We will start momentarily at 2pm ET

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http://acswebinars.org/red-white-beer

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Thursday, April 24, 2014

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“Key Concepts in Identifying Drug Leads”

Dr. Tudor Oprea, UNM School of Medicine
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Red and White Beer for St. George’s Day

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Color Chemistry:
Red and White Beer for St. George’s Day

Charlie Bamforth
Barley

Steep at 14-18°C (57-64°F) to 43-46% moisture (2 d)
Germinate 16-20°C (61-68°F) (4-6 d)
Kiln 50-110°C (122-230°F) (18-36 h)

Malt

In germination
make sugars
make amino acids

In kilning
Melanoidins
(color)
Flavors

MELANOIDINS

http://sciencegeist.net/the-chemistry-of-caramel
Roast barley
Chocolate malt
Wheat malt
Pale malt
Munich malt
Light Caramel malt
Dark Caramel malt
Specially Processed malt (kilned and roasted)

Oxygen

Audience Trivia Question

“Which of these is a Black Lager?”

- Dunkel
- Schwarzbier
- Rauchbier
- Helles
- Dubbelbock
Answer

- Schwarzbier
Light Source

White Light

Red Light

“Ah, red”

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Absorbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>Stout</td>
</tr>
<tr>
<td>450</td>
<td>Porter</td>
</tr>
<tr>
<td>500</td>
<td>Amber Ale</td>
</tr>
<tr>
<td>550</td>
<td>American Lager</td>
</tr>
<tr>
<td>600</td>
<td></td>
</tr>
<tr>
<td>650</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td></td>
</tr>
</tbody>
</table>
Transmittance spectra for beer

ASBC color measurement standard

- Measure absorbance at 430nm in a ½ inch cell
- $A_{430} \times 10 = \text{ASBC Color (SRM – Std. Ref. Method)}$
  - $A_{430} \times 12.7 = \text{ASBC Color (in 10 mm cuvette)}$
  - SRM correlates with °L (Lovibond)
  - SRM = °L = ASBC color ≠ EBC color
  - EBC Color = $A_{430} \times 25$

American Society of Brewing Chemists
European Brewery Convention
Color based on Standard Reference Method (SRM)

<table>
<thead>
<tr>
<th>SRM/Lovibond</th>
<th>Example</th>
<th>Beer color EBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Pale lager</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>German Pilsner</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Pilsner Urquell</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>Weissebier</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>Bass pale ale</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>17</td>
<td>Dark lager</td>
<td>33</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>29</td>
<td>Porter</td>
<td>57</td>
</tr>
<tr>
<td>35</td>
<td>Stout</td>
<td>69</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>79</td>
</tr>
<tr>
<td>70</td>
<td>Imperial stout</td>
<td>138</td>
</tr>
</tbody>
</table>
Blending beers to same ASBC color were identified as different in nearly all cases.

<table>
<thead>
<tr>
<th>Beer</th>
<th>Color (ASBC)</th>
<th>Color (Lovibond)</th>
<th>Color (ASBC) after dilution*</th>
</tr>
</thead>
<tbody>
<tr>
<td>US lager</td>
<td>4.0</td>
<td>4.2</td>
<td>3.6</td>
</tr>
<tr>
<td>European lager</td>
<td>8.2</td>
<td>8.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Ale</td>
<td>24.6</td>
<td>24.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Stout</td>
<td>86.4</td>
<td>115</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Correct Same or Different</th>
<th>Difference B - A</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. lager vs. Euro lager</td>
<td>0/31</td>
<td>p &gt; 0.999</td>
</tr>
<tr>
<td>Stout vs. Ale</td>
<td>29/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>U.S. lager vs. Ale</td>
<td>29/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Stout vs. Stout</td>
<td>29/31</td>
<td>p &lt; 0.001</td>
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<tr>
<td>Euro lager vs. Ale</td>
<td>24/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Stout vs. Euro lager</td>
<td>31/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>U.S. lager vs. U.S. lager</td>
<td>30/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>U.S. lager vs. Stout</td>
<td>30/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Ale vs. Ale</td>
<td>26/31</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Euro lager vs. Euro lager</td>
<td>27/31</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>
ASBC color measurement issues

- Works for lightly colored (yellow) beers
- Doesn’t work as well for highly colored beers
  - Identical SRM values can appear different to the human eye

For example...

\[ \Delta E = 6.39 \]

Consumers perceived difference, \( p < 0.001 \).
\[ \Delta E \] as low as 1 perceptible

Tristimulus color – \( L^*, a^*, b^* \)

**Color Coordinates**

- \( L^* \) Lightness
- \( a^* \) Red/Green axis
- \( b^* \) Yellow/Blue axis
- \( C^* \) Chroma
- \( h \) hue
**Audience Trivia Question**

Which of these translates to “light” in the sense of color, not calories?

- Pilsner
- Bock
- Weisse
- Helles
- Gose
**Answer**

- Helles

---

**Maillard Reaction Products**

- Reducing sugar (maltose) + Amino compounds → Maillard Reaction Products
  - Yellow, Orange, Red (initially)
  - Brown (late)
Caramelization

- Thermal degradation of sugars
  Leads to **amber** and **red** colors

- Stewing green malt at warm temperatures promotes enzymatic hydrolysis
  - near complete liquefaction of endosperm

- Heat develops unique color and flavor

---

**Caramel malt types – color and flavor**

<table>
<thead>
<tr>
<th>Malt type</th>
<th>Color (SRM)</th>
<th>Beer type</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munich malt</td>
<td>20</td>
<td>Amber beer</td>
<td>Intensely malty</td>
</tr>
<tr>
<td>Cara Pils</td>
<td>2</td>
<td>Lagers</td>
<td>Sweet, Biscuit</td>
</tr>
<tr>
<td>Crystal malt</td>
<td>40 – 120</td>
<td>Ales &amp; Lagers</td>
<td>Toffee, Burnt</td>
</tr>
</tbody>
</table>

- Green malt is stewed at warm temperatures
  - Promotes enzymatic hydrolysis of starch

- Kilned traditionally to produce Munich malt

- Kilned in drum roaster to produce Crystal malt

- Colors are deep **amber** and can be **reddish**
Roasted malt types – color and flavor

<table>
<thead>
<tr>
<th>Malt type</th>
<th>Color (SRM)</th>
<th>Beer type</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate malt</td>
<td>350</td>
<td>Porters &amp; Stouts</td>
<td>Coffee</td>
</tr>
<tr>
<td>Black malt</td>
<td>500</td>
<td>Porters &amp; Stouts</td>
<td>Neutral</td>
</tr>
<tr>
<td>Black Barley</td>
<td>500</td>
<td>Porters &amp; Stouts</td>
<td>Bitter, burnt</td>
</tr>
</tbody>
</table>

- Dried malt that is drum roasted
- Carbonization dominates
- Colors are dark brown to black

How can color of beer be tweaked?

- Caramel
  - Class III caramel
- Roasted malt extracts
  - High MW – color without flavor
  - Low MW – flavor without color
White beer
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