Differences Among and Within Poplar Genotypes for Cellulose, Hemicellulose, and Lignin Concentrations

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Fiber composition (percentages cellulose, hemicellulose, and lignin) is an important aspect of genetic improvement for traditional pulpwood applications and bioenergy technologies such as cellulosic ethanol and pyrolysis oil. Another emerging field is that of nanocellulose materials for specialized applications including selective membranes and self-sharpening surfaces. In this study, we evaluated 12 poplar genotypes harvested from 17 sites to determine percentages of cellulose, hemicellulose, and lignin in biomass sampled from bole (stem at breast height) and crown (stem at two-thirds tree height) components. For cellulose, significant differences were detected among genotypes ($p = 0.0005$) and tree components ($p < 0.0001$), with no significant genotype × component interactions ($p = 0.59$). For both hemicellulose and lignin, significant differences were found for genotypes, components, and genotype × component interactions ($p < 0.0001$ in all cases). In general, mean cellulose concentrations varied from 61.5 to 65.5%, with bole wood concentrations being consistently higher than crown wood by an average of 1.3%. Mean hemicellulose concentrations varied from 17.4 to 24.1%, with bole wood ranging from 1.5% lower to 2.5% higher than crown wood. For lignin, mean concentrations varied from 11.5 to 20.3%; all genotypes had higher concentrations in crown wood, but the magnitude of the differences varied from 0.7 to 3.7%. The potential implications of these results will be discussed in the context of identifying the most suitable materials for traditional and emerging woody biomass applications.

Keywords: cellulosic ethanol, genetics, nanocellulose, *Populus*, pulpwood, pyrolysis oil

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Biography for William Headlee

Bill earned his PhD in forestry from Iowa State University in 2012. He worked as a postdoctoral researcher for the USFS Northern Research Station from 2012 to 2013, and as a USDA-NIFA Postdoctoral Fellow from 2013 to 2015. Since 2015, he has been an assistant professor of biometrics, having a joint appointment with the UA Division of Agriculture Arkansas Forest Resources Center and the University of Arkansas at Monticello School of Forestry & Natural Resources. Among other things, his current research includes evaluating woody crops for the development of nanocellulose materials, as part of the NSF EPSCoR Center for Advanced Surface Engineering project.