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ACS WEBINARS® May 1 @ 2PM ET

"CANNABIS CHEMISTRY 101"

Featuring Christopher J. Hudalla, Ph. D.,
Chief Scientific Officer, ProVerde Laboratories

Thursday, May 1, 2014

"Cannabis Chemistry 101"

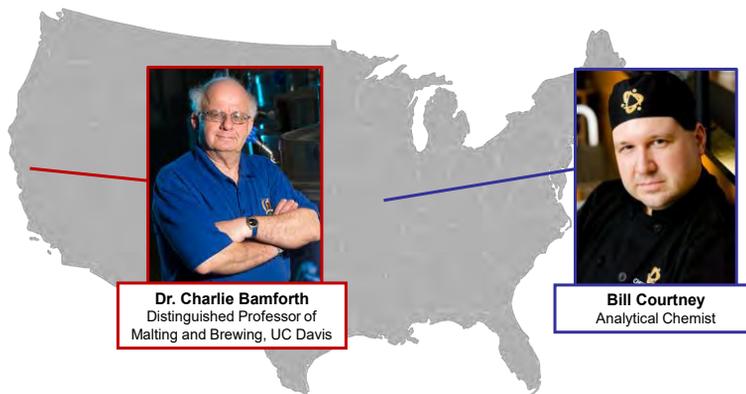
Christopher Hudalla, Ph.D., ProVerde Laboratories

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

Liquid Chemistry... Round Two



Dr. Charlie Bamforth
Distinguished Professor of
Malting and Brewing, UC Davis

Bill Courtney
Analytical Chemist

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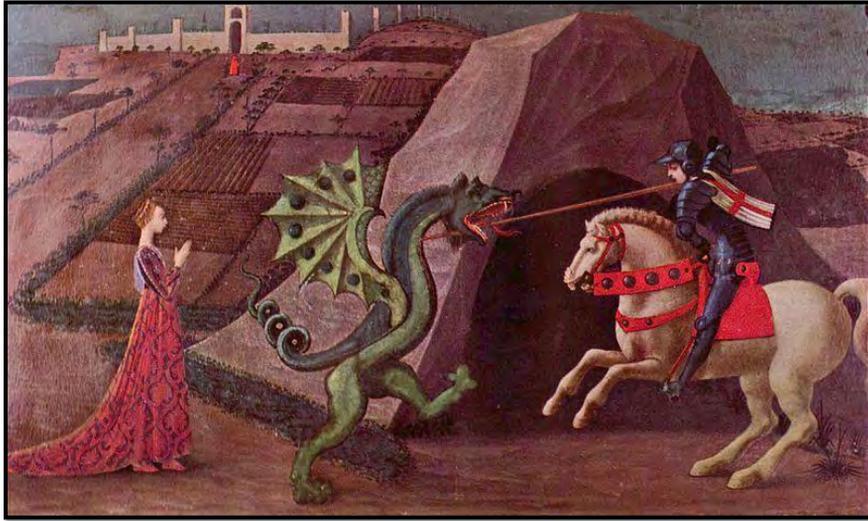
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**Color Chemistry:
Red and White Beer for St. George's Day**

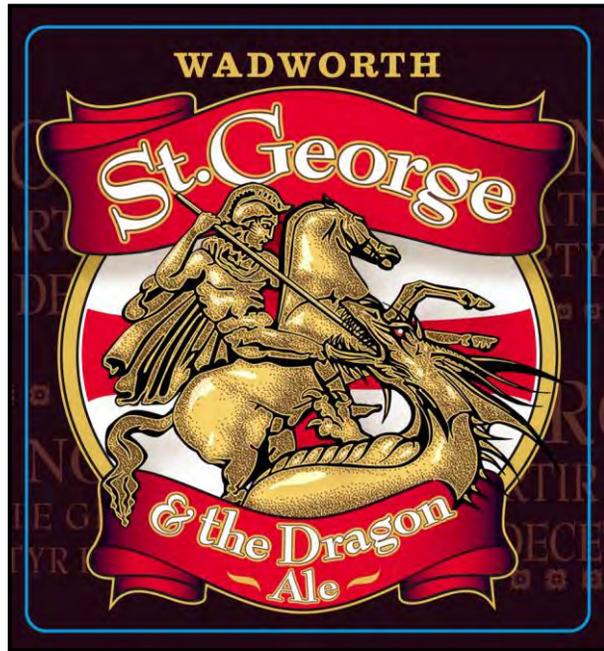
Charlie Bamforth



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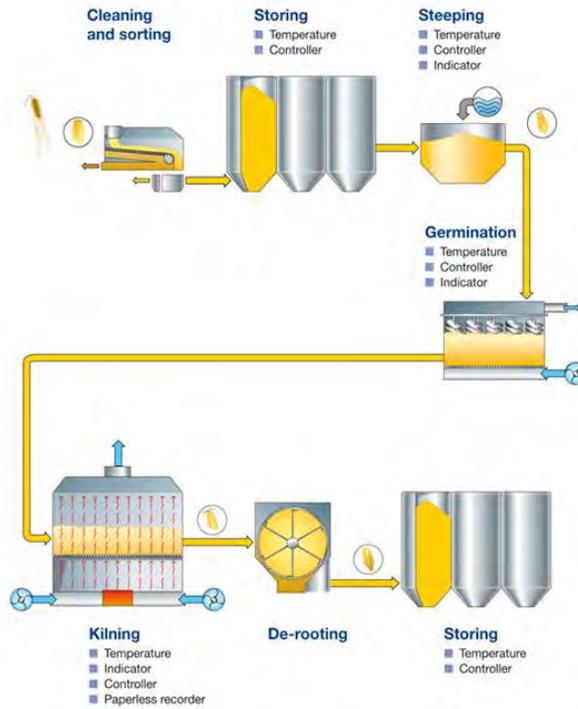
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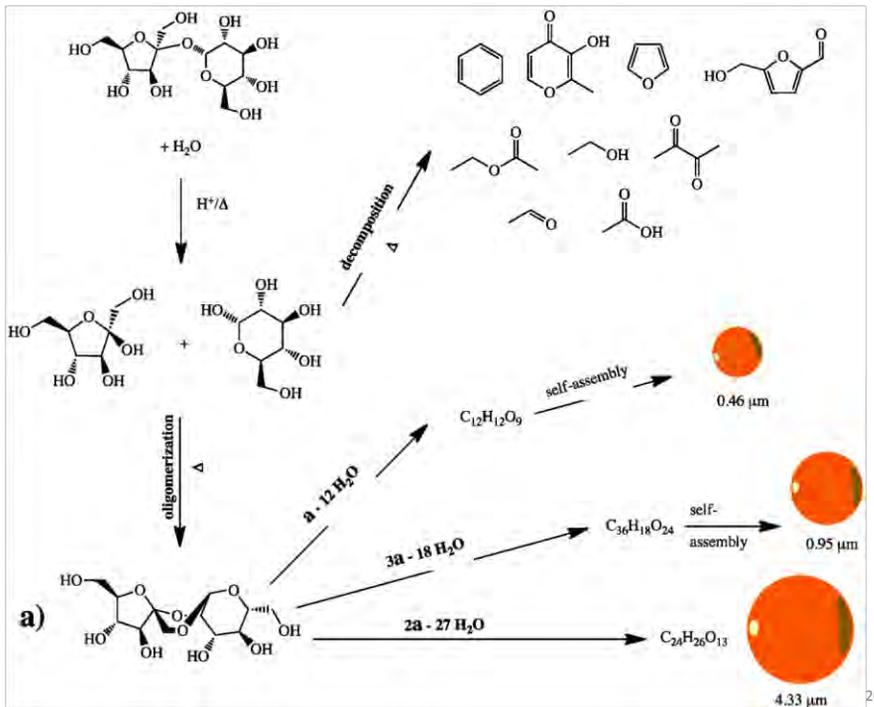
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http://www.jumo.ca/en_CA/industry/food/applications/malthouse/malting-process.html



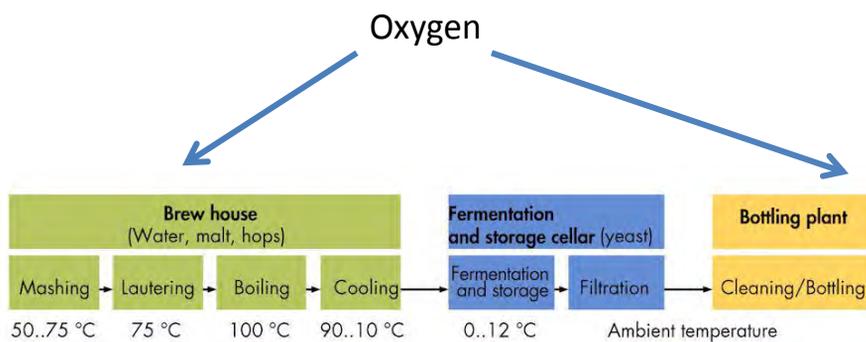
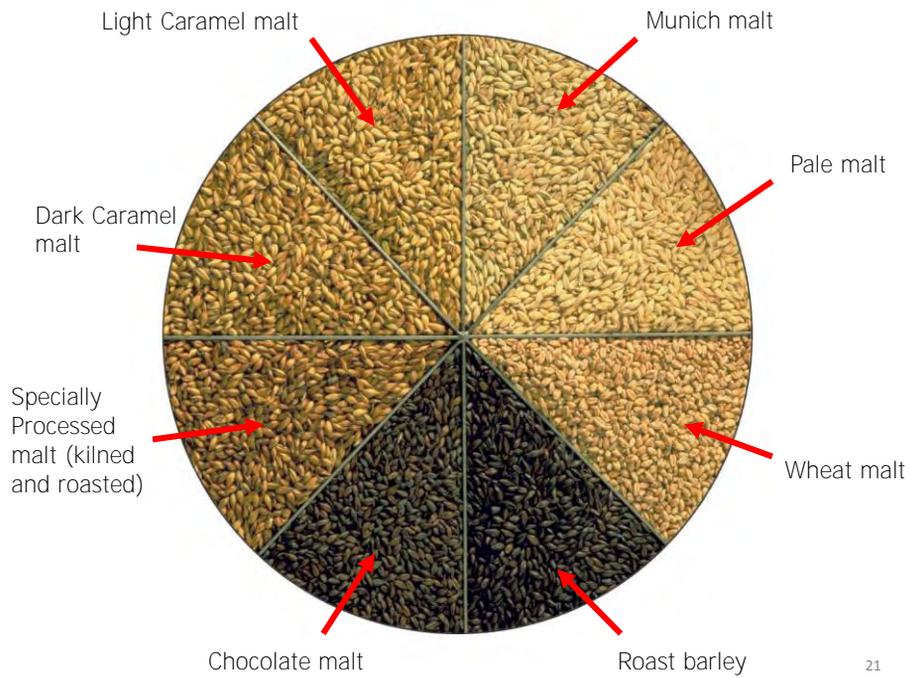
http://maltspecialists.com/index.php?main_page=page&id=23

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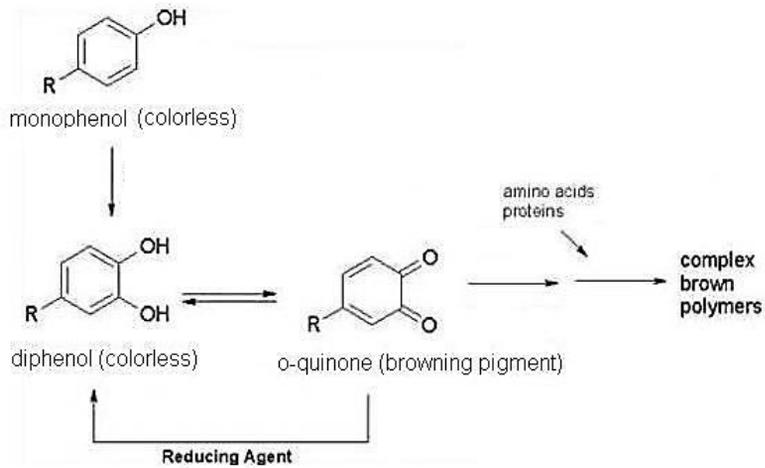


<http://sciencegeist.net/the-chemistry-of-caramel>

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<http://www.bine.info/en/publications/publikation/mit-solarer-waerme-bier-brauen/hofmuehl-brauerei-in-eichstaett>



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Audience Trivia Question

“Which of these is a Black Lager?”

- Dunkel
- Schwarzbier
- Rauchbier
- Helles
- Dubbelbock



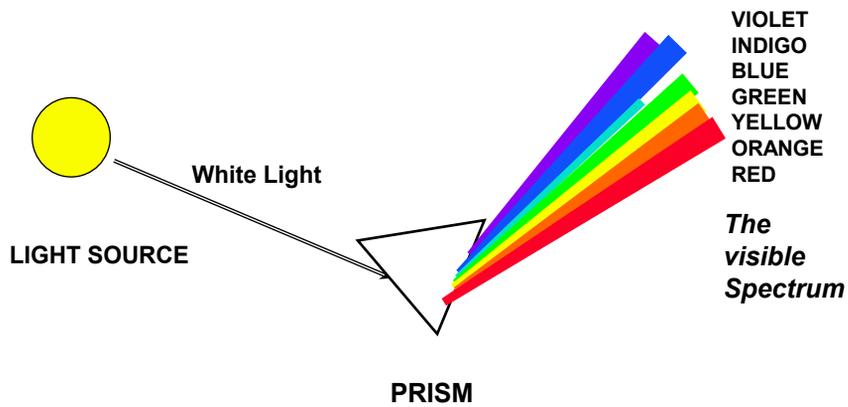
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Answer

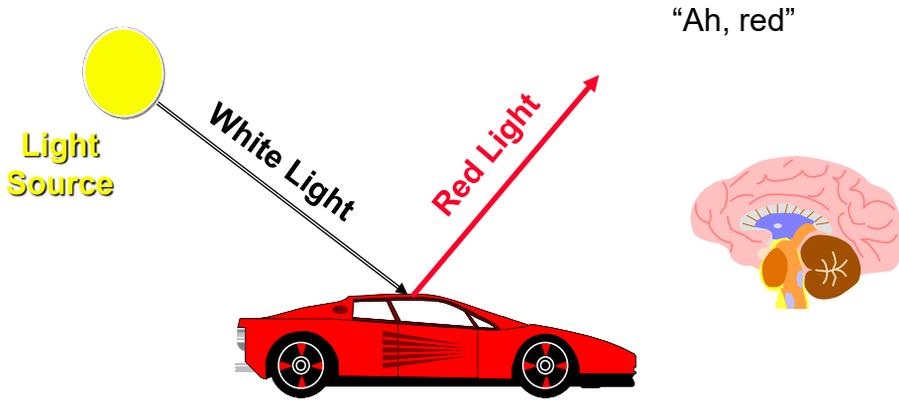
- Schwarzbier



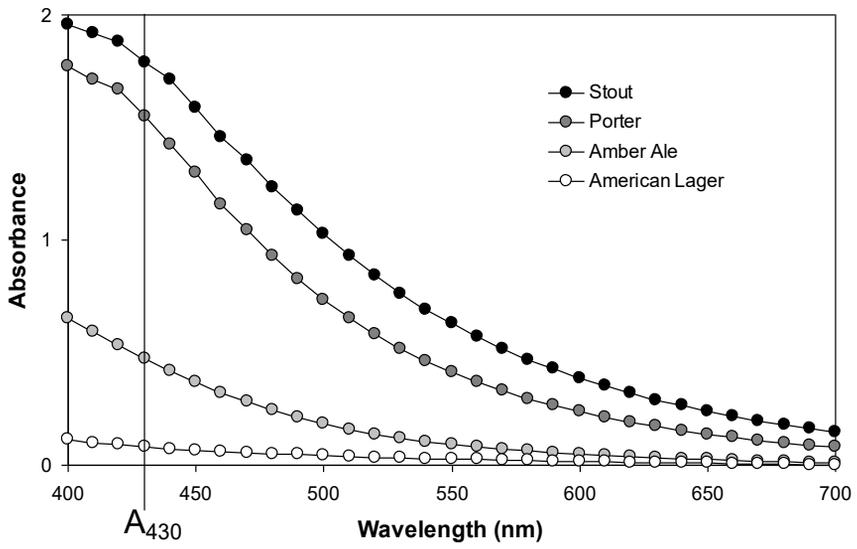
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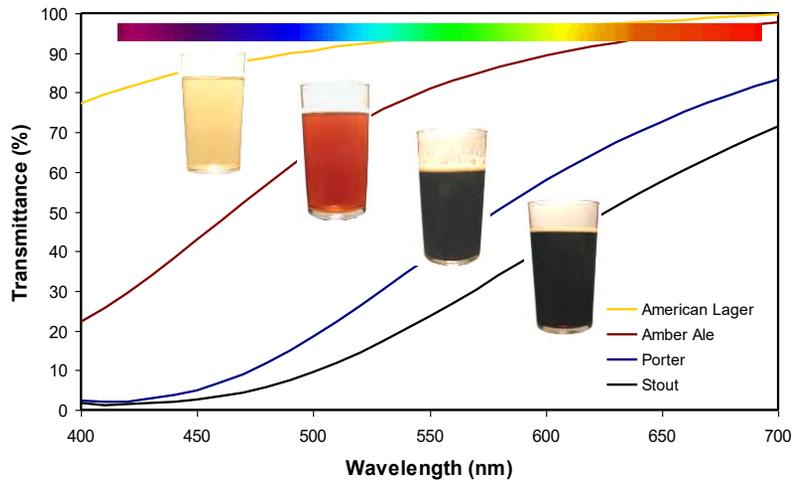


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Transmittance spectra for beer



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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)
 - $\text{SRM} = \text{°L} = \text{ASBC color} \neq \text{EBC color}$
 - $\text{EBC Color} = A_{430} \times 25$

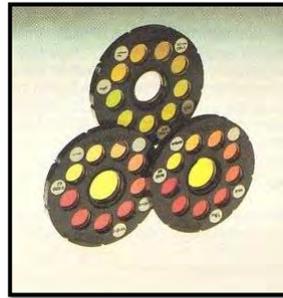


American Society of Brewing Chemists



European Brewery Convention

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Color based on Standard Reference Method (SRM)

SRM/Lovibond	Example	Beer color	EBC
2	Pale lager		4
3	German Pilsener		6
4	Pilsner Urquell		8
6			12
8	Weissbier		16
10	Bass pale ale		20
13			26
17	Dark lager		33
20			39
24			47
29	Porter		57
35	Stout		69
40			79
70	Imperial stout		138

http://www.brewerschoice.net.au/html/articles.html

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Beer	Color (ASBC)	Color (Lovibond)	Color (ASBC) after dilution*
US lager	4.0	4.2	3.6
European lager	8.2	8.4	3.5
Ale	24.6	24.2	3.6
Stout	86.4	115	3.5

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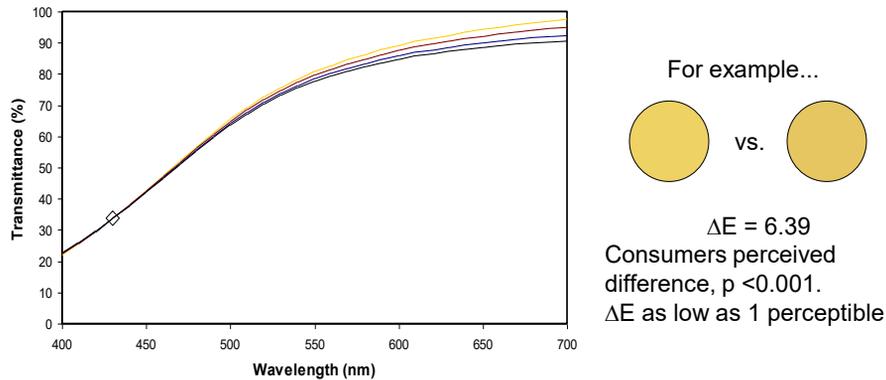
Blending beers to same ASBC color were identified as different in nearly all cases

Comparison	Correct Same or Different	Difference B - A
U.S. lager vs. Euro lager	0/31	$p > 0.999$
Stout vs. Ale	29/31	$p < 0.001$
U.S. lager vs. Ale	29/31	$p < 0.001$
Stout vs. Stout	29/31	$p < 0.001$
Euro lager vs. Ale	24/31	$p < 0.001$
Stout vs. Euro lager	31/31	$p < 0.001$
U.S. lager vs. U.S. lager	30/31	$p < 0.001$
U.S. lager vs. Stout	30/31	$p < 0.001$
Ale vs. Ale	26/31	$p < 0.001$
Euro lager vs. Euro lager	27/31	$p < 0.001$

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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

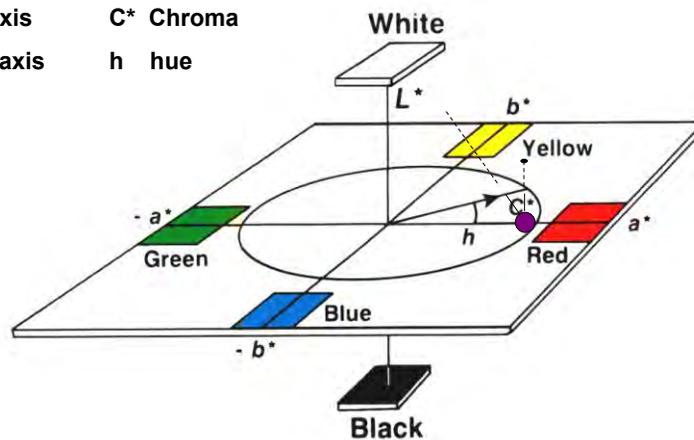


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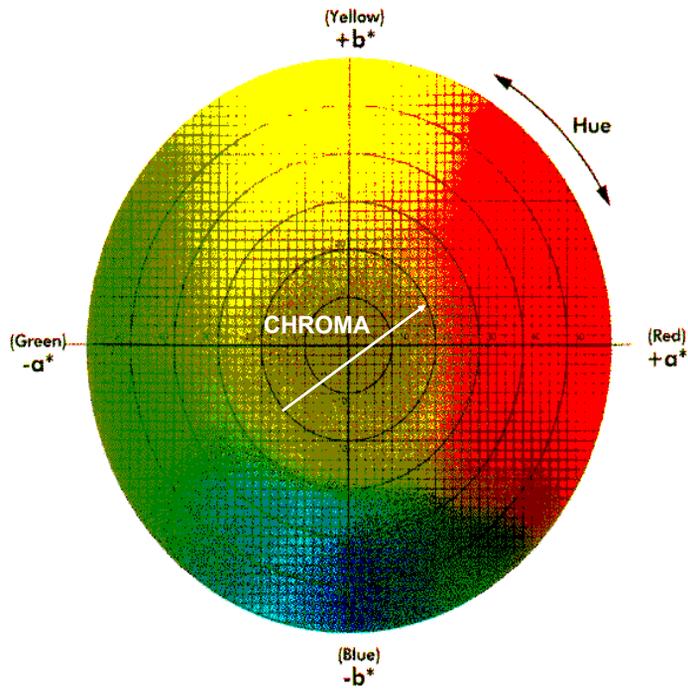
Tristimulus color – L^* , a^* , b^*

Color Coordinates

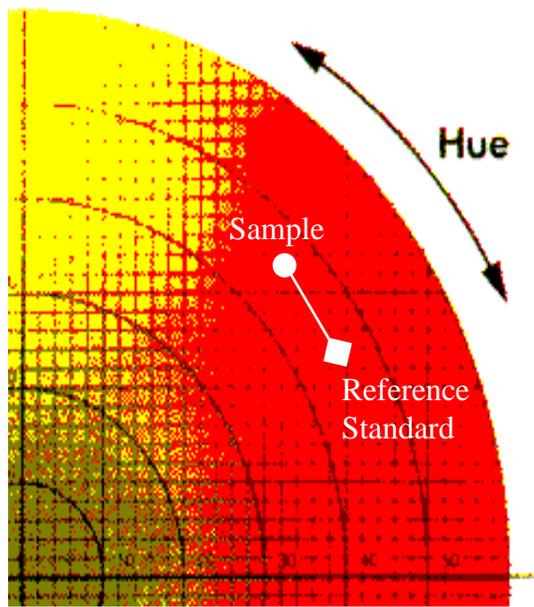
L^* Lightness	L^* Lightness
a^* Red/Green axis	C^* Chroma
b^* Yellow/Blue axis	h hue



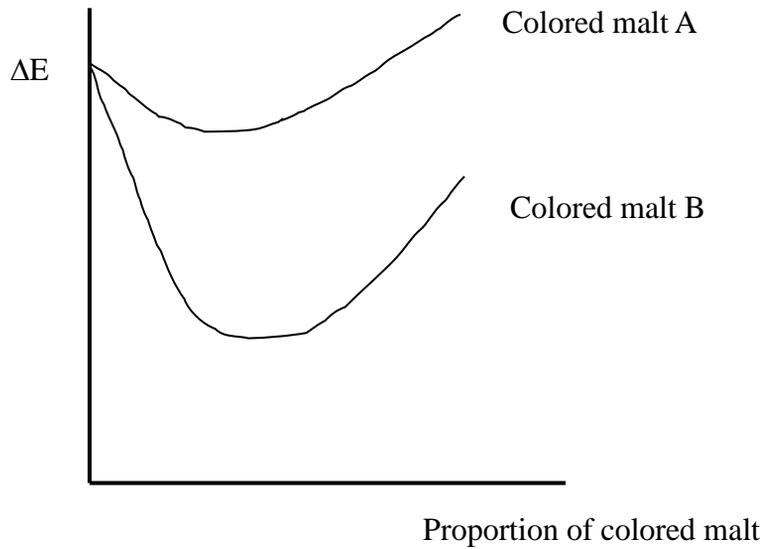
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Audience Trivia Question

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

- Pilsner
- Bock
- Weisse
- Helles
- Gose



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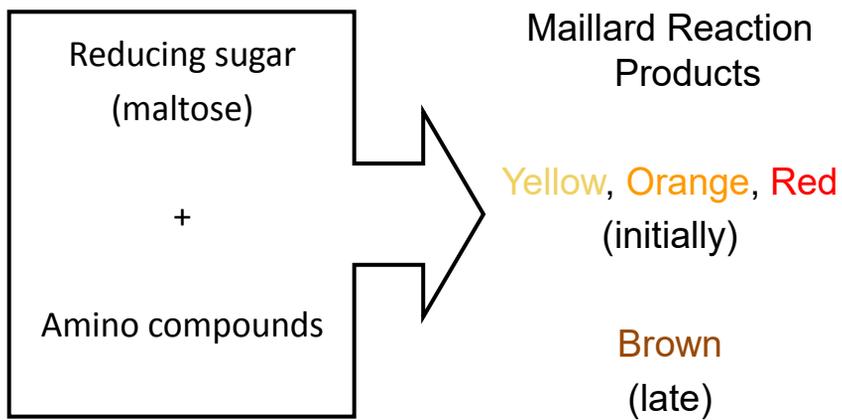
Answer

- Helles



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Maillard Reaction Products



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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

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Caramel malt types – color and flavor

Malt type	Color (SRM)	Beer type	Flavor
Munich malt	20	Amber beer	Intensely malty
Cara Pils	2	Lagers	Sweet, Biscuit
Crystal malt	40 – 120	Ales & Lagers	Toffee, Burnt

- 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**

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Roasted malt types – color and flavor

Malt type	Color (SRM)	Beer type	Flavor
Chocolate malt	350	Porters & Stouts	Coffee
Black malt	500	Porters & Stouts	Neutral
Black Barley	500	Porters & Stouts	Bitter, burnt

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

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How can color of beer be tweaked?

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

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White beer

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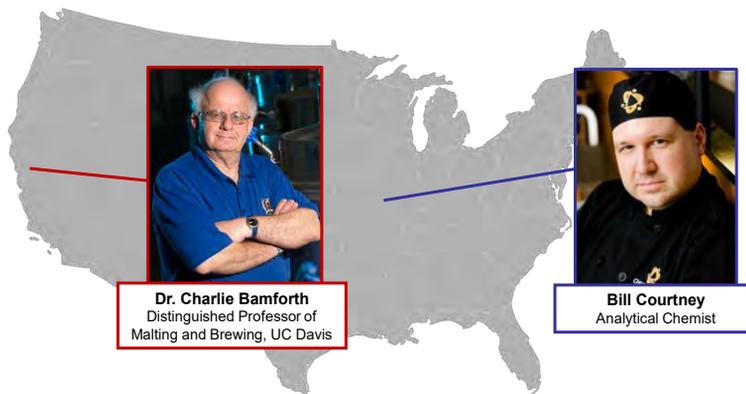
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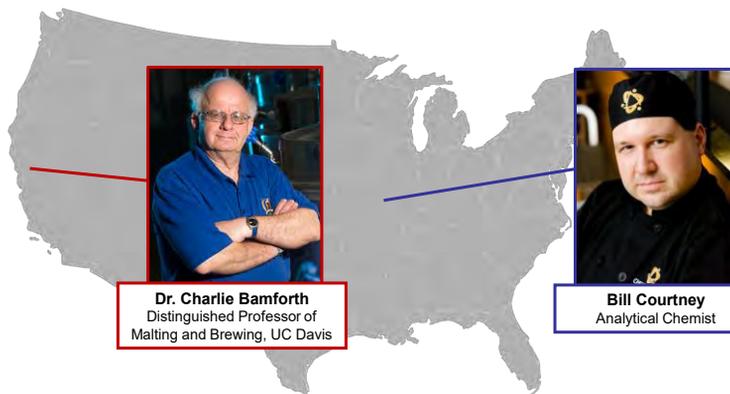
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