMSO:Py, and analyzed by gel-state HSQC NMR (Mansfield, S. D., et al. (2012) Nature Protocols, 7(9), 1579-1589)

<sup>b</sup>Quantitative data on the different types of chemical linkages between monolignols in a biomass sample. Determined by integrating peak volumes in solution-state HSQC NMR spectra of acetylated whole cell wall samples

<sup>c</sup>Ether bond between the  $\beta$  carbon on one monolignol to the phenolic oxygen on a second monolignol. This is typically the most common linkage found in native lignin samples (Vanholme, R., et al. (2010) Plant Physiol., 153, 895-905)

## Particle Characteristics



**Figure 1.** Cumulative passing percent of 1-inch Reference Wheat Straw determined according to ANSI/ASAE S319.4 using a Ro-Tap test sieve shaker (Model RX-29, W.S. Tyler) and a 15 minute total sieving time (completed 6/2015). The cumulative passing percentile sieve sizes (e.g.,  $t_{16}$ ) were calculated by interpolation and represent theoretical sieve sizes that would retain 16, 50 or 84% of the particles by mass.

## Contact

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