UW - Extension
Hop Quality 101
Wisconsin Dells
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Hop Solutions

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Hop Quality 101

- Hops & brewing review

- Hop Quality farm to bale
  - Sanitation
  - Pests
  - Diseases
  - Drying & baling

Chemistry & Brewing

- Why are Hops added to Beer?

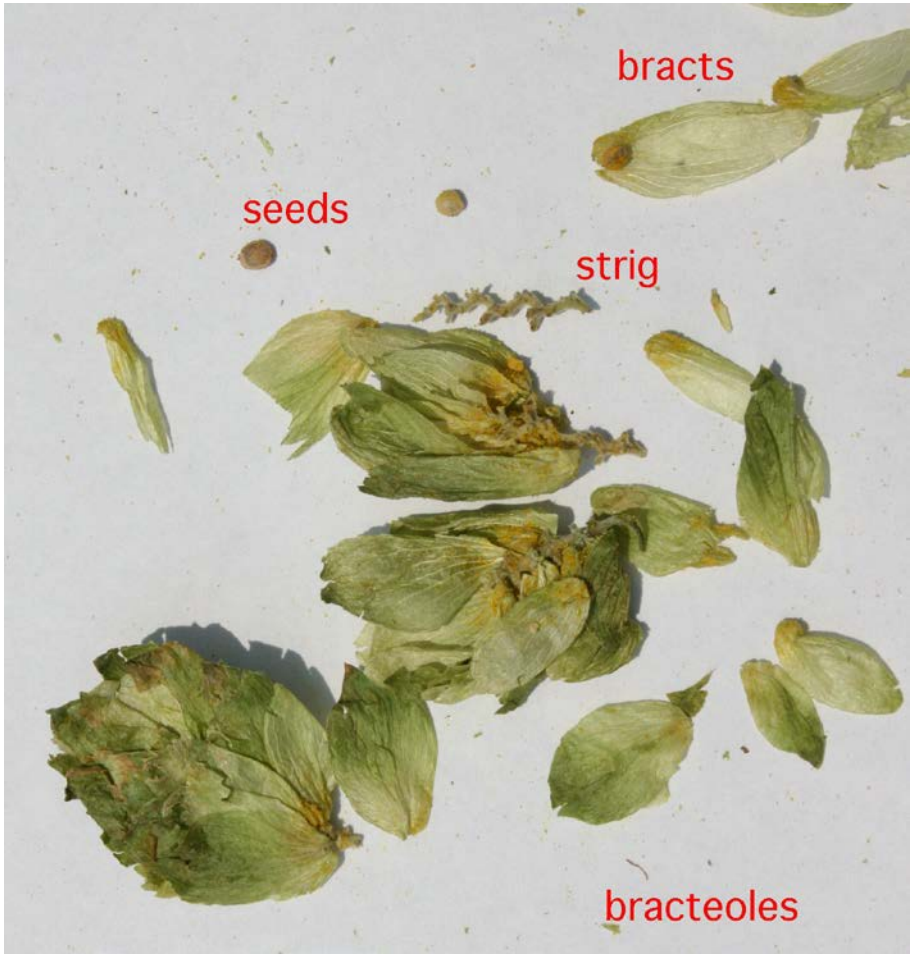
- Bitterness to balance sweetness
- Foam stability
- Non-bitter flavor (aroma)
- Microbiological stabilization

Chemical Composition of Dried Hops

Constituent	Percentage
Water	6-12
Soft Resins	
Alpha acids	2-16
Beta acids	1-10
Essence Oil	0.5-2.5
Hard Resins (Tannins & polyphenols)	2-5
Amino acids	0.1
Simple Sugars	2
Pectin	2
Oils & Fatty acids (unseeded hops)	0-2.5
Protein & non-Cellulose Carbohydrate	15
Ash (Mineral content)	8-10
Cellulose	40-50

Hop Cones & Parts

Hop Cones & Parts – Dried & Baled



Lupulin Glands

This is where most of the materials

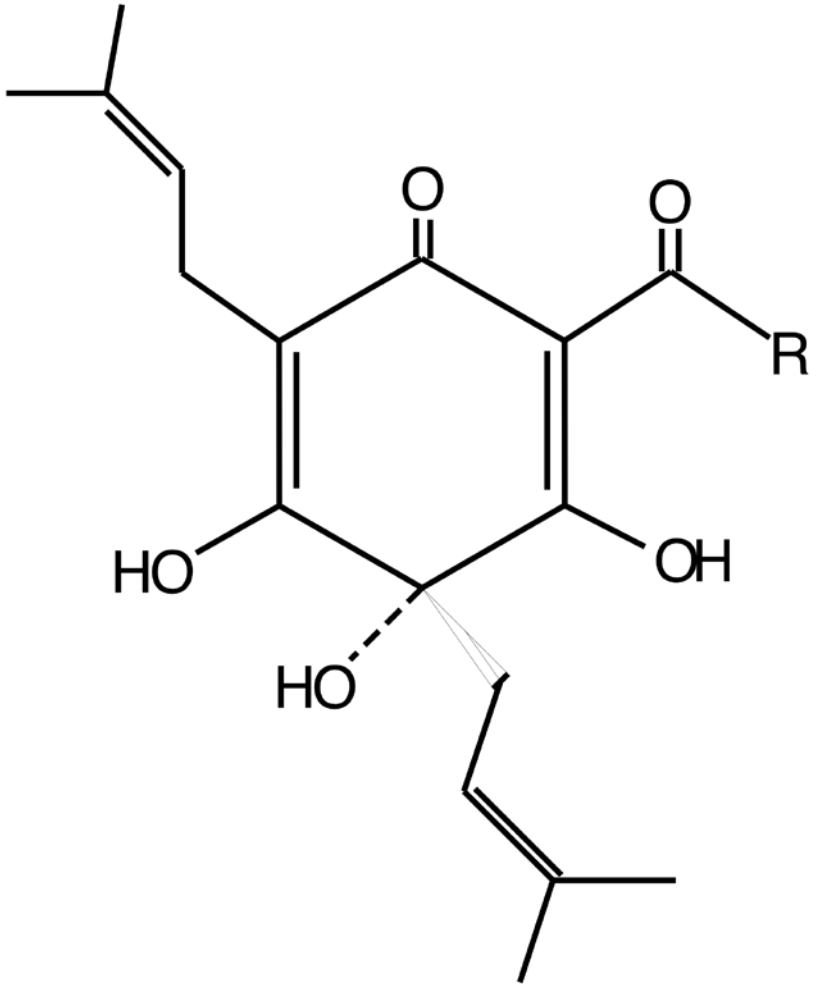
of interest to the brewer are located. α & β acids, hop oil & Xanthohumol.

☛Proanthocyanidins & glycosides in green tissue.

Alpha Acids

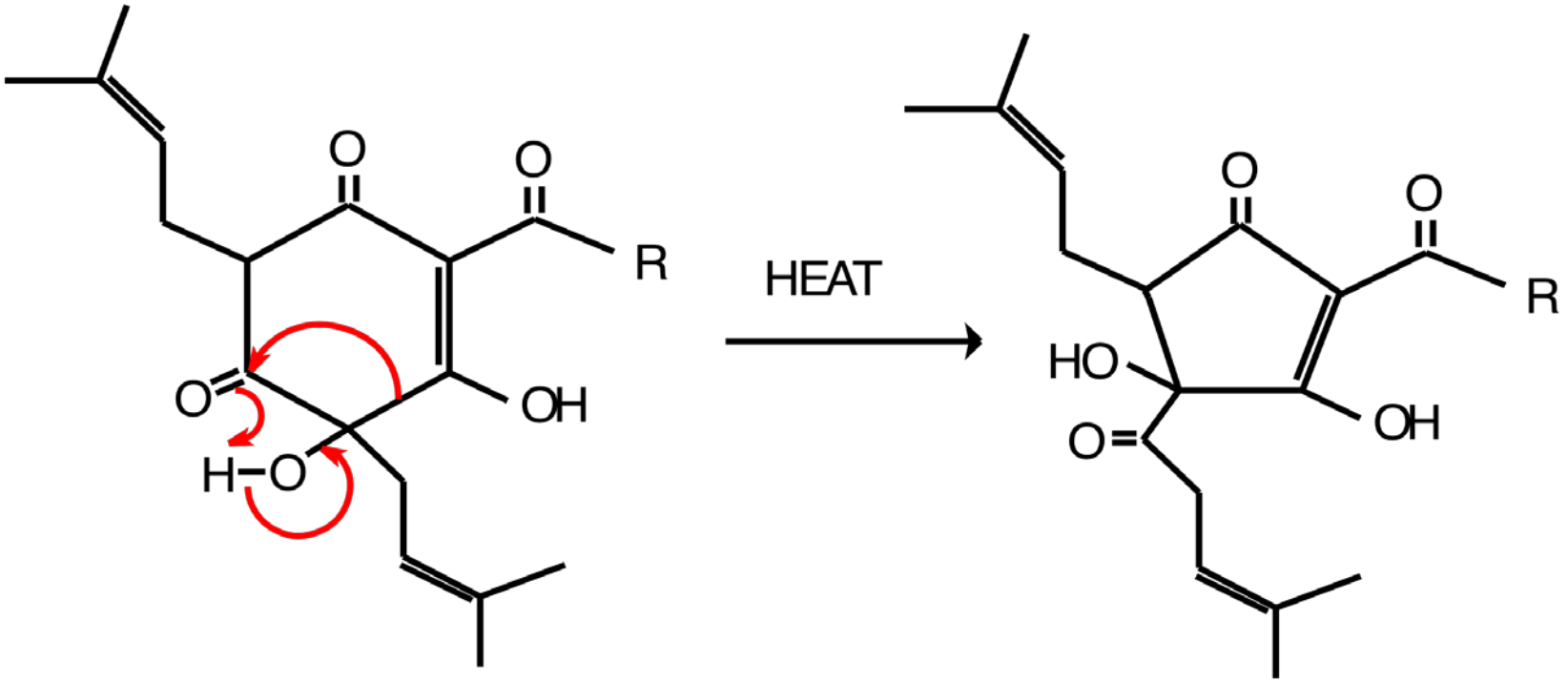
Term is plural!

3 major & several minor alpha acids. Ratio of these is variety dependent.



R = isopropyl	cohumulone	11-52%
R = isobutyl	n-humulone	40-82%
R = sec-butyl	adhumulone	5-17%

Kettle Isomerization of Alpha acids to more bitter iso-Alpha acids



Alpha acid

10 ppm

solubility

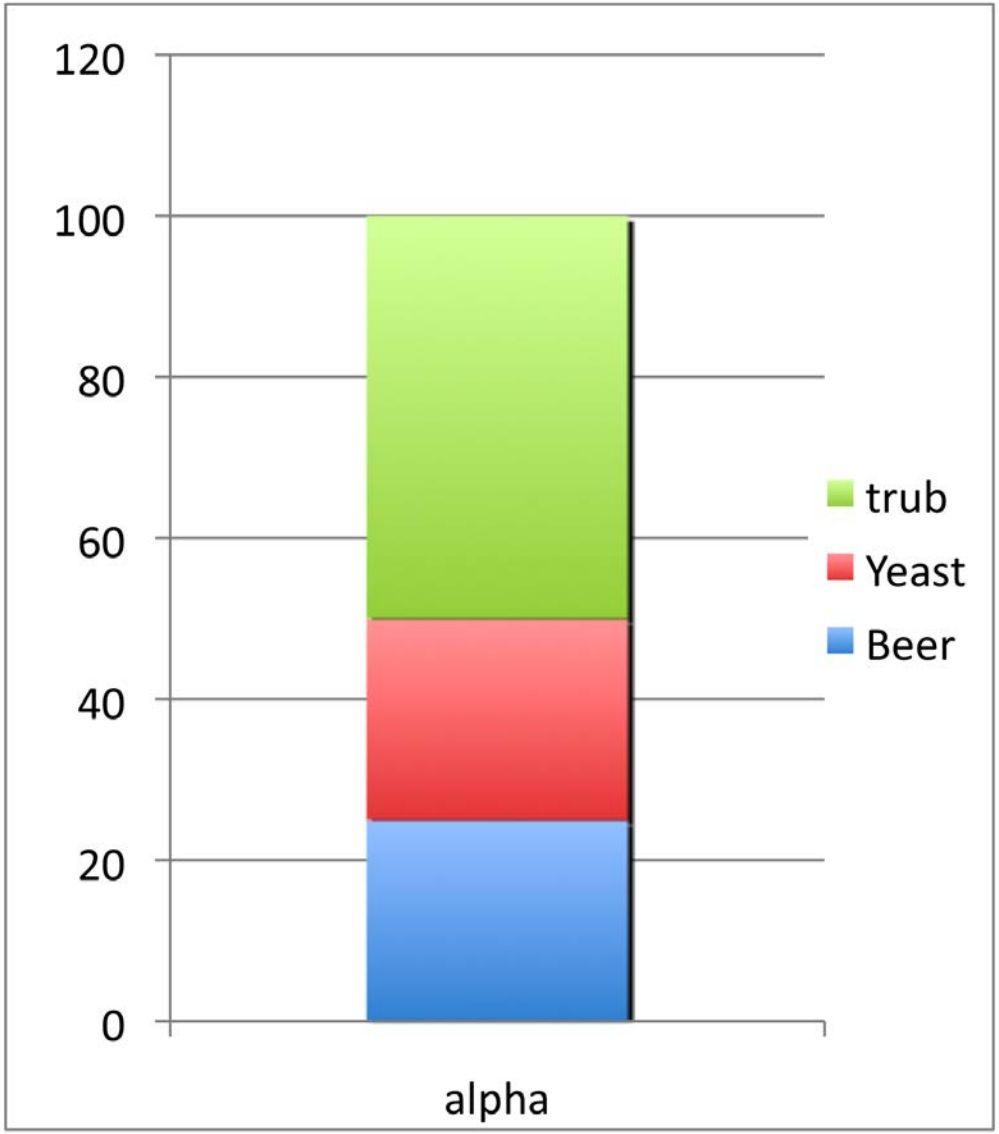
Iso-alpha acid

120 ppm

Alpha Utilization

Typically, 50% of alpha added to kettle is removed with trub & hops. Most of what remains in wort is iso-alpha.

50% of what survives wort boil (as iso-) is removed with yeast. Overall Utilization 25%

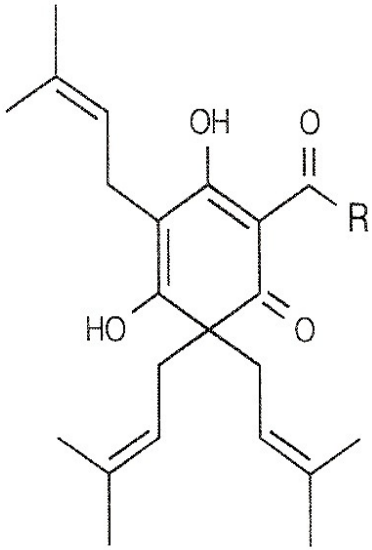


Factors Affecting Utilization

- Wort pH
- Altitude (boiling point of wort)
- Gravity (boiling pt & increased trub)
- Kettle depth & boil time
- Hopping rate (more hops = worse utilization)
- Yeast count & foam loss in fermentation
- Aseptic filtering & chill-proofing
- Many others…….

Beta Acids

- ☛Beta acids completely insoluble in beer.
- ☛Beta acids do NOT isomerize – no iso-beta
- ☛Oxidation products of beta acids formed during bale storage are bitter and found in beer.

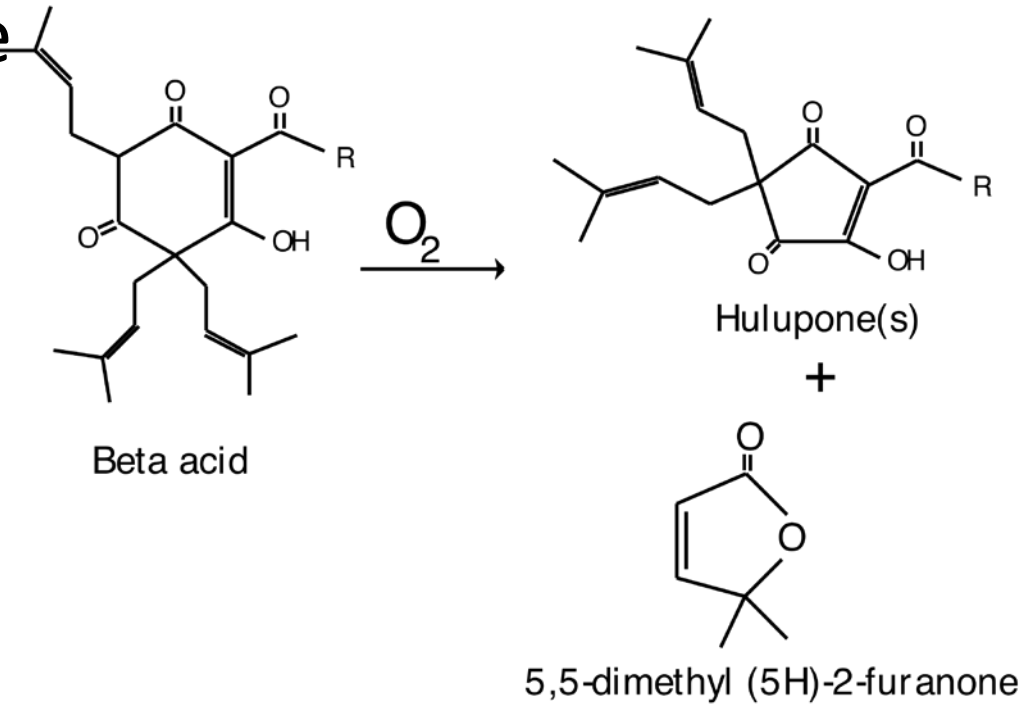


Beta Acid	R =	% of Beta Acids
Lupulone	iso-butyl $CH_2CH(CH_3)_2$	15-60%
Colupulone	iso-propyl $CH(CH_3)_2$	35-80
Adlupulone	sec-butyl $CH(CH_3)CH_2CH_3$	5-12

Beta Oxidation to Hulupones

Hulupones increase in baled hops (oxygen!) with age.

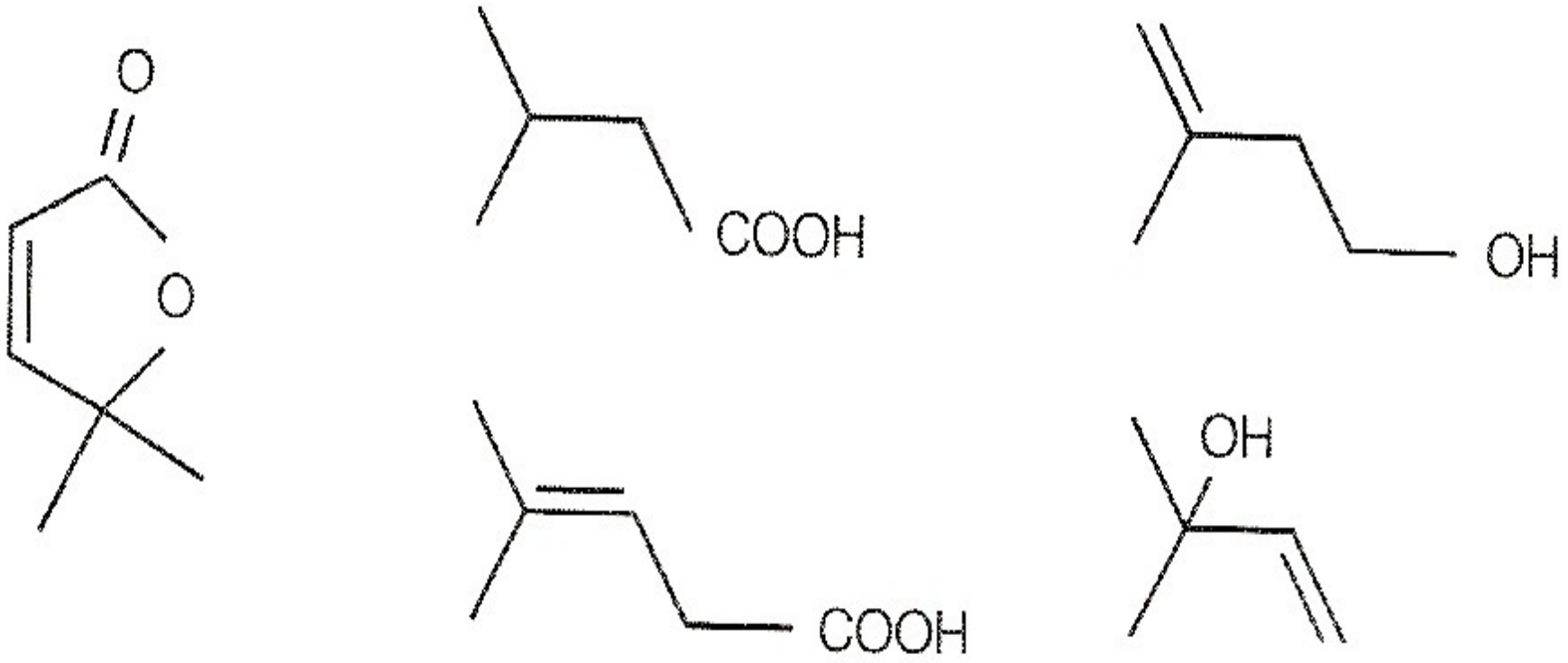
Are bitter & measured by IBU analysis



Hop Bale Aging & Bitterness Potential

- Baled hops lose alpha with age. Alpha ox products not particularly bitter.
- Baled hops lose non-bitter beta as well and ox products ARE bitter.
- If there is about as much beta as alpha, these two processes balance out and hops lose no bitterness potential with time.
- Only aroma hops have as much beta as alpha.

Old “Cheesy” Hops
Oxidation Products of α & β formed in bales, found in Beer



Hop Storage Index (HSI)

- Used on hops & pellets to determine what % of α & β acids have been lost to oxidation.
- Part of normal ASBC alpha analysis. After toluene extraction & alk. MeOH addition, UV absorbance @ 275 & 325 nm taken.
- HSI = 275 nm/325 nm absorbance
- = 0.25 for fresh hops, about 2 for hops with no alpha remaining

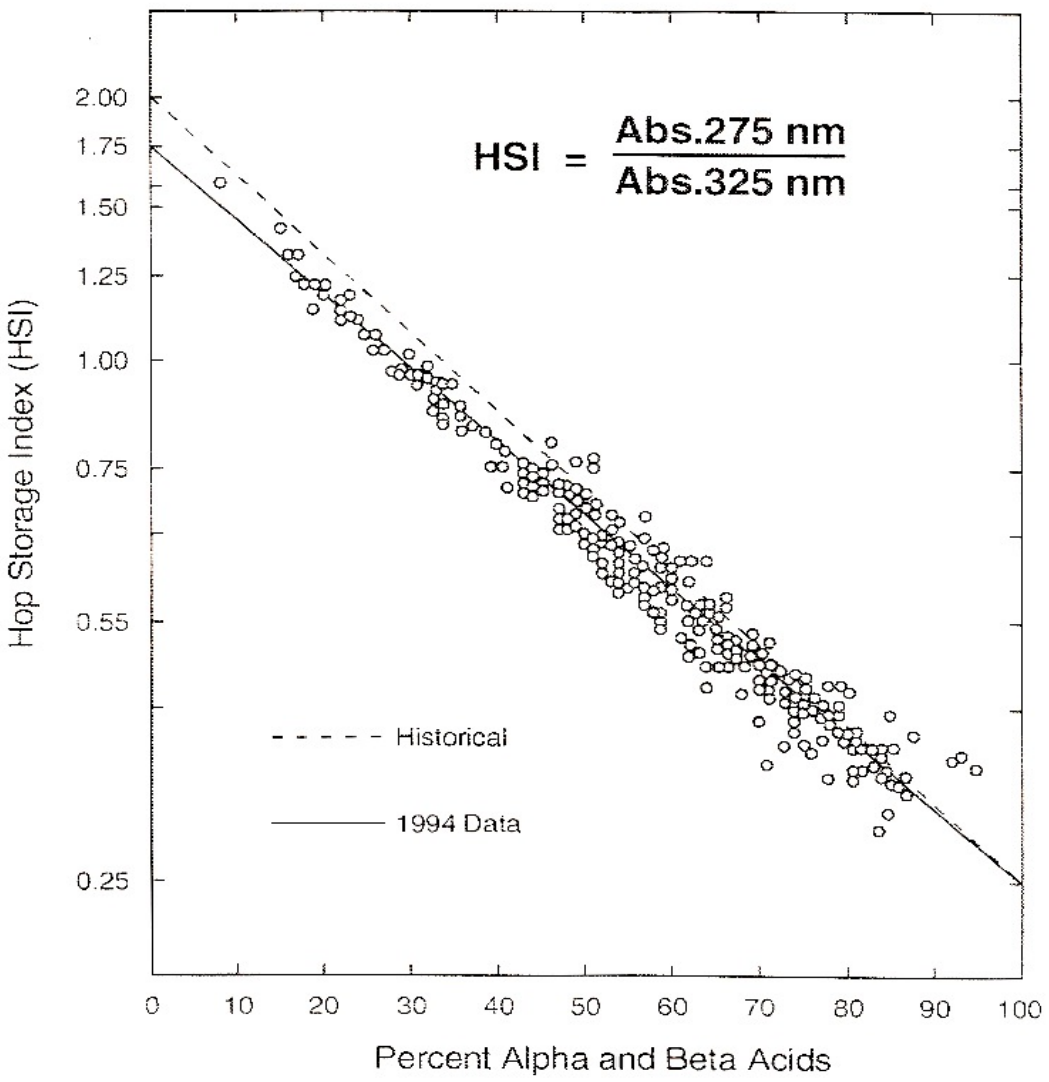
HSI vs. % (α & β) remaining

Nickerson update to original (1970) HSI correlation:

%(α+β) lost =

Log(HSI/0.25) X 110

Originally, X 100



Hop Oxidation and Quality of Bitterness

- Even though VERY oxidized hops may give comparable IBU levels as fresh hops, there are large qualitative differences.
- The bitterness of beer with largely non-iso-alpha bitterness (from old hops) will be harsher and more lingering than beer with the same IBU's of iso-alpha.
- Foam will be very much inferior in beer made with old hops.

How Hops are used require different levels of sanitation

Kettle hopping

- Hops boiled for 20-60 minutes: Kills just about everything.
- Non-water soluble materials removed with the precipitated protein & hops.
- Fermentation is also a purification process.

Dry-hopping – hops added just at the end.

- No chance to kill micro-organisms with a boil.
- Any impurities and toxins are exposed to the beer just before bottling.
- Sanitation needs are much greater.

Farm Practices

- Your harvesting Facilities are a FOOD PLANT
- Birds & rodents to be excluded from harvest facilities even during down times.
- Clean equipment at the end of harvest as well as beginning.
- Motor oil, fuel, and anti-freeze should never touch surfaces (floors) that will touch hops.

Leaf & Stem and Seed

- Non-hop material and leaf & stem to be minimized.

- Brewers don’t like seeded hops. Rouge all males in the field and in nearby locations in the wild.

Male Hops

No cones – cones are female organs

Pollen sacks instead

Used for breeding

Hop Pests – Spider Mites

Problem in HOT weather – usually late season.

Life cycle accelerated with temperature

Reduces yield & perhaps quality

Mite Damage

Brown cones and accelerated maturity

If only cause of brown color – perhaps not a great problem

Mites will reduce yields

Aphids

Hop Aphid over-winters in plum & other fruit trees. Return to hops in spring. (13° C)

Reduces yield & quality – vector for diseases

Aphid mass on Leaf

Aphid Damage – Dried cone

Aphids secrete honey-dew on interior surface.

Mold grows on this creating “sooty-mold”

Sooty Mold in Undried Cone

Powdery Mildew

Fluffy, white fungus that over winters in the root crown.

Attacks leaves & cones as the season progresses

Powdery Mildew

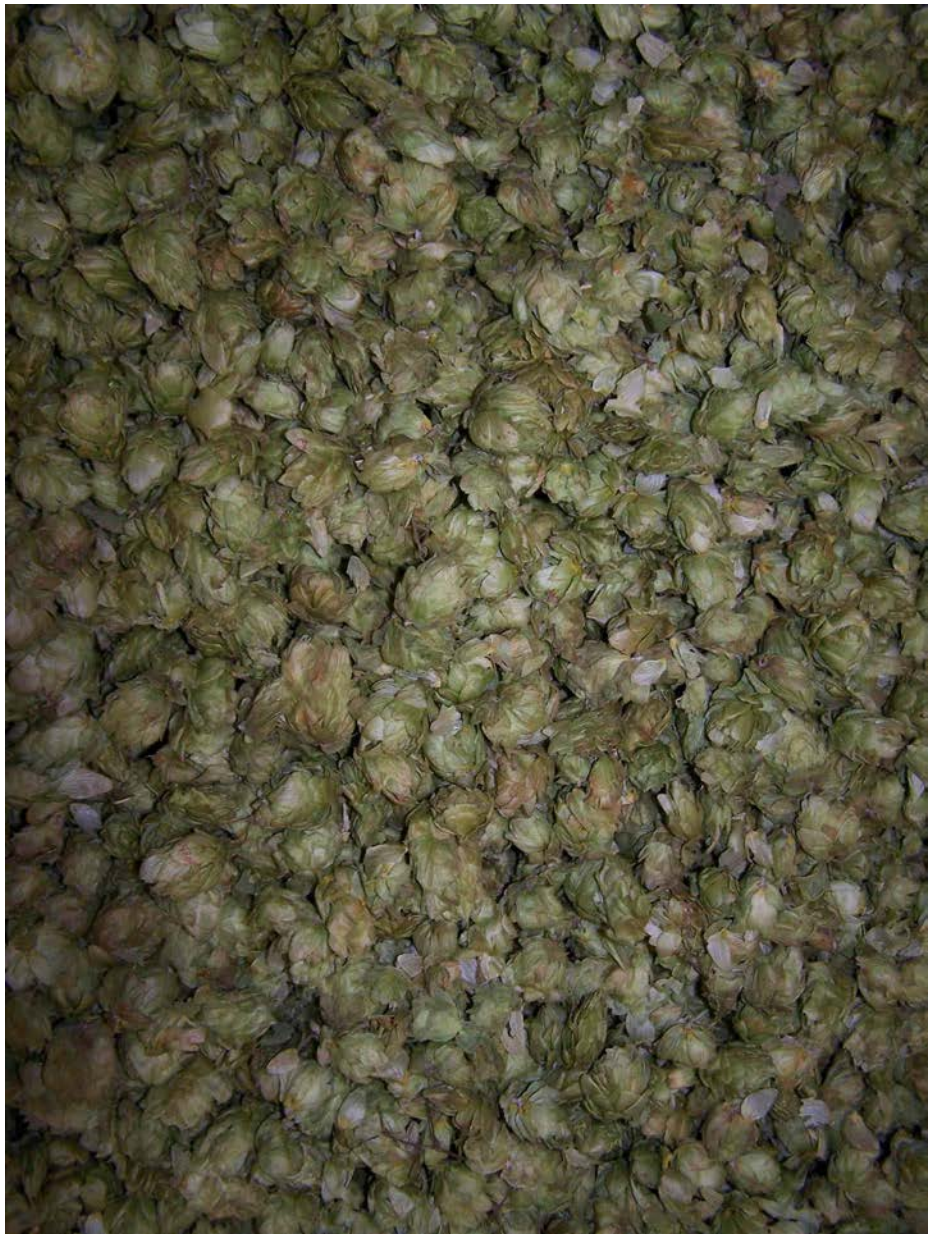
Reduces Yield & Quality

Infected cones often suitable for kettle hopping, but not for dry-hopping

Powdery M. in Cones

Early infection: White mass on deformed cone

Late infection: Cones normal in field, turn brown as they dry.



Downy Mildew

Primary infection from over-winter in root.

Secondary infection on leaves & cones

Downy Mildew

Secondary infection underside of leaf during cool, wet weather.

Downy Mildew more problematic for kettle & especially dry-hopping

Avoid Disease Prone Hops

- If you grow a small amount of a hop that is VERY susceptible to Downy and/or Powdery Mildew, it will act as a source of infection for all hops within a mile or more.
- This will increase cost of production (more spray) and decrease yields for more disease resistant hops nearby.
- Solution: Don’t grow these hops!

Disease Prone Hops to AVOID!

- #1 Columbus (CTZ) very prone to both Downy and Powdery. Spreads both like crazy.
- Palisade – very prone to Downy – dies in Oregon.
- Cluster and Galena also prone to Downy.
- If a hop is NOT grown in Oregon, I would NOT grow it in Wisconsin! If folks in Yakima say a hop is resistant to Downy – this has no meaning. Yakima is in the desert – NO DM!

Wind damage largely cosmetic, accelerates maturity. In extreme cases may be cause for concern.

Harvest Date

- The majority (but not all) craft brewers seem to prefer a later-harvested hop. Maybe 5-7 days past were a hop would traditionally be harvested.
- Later harvest results in a bit more alpha and oil content. Aroma of hop is more aggressive and pungent – less refined.
- Bitterness of beer made with such hops may tend to have a harsher, more lingering bitterness.
- A minority of brewers prefer a traditional harvest date.

Over-dried Hops

Hops dried below 8% moisture lose some or all aroma and will age much quicker. Cones shatter when baled.

Over-Dried Hops

- High Oxidation
- Bad storage
- Loss of aroma
- Very poor for dry-hopping
- Want moisture between 8 and 10%. The closer to 10%, the better.