Wood Chemistry
PSE 406/ Chem E 470

Lecture 8
Hemicellulose II

Class Agenda

- Arabinogalactans
- Minor Species
  - Glucans
  - Galactans
  - Pectins
- Starch
- Chitin

Arabinogalactan

- Minor hemicellulose except in Larch
  - 10-20% of Larch
  - 0.5-3% of other woods
- DP ~ 220
- Backbone 1→3 β-D-Galactopyranose units
- Branches: Nearly every galactose in backbone attached 1→6 to:
  - β-D-Galactopyranose
  - α-L-Arabinofuranose, β-L-Arabinopyranose
  - β-D-Glucopyranosyluronic acid

R = galactopyranose or L-Arabinofuranose or D-glucopyranosyluronic acid

\[\begin{align*}
3 \beta-D-Galp & \rightarrow 3 \beta-D-Galp \\
\beta-D-Galp & \rightarrow \beta-D-Galp \\
\end{align*}\]
Pectins

- Often described as water soluble extractives, not as hemicelluloses.
- Found in middle lamella and primary cell wall.
- Pectins is a class of several compounds
  - Galactans (discussed on next slide)
  - Galacturonans:
    - Rhamnogalacturonan: \( \alpha_1 \rightarrow 4 \) galacturonic acid backbone with rhamnose 1/8 units, sidechain of galacturonic units
  - Arabinans
    - 90% arabinose linked \( \alpha_1 \rightarrow 5 \)

Galactans

- Very minor component in normal and tension wood. Can be major (10%) component of compression wood.
- Galactan from Tamarack
  - 200-300 \( \beta_1 \rightarrow 4 \) galactopyranose backbone, 1/20 \( \beta_1 \rightarrow 6 \) galacturonic acid
- Rhamnoarabinogalactan
  - Sugar Maple
    - Gal:Ara:Rha (1.7:1:0.2)
- Many other varieties

Glucans

- Glucans are very minor components in wood.
  - The major representatives of this group are starch and callose.
    - Starch
      - Amylose: \( 1 \rightarrow 4 \) \( \alpha \)-D-Glucopyranose
      - Amylopectin: \( 1 \rightarrow 4 \) \( \alpha \)-D-Glucopyranose + \( 1 \rightarrow 6 \) \( \alpha \)-D-Glucopyranose
    - Callose \( 1 \rightarrow 3 \) \( \beta \)-D-Glucopyranose

Callose

- Callose is found in very minor amounts in wood.
  - Small granular hemicelluloses found in a few isolated locations.
- Polymer of \( 1 \rightarrow 3 \) \( \beta \)-D-Glucopyranose
Starch in Plants

- Starch serves as an energy reserve in plants.
  - High concentrations of starch are found in seeds, bulbs, and tubers.
  - Starch can be as high as 70-80% of certain tubers and seeds.
- Wood contains minor amounts of starch in the form of granules in living parenchyma cells.
  - Typical amounts: 0.2-0.6% of total wood
  - Sapwood >3%

Chemical Composition of Starch

- Plants contain two types of starch, linear (helix) amyloses and branched amylopectins.
- The amounts of each of these starch types present is plant dependent.
  - Typical amounts are 25% amylose, 75% amylopectin
  - Mutant species can have from 50-90% amylose

Amylose

- 1→4 α-D-Glucopyranose
- Because of the bonding, this molecule forms a helix
  - It takes 6 glucopyranose units for each turn
  - Addition of iodide to amylose results in a deep blue color. It is believed to be due to a complex of I<sub>5-</sub> within the polyglucoside spiral.
  - Amylose is not water soluble

Amylopectin

- 1→4 α-D-Glucopyranose + 1→6 α D Glucopyranose
- Amylopectin is a branched polymer
  - Branching inhibits helix formation
  - This starch is therefore somewhat water (hot) soluble.
Isolation of Starch

- From tubers (potato, tapioca, etc.)
  - Wet tuber is ground fine.
  - Hot water dissolves soluble fraction of tuber.
  - Insoluble starch is separated from the liquid phase.
  - Starch is dried.

- From corn
  - The skin and the germ (oil-containing portion) are mechanically removed from the kernel after soaking in water. Isolation of the starch is then similar to tubers.

Chitin

- Cellulose-type polymer found in insects and crustaceans; used in making the hard exoskeletons (~30%). Second or third most abundant biopolymer.
  - Second most abundant if you study this kind of thing for a living.
  - Third most if you are a lignin chemist.

Chitin Structure

- Chitin is an amino polysaccharide
  - It is a linear polymer of 1→4-β-D-Glucopyranose units just like cellulose
  - The difference is that the hydroxyl group of C2 has been replaced by an amide group.