Wood Chemistry
PSE 406/Chem E 470

Lecture 3
Wood Sugars

Wood Carbohydrates

- Major Components
  - Hexoses
    - D-Glucose, D-Galactose, D-Mannose
  - Pentoses
    - D-Xylose, L-Arabinose
  - Uronic Acids
    - D-glucuronic Acid, D-Galacturonic Acid

- Minor Components
  - 2 Deoxy Sugars
    - L-Rhamnose, L-Fucose

Wood Sugars: L Arabinose

- Pentose (5 carbons)
- Of the big 5 wood sugars, arabinose is the only one found in the L form.
- Arabinose is a minor wood sugar (0.5-1.5% of wood).

Wood Sugars: D Xylose

- Pentose
- Xylose is the major constituent of xylans (a class of hemicelluloses).
  - 3-8% of softwoods
  - 15-25% of hardwoods
Wood Sugars: D Mannose

- Hexose (6 carbons)
- Mannose is the major constituent of Mannans (a class of hemicelluloses).
  - 7-13% of softwoods
  - 1-4% of hardwoods

Wood Sugars: D Glucose

- Hexose (6 carbons)
- Glucose is the by far the most abundant wood monosaccharide (cellulose). A small amount can also be found in the hemicelluloses (glucosamins)

Wood Sugars: D Galactose

- Hexose (6 carbons)
- Galactose is a minor wood monosaccharide found in certain hemicelluloses
  - 1-6% of softwoods
  - 1-1.5% of hardwoods
Sugar Numbering System

- Aldoses are numbered with the structure drawn vertically starting from the top (the aldehyde group) as the #1 carbon.
- Numbering is important as we learn about ring formation and substitution.

Uronic Acids

- Uronic acids are polyhydroxy carboxylic aldehydes. The acid group is at the #6 carbon.
- Only glucuronic and galacturonic acids exist in wood.
- They are minor components of hemicelluloses.

Uronic Acids II

- In hemicelluloses, glucuronic acid often has a methyl ether at the #4 carbon.
- This is important because this ether linkage is easily broken (during pulping/bleaching) resulting in the release of methanol.

Deoxy Sugars

- Deoxy sugars are very minor constituents of cell wall polymers.
- Notice that the #6 carbon is a CH₃ group instead of an alcohol.
Ketoses

- Ketoses are polyhydroxy ketones. Fructose is the best known example.
- They are found in extremely limited amounts in wood but are found in larger amounts in some plants.
- Ketoses can be formed through alkaline rearrangements of aldoses.

Aldonic acids

- Aldonic acids are polyhydroxy carboxylic acids. The acids group is on the #1 carbon.
- Aldonic acids do not occur naturally in wood.
- They are produced through the acid sulfite treatment of sugars.
  - Xylonic, arabonic, gluconic, galactonic, and mannonic acids.

Alditols

- Do not occur naturally in wood.
- Can be made by microorganisms.
- Made through the reduction of sugars.
- Commercial sweeteners.

The Unloved Pentoses
(not found in wood polymers (D or L))

- D Mannitol
- D Xylitol
- D Ribose
- D Lycose
The Unloved Hexoses
(not found in wood polymers (d or L))

Physical Properties of Sugars

<table>
<thead>
<tr>
<th></th>
<th>Melting Point (°C)</th>
<th>H₂O Solubility (g/100ml)</th>
<th>CH₃OH Sol. (g/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>146</td>
<td>91/100</td>
<td>~1/100</td>
</tr>
<tr>
<td>Mannose</td>
<td>133</td>
<td>250/100</td>
<td>~1/100</td>
</tr>
<tr>
<td>Xylose</td>
<td>143-145</td>
<td>125/100</td>
<td>?</td>
</tr>
<tr>
<td>Fructose</td>
<td>Dec. 103</td>
<td>freely</td>
<td>7/100</td>
</tr>
<tr>
<td>Xyitol</td>
<td>93-94.5</td>
<td>64/100</td>
<td>6/100</td>
</tr>
</tbody>
</table>

CHO
H₂O
CH₂OH