**Introduction**

What is pyrolysis?
Pyrolysis is the thermal decomposition of organic matter in the absence of oxygen. Pyrolysis of biomass produces a mixture of compounds called pyrolysis oil or bio-oil that is characteristic of the starting feedstock. This oil can be converted to fuel and other chemicals via catalytic upgrading.

Characterization of Biomass using Pyrolysis
Different types of biomass have different amounts and structures of lignin, cellulose and hemicellulose. Pyrolysis provides a means of quantifying differences in the relative abundance of these polymers within biomass, as well as providing insights into structural variations within the polymers. These differences may be important for comparing genetic mutations in biomass that control pathways for cellulose and lignin production. They may also provide insights regarding the potential of biomass to serve as a feedstock for the production of fuels or chemicals.

**Waste Lignin as a Potential Fuel**
Waste lignin from the pulping process and high-lignin wastes such as olive pits and coconut shells are produced on massive scales world-wide. Pyrolysis of these feedstocks produces bio-oil that could be used as an energy source in poverty-stricken regions of the world.

**Pyrolysis-GC/MS**
Pyrolysis-GC/MS (Py-GC/MS) is a method that utilizes a micro scale pyrolysis unit called a pyroprobe that is attached directly to a GC/MS inlet. Pyrolysis vapors are transferred to the GC/MS without the need for tedious sample preparations. This allows for rapid analysis of the pyrolytic profile of various types of biomass.

**Methods**

**Py-GC/MS Procedure**
- CD3 Analytical 5200 Pyroprobe
- 650°C pyrolysis for 20 sec, He atmosphere
- Agilent 7890 GC with 5975C MS detector

**Calibration of Py-GC/MS for Determination of S:G Ratios in Lignin**
- Pyrolyze sinapyl alcohol, coniferyl alcohol and mixtures of the two monomers in various molar ratios (S:G ratios).
- Establish “marker pyrolylates” for each monomer and add the area % contribution of each of the compounds from the pyrolysis. For the mixtures, divide the sum area % of the S monomer marker compounds by those for the G and plot the “sum area % S:G” vs the molar S:G.
- Repeat using different marker groups to represent each monomer.

**Py-GC/MS Analysis of Biomass and Lignin**
- Energy crops: switchgrass
- High lignin endocarp: coconut shells, peach pits, olive pits, wheat shells
- Mutatation comparisons: arabidopsis, switchgrass, sorghum
- Lignin extracted from the above mentioned biomass via formic acid extraction

**Results and Discussion**

**S:G Ratio of Lignin: Calibration**

**Analysis of Biomass and Lignin**

**Right:** Pyrogram showing the products formed from pyrolysis of switchgrass. Products on the left (lower retention time) are mostly derived from the hemicellulosic fraction whereas products formed from the lignin pyrolysis elute mostly at later retention times. S:G ratio: 0.27

**Conclusions**

- Py-GC/MS was used to analyze sinapyl and coniferyl alcohol pyrolysis products which were then used to calibrate the pyrolysis for molar S:G ratios.
- Pyrolysis of biomass yields products associated with both the hemicellulosic and lignin fractions within the biomass. Variations were observed in the relative product distributions between switchgrass, switchgrass-mutated arabidopsis and drupe endocarp feedstocks as well as the lignin extracted from the biomass. These differences allow classification of the biomass and provide insight as to whether or not a particular feedstock would yield products for specific applications via thermochemical processes.

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**References**


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