Making Hard Apple Cider

“It is not the cidermaker who makes the cider; the cider makes itself from the apples.” - Claude Jolicoeur.
Note on the word “Cider”

- In North America, “cider” refers to farm-pressed apple juice. “Hard cider” refers to fermented cider.
- In the rest of the world, “cider” refers to fermented apple juice.
Agenda

- 11-12: lecture
- <10 minute break>
Cider Apples
Cider Apple Qualities

- “Cider is traditionally made with one third each of sweet, bittersweet, and sharp apples. The principle characteristics of cider apples which contribute to this classification are the content of phenolic compounds (tannins) and the acidity.”

# Tannins & Acids

<table>
<thead>
<tr>
<th>Type</th>
<th>Tannin %</th>
<th>Acid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td>&lt;0.2%</td>
<td>&lt;0.45%</td>
</tr>
<tr>
<td>Sharp</td>
<td>&lt;0.2%</td>
<td>&gt;0.45%</td>
</tr>
<tr>
<td>Bittersweet</td>
<td>&gt;0.2%</td>
<td>&lt;0.45%</td>
</tr>
<tr>
<td>Bittersharpe</td>
<td>&gt;0.2%</td>
<td>&gt;0.45%</td>
</tr>
</tbody>
</table>
Cider Apple Classifications

Characteristics of 40 apple cultivars

- Bittersweets
- Bittersharps
- Mildsweets
- Sharps

Tannin % vs. Acid %
Tannins

- “A tannin (a.k.a. vegetable tannin, i.e. a type of biomolecule, as opposed to modern synthetic tannin) is an astringent, bitter plant polyphenolic compound that binds to and precipitates proteins and various other organic compounds including amino acids and alkaloids.

- The astringency from the tannins is what causes the dry and puckery feeling in the mouth following the consumption of unripened fruit or red wine. Likewise, the destruction or modification of tannins with time plays an important role in the ripening of fruit and the aging of wine.”

Yeast & Fermentation
Saccharomyces cerevisiae (yeast)

- **Yeast**s are **eukaryotic microorganisms** classified in the **kingdom Fungi**, with 1,500 **species** currently described.

**Saccharomyces** (Latinized Greek)
- Saccharo: sugar
- Myces: bacteria or fungi

**Cerevisiae**: (Latin)
- “of beer”

**Scientific classification**
- Kingdom: Fungi
- Phylum: Ascomycota
- Subphylum: Saccharomycotina
- Class: Saccharomycetes
- Order: Saccharomycetales
- Family: Saccharomycetaceae
- Genus: **Saccharomyces**
- Species: **S. cerevisiae**
Simplified tree showing fungi in relation to other kingdoms

Yeast + Glucose (- Oxygen) = Alcohol

“Yeast are **facultative organisms** - which means that they can live **with or without oxygen**. In a normal fermentation cycle they use oxygen at the start, then continue to thrive once it has all been used up. It is only during the anaerobic (without oxygen) period that they produce ethanol.” - [http://homedistiller.org/ferment.htm](http://homedistiller.org/ferment.htm)
What if oxygen is added?

“If the yeast have oxygen, they'll switch from anaerobic fermentation to aerobic respiration, resulting in vinegar.”

Carbon footprint of cider vs. beer

- Cider is made from fruit juice that naturally contains glucose.
- No cooking or heating is required.

\[
\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{CO}_2 + 2\text{C}_2\text{H}_5\text{OH} + \text{energy}
\]

- glucose
- carbon dioxide
- ethanol
Beer fermentation: heat required

- Beer is made from starchy grains.
- The starch needs to be converted to sugar before it can then be fermented. This extra processing often increases the carbon footprint of the resulting product.
  - roasting grain to stop germination
  - heating grain with water to extract sugar (malt).
Sugar & alcohol content over time

- Circles
  - yeast population
- Triangles
  - C02 emission
- Squares
  - Alcohol concentration
Variability in yeasts

- Many factors affect how the yeast will ferment, causing variability in the end product
  - “flavor profile” of the yeast itself (neutral vs. full-bodied)
  - Temperature of fermentation
  - Sugar concentration (at the start)
    - Some yeasts cannot tolerate high sugar concentrations
  - Alcohol concentration (at the end)
    - Yeasts cannot live past a certain concentration of alcohol
  - Nutrients present (nitrogen)
- No fermentation? Your yeast is “stuck”. It’s possible to “start over” after a yeast gets stuck.
Measuring sugar & alcohol
Sugar & Alcohol Concentrations

- It is tempting to add lots of sugar at press time to increase the end alcohol content. However, yeast is killed by high concentrations of sugar as well as high concentrations of alcohol. There is a happy medium in which the yeast will flourish – a starting specific gravity of 1060 – 1080.
Hydrometer

- Alcohol has a lower density than water.
- Sugar water has a higher density than distilled water.
- A hydrometer measures the density of a liquid compared to water.
# Specific Gravity & Alcohol Potential

<table>
<thead>
<tr>
<th>Specific Gravity S.G.</th>
<th>Brix</th>
<th>Potential Alcohol By Volume (%)</th>
<th>Pounds and Ounces of Sugar in One U.S. Gallon of Water (lb – oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>0.00</td>
<td>0</td>
<td>0 – 0</td>
</tr>
<tr>
<td>1.005</td>
<td>1.28</td>
<td>0.5</td>
<td>0 – 2</td>
</tr>
<tr>
<td>1.010</td>
<td>2.56</td>
<td>0.9</td>
<td>0 – 4</td>
</tr>
<tr>
<td>1.015</td>
<td>3.82</td>
<td>1.6</td>
<td>0 – 6</td>
</tr>
<tr>
<td>1.020</td>
<td>5.08</td>
<td>2.3</td>
<td>0 – 8</td>
</tr>
<tr>
<td>1.025</td>
<td>6.32</td>
<td>3.0</td>
<td>0 – 9</td>
</tr>
<tr>
<td>1.030</td>
<td>7.55</td>
<td>3.7</td>
<td>0 – 11</td>
</tr>
<tr>
<td>1.035</td>
<td>8.77</td>
<td>4.4</td>
<td>0 – 13</td>
</tr>
<tr>
<td>1.040</td>
<td>9.98</td>
<td>5.1</td>
<td>0 – 15</td>
</tr>
<tr>
<td>1.045</td>
<td>11.18</td>
<td>5.8</td>
<td>1 – 0</td>
</tr>
<tr>
<td>1.050</td>
<td>12.37</td>
<td>6.5</td>
<td>1 – 2</td>
</tr>
<tr>
<td>1.055</td>
<td>13.55</td>
<td>7.2</td>
<td>1 – 4</td>
</tr>
<tr>
<td>1.060</td>
<td>14.72</td>
<td>7.8</td>
<td>1 – 6</td>
</tr>
<tr>
<td>1.065</td>
<td>15.88</td>
<td>8.6</td>
<td>1 – 7</td>
</tr>
<tr>
<td>1.070</td>
<td>17.03</td>
<td>9.2</td>
<td>1 – 9</td>
</tr>
<tr>
<td>1.075</td>
<td>18.18</td>
<td>9.9</td>
<td>1 – 10</td>
</tr>
<tr>
<td>1.080</td>
<td>19.31</td>
<td>10.6</td>
<td>1 – 12</td>
</tr>
<tr>
<td>1.085</td>
<td>20.43</td>
<td>11.3</td>
<td>1 – 14</td>
</tr>
<tr>
<td>1.090</td>
<td>21.54</td>
<td>12.0</td>
<td>2 – 0</td>
</tr>
<tr>
<td>1.095</td>
<td>22.65</td>
<td>12.7</td>
<td>2 – 2</td>
</tr>
<tr>
<td>1.100</td>
<td>23.75</td>
<td>13.4</td>
<td>2 – 4</td>
</tr>
<tr>
<td>1.105</td>
<td>24.83</td>
<td>14.1</td>
<td>2 – 5</td>
</tr>
<tr>
<td>1.110</td>
<td>25.91</td>
<td>14.9</td>
<td>2 – 7</td>
</tr>
<tr>
<td>1.115</td>
<td>26.98</td>
<td>15.6</td>
<td>2 – 9</td>
</tr>
<tr>
<td>1.120</td>
<td>28.05</td>
<td>16.3</td>
<td>2 – 11</td>
</tr>
</tbody>
</table>

Excellent basics:

- http://homedistiller.org/ferment.htm
Stuck Fermentations
Why grape wine is so popular

- “Grape juice has exactly the right levels of Yeast Nutrients, Sugar, Acid, and Tannin and this is why wine from grapes is much easier than wine from other fruits.”
- [http://www.yobrew.co.uk/stuck.php](http://www.yobrew.co.uk/stuck.php)
1. Too Hot or too cold

- Did the temperature get outside the range indicated for your yeast?

  - **Too Hot:**
    - You may have killed the yeast.
      Stabilize the temperature and restart.

  - **Too Cold:**
    - Raise temperature. No restart should be necessary (the yeast isn’t killed, it’s dormant)
No bubbles. Ever.

A) Your yeast was dead before you started.
   • Get good yeast and restart.

B) You used apple juice with preservatives, killing the yeast.
   • Crush your own apples or buy apple juice with NO preservatives (pasteurized only).
Stalled above 1030

- Did you have enough acidic apples?
- Did you have enough bitter (tannic) apples?

Yeast requires both acid and tannin to function correctly. With a blend of apples this should not be a problem (most apple juice you buy is a blend of apples).

If you feel your original apples were lacking tannin or acid, add some (lemons, grape juice) and restart.
Specific gravity stall

- Everything was going fine! But the SG stalls above 1000 (but below 1030).
- Too much sugar or temperature fluctuated. Yeast has stopped fermenting.
- This wine will be sweeter as not all sugar was consumed. A good light dessert cider. (Don’t restart unless you really want more alcohol)
Restarting fermentation

- “Gradual Restart”
- http://www.yobrew.co.uk/stuck.php