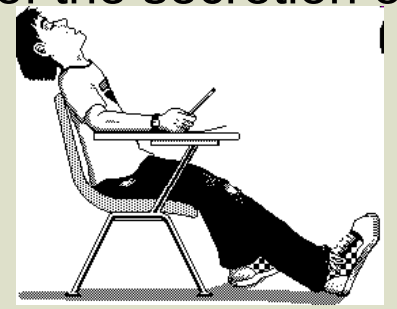
(Almost) All About Hops

What this presentation is NOT about:

- Lots of scientific information why tetrahydro-isoalpha acids have a greater impact on sensory bitterness, nor
- Dissertation on the Ontogeny and histochemical characterization of the secretion of glandular trichomes



(Almost) All About Hops

What this presentation DOES cover:

- History of hops
- Brewing with hops
- Hop components and their characteristics
- Hop shortage? What hop shortage?!
- “Show and smell” of 3 common hops

Introduction

Hops provide a bitterness to beer that complements the sweetness from malt. Hops also impart flavor and aroma to beer. Moreover, hops act as a preservative for beer.

History of Hops

Hops were introduced in beer making prior to 1000 A.D., and came into widespread use in the 16th century when they were legislated as a required ingredient in the famous Reinheitsgebot, or German Beer Purity Law of 1516.

Hops are a natural preservative and part of the early use of hops in beer was to preserve it. This is how one particular style of beer, India Pale Ale, was developed.

History of Hops

At the turn of the 18th century, British brewers began shipping strong ale with lots of hops added to the barrels to preserve it over the several month voyage to India. By journey's end, the beer had acquired a depth of hop aroma and flavor.

Hop Biology

- Hops come from the *Humulus lupulus* plant
- Related to *Cannabis sativa* (marijuana)
- Hops are a cone-like flower containing many luplin glands that house the resins and essential oils which provide hop bitterness, aroma and flavor.
- Only the female hop plant contains a significant number of the luplin glands. The male hop plant is not used for brewing purposes.
- The soft resins of the luplin gland contain alpha and beta acids.

Alpha Acids

- Most of the bitterness from hops comes from the alpha acids

- The alpha acids consist of humulone, cohumulone, and adhumulone

- Cohumulone is more soluble and produces a harsher bitterness than humulone or adhumulone

Cone-Structure	Compact, medium sized, slightly square-shaped
Lupulin	Moderate amount, yellow color; develops compact balls of Luplin in the cone; unique to Cascade
Aroma	Flowery and citrusy. Can have a grapefruit note.
Alpha Acids	4.5 – 7.0% w/w
Beta Acids	4.5 – 7.0% w/w
Co-Humulone	33 – 40% of alpha acids
Storageability	48 – 52% alpha acids remaining after 6 months storage at 20ºC
Total Oil	0.8 – 1.5 mls/100 grams
Myrcene	45 – 60% of whole oil
Humulene	10 - 16% of whole oil
Caryophyllene	3 - 6% of whole oil
Farnesene	4 – 8 % of whole oil
General Trade Perception	Aroma variety with well balanced bittering

Beta Acids

- Beta acids are not as soluble as alpha acids and contribute very little bitterness to beer, even when boiled

- Beta acids consist of lupulone, colupulone, and adlupulone

- When beta acids are oxidized (especially during storage) some bitter compounds form.

Essential Oils

- The essential oils are responsible for the *hop aroma and flavor* in beer.

- There are hundreds of compounds associated with the essential oils but current research has isolated a few dozen that have a major impact on flavor and aroma.

- The essential oils are very volatile and typically do not survive long boils.

Bittering

Bittering hop additions are boiled for 45 to 90 minutes to isomerize the alpha acids. Boiling longer than 90 minutes adds virtually no additional bittering.

Using high alpha hop varieties makes more economical sense – less hops are needed. Duh!

Common varieties include Brewer's Gold, Nugget, Chinook, Eroica, Galena, and Bullion

Flavoring

Adding hops for 15-40 minutes of the boil adds hop flavor because, while some evaporation of aromatics takes place, isomerization of alpha acids is achieved. Adding a combination of hop varieties during this period will often add complexity.

Common varieties include Saaz, Tettnanger, Spalt, Hallertauer, East Kent and Styrian Goldings, Fuggles, Cascade, Willamette, Liberty, Crystal, Ultra, and Mount Hood

Finishing / Dry Hopping

Finishing hops are added in the last couple of minutes of the boil, or simply steeped for ±10 minutes after “knockout” (turning heat off). Little of the aromatic oils are lost to evaporation, thus retaining the hop aroma.

Dry hopping is done late in the fermentation cycle, typically in secondary. Do this after bubbling has stopped so the aroma won’t be carried away with the CO_2. Dry hopping will assert the hop character within 4-7 days.

Multi-purpose Hops

Some hops are well suited to provide both bittering and flavor/aroma character to beer.

Common varieties include Northern Brewer, Columbus, Cluster, Perle, and Centennial

Noble Hops

- Commonly used as aroma hops, especially in lagers

- Varieties include Saaz, Tettnanger, Spalt, and Hallertauer Mittelfrueh

- Perle, Crystal, Mt. Hood, Liberty, and Ultra were bred from the noble types and have very similar aroma profiles

Noble Hops

Characteristics:

- Low alpha acid percent (below 6%)
- Alpha acid close to the beta acid percentage
- Low cohumulone alpha acid content
- Low myrcene oil content
- High humulene in the hop oil
- Poor storage attribute

IBUs

- The International Bittering Unit (IBU) is a measure of the concentration of isomerized alpha acids present in the finished beer, and is expressed in milligrams per liter, or parts per million (ppm).

- IBUs depend on length of the boil, wort gravity, vigor of the boil, wort pH, age/condition of hops, hop form (whole, plugs, or pellets), etc.

- The relative IBU level does not always translate directly to the perceived bitterness of the finished beer. 90-100 IBUs is often considered the max.

Hop Utilization

- IBU = 7489 x (W x A x U)/V where
  W = weight (ounces)
  A = alpha acid
  U = utilization factor
  V = final volume (gallons)

- Utilization factor is often the most important variable in the equation

- Utilization normally tops out at about 30% in the home brewery; often significantly lower

Hop Utilization

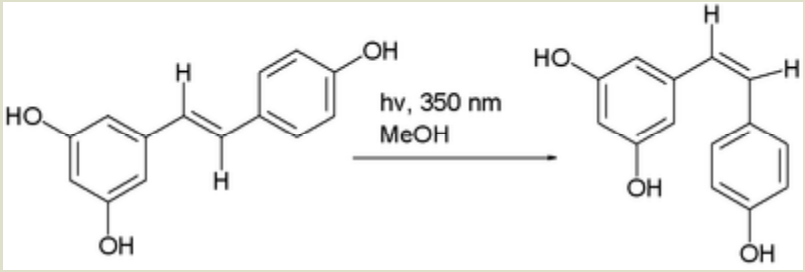
Utilization is reduced by:

- reducing the contact time with boiling wort
- reducing the boiling temperature of the wort
- increasing the wort gravity
- using whole hops instead of pellets
- increasing the hopping rate
- using hop bags during the boil
- using older hops
- decreasing wort pH
- using more flocculent yeast
- filtering the beer

Isomerization

- Isomerization is the process by which one molecule is transformed into another molecule which has exactly the same atoms, but whose atoms are rearranged e.g., A-B-C → B-A-C

- These related molecules are known as isomers.



Isomerization

- Isomerizing hops means to chemically rearrange the molecular structure of lupulin (alpha acids) so that they are soluble in water and thus impart their bitter qualities

- Alpha acids are not very soluble in water. The heat of boiling water causes a chemical reaction – isomerization – which makes the alpha acid resins soluble in water

First Wort Hopping

David Jones wrote an article on this in 2007

http://carolinabrewmasters.com/2Q_2007_Newsletter.pdf

Nutshell version: hops in mash runnings (pre-boil) release their aromatic oils and isomerize faster than if pitched into a boil where they are still insoluble and simply lost to steam.

Hop Forms

Form	Advantages	Disadvantages
Whole	They float, and are easy to strain from wort. Best aroma character, if fresh. Good form for dry hopping.	They soak up wort, resulting in some wort loss after the boil. Bulk makes them harder to weigh.
Plug	Retain freshness longer than whole form. Convenient half ounce units. Behave like whole hops in the boil. Good form for dry hopping.	Difficult to use in other than half ounce increments. They soak up wort like whole hops.
Pellet	Easy to weigh. Small increase in isomerization due to shredding. Don't soak up wort. Best storability.	Forms hop sludge in boil kettle. Difficult to dry hop with. Aroma content tends to be less than other forms due to amount of processing.

Hop Storage Tips

- Hops are harvested in late summer and stored in huge warehouses at about 26 F and remain there until they are shipped to a brewery or hop supplier

- Hops start to lose their a-acids and oils as soon as they are harvested. The rate of loss depends on the storage temperature, the amount of air present, and the hop variety. The lower the temperature, the less the hops deteriorate. The rate of loss is cut in half for every 15 degrees C (27 degrees F) drop in temperature

Hop Storage Tips

- Alpha acids are affected by time, oxygen, and light. Minimize each of these to maintain freshness. Buy hops stored in light- and oxygen-barrier packaging

- Polyethylene Ziploc bags are okay; clear boiling bags are better since they provide an oxygen barrier; aluminized Mylar bags are best and provide a 10x barrier protection over boiling bags, but at double the cost

Hop Storage Tips

- If you keg, you can flush a mason or PET (peanut butter) jar with CO_2, put the hops in, add a layer of gas and reseal the jar.

- How long do hops last? “It depends!” Temperature is the most influential factor, followed by hop variety, then aerobic or anaerobic storage conditions

Handouts

- Hop Substitution table
- Hop Storagability

Show & Smell

- Cascade - Grapefruity-citrus aroma makes Cascade the signature aroma hop of Anchor Liberty Ale, Sierra-Nevada Pale Ale, and many other West Coast ales.

- Fuggle - Spicy, mild aromatic hop with a slight fruitiness and woody character

- Spalt - Very mild, spicy, earthy and distinctive floral aroma. (Noble hop)