

2009 BJCP Exam Study Group

Class 4: Hops

<http://destroy.net/brewing/BJCP2009-hops.pdf>



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BJCP Exam Study- Hops - Outline

- Prerequisites: 2009 BJCP Study Guide (Section D, “The BJCP Exam”) and 2008 style guidelines.
- Introduction
- BJCP Exam hop perspective
 - Style questions.
 - Sensory perception language.
 - Recipe question
 - T4, The Big written question.
 - Hop aspects of other written questions
- Summary & Hops beyond the BJCP exam.



BJCP Exam Study- Hops - Introduction

- What are/is....
 - hops and why are they relevant to brewing?
 - the active ingredients in hops?
 - the history of hops in beer?
 - the different varieties of hops?
- How are..
 - Hops cultivated and what do they look like?
 - hops used in the brewing process?



BJCP Hops – Introduction

- What are hops and why are they relevant to brewing?
 - Female flowers of the *humulus lupulus* plant.
 - Vine-like dioecious perennial.
 - Long climbing bine with dark green leaves.
 - members of the *cannabaceae* plant family, closely related to hemp and nettles. (1)
 - 1 crop yield per year, dormant phase necessary during the non-productive season.



BJCP Hops – Introduction

- Primary benefits of hop use in brewing:
 - Taste: bittering agent to balance sweetness, distinctive flavor compounds.
 - Aroma: Spicy, fruity, herbal, earthy complexity.
 - Longevity: Preservative. Hops have a bacteriostatic effect against gram-positive bacteria. (9)
 - Visual: Head retention.
 - Process: Kettle coagulation, rough wort filter, help precipitate proteins if used in high amounts. (11)
- Potential drawbacks:
 - Light Sensitivity
 - Haze
 - Polyphenols
 - Astringency

Hops during the growing season



2.5 months, climbing trellis



2.5 months, vegetative growth, dark green leaves.

Hops during the growing season



3.5 months, Cascade flowers starting



4 months, Cascade flowers maturing.



BJCP Hops - Introduction

Hop Cultivation

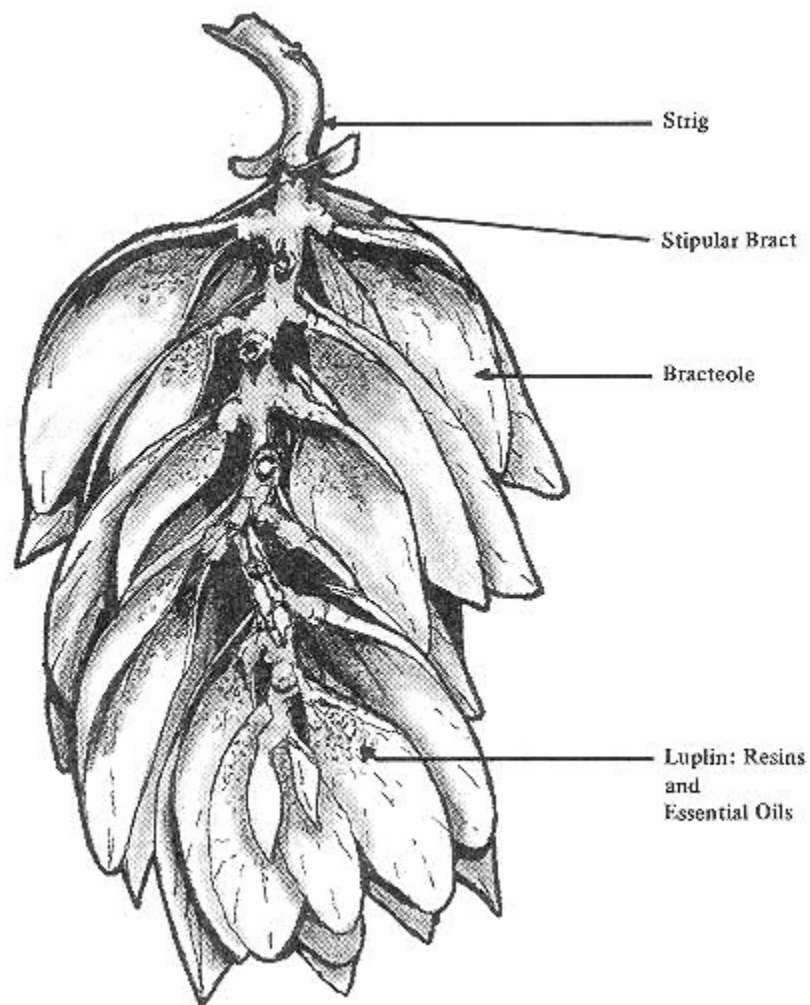
- Yield per acre high priority of the commercial grower. (7)
 - High AA% (Columbus/Tomahawk/Zeus): 3000Lb/acre.
 - Low AA% (Cascade): 2000Lb/acre.
 - Noble, very low AA% (Hallertau): 1000Lb/acre.
- Commercial Hop Growing, Worldwide (6,7):
 - Hops grow best in hot, dry climate between 34-50 degrees N/S.
 - Yakima, WA, 46 degrees N. Nelson, New Zealand, 41 degrees S.
 - Hallertau, Germany, 49 degrees N. Kent, UK, 51 degrees N.
 - 1992: 236k acres worldwide. 2006: 113k acres.
 - USA: 30k acres, Germany: 40k acres.
 - USA: 70% Yakima, WA. 15% Oregon, 15% Idaho.
 - 70% of all crop produced is high alphas for extract. (6,7)
- Hop growing region just as important as variety.
 - Example: U.S. Saaz different than Czech Saaz.



BJCP Hops – Intro Hop flower Profile



Mature hop flower, profile, split in half, displaying lupulin glands. (8)





BJCP - Hops Introduction - History

- What is the history of hops in beer?
 - Most recent addition of the 4 common ingredients.
 - Gruit before hops, combination of herbs/spices.
 - First documentation..
 - Gaius Plinius Secundus aka. Pliny the Elder (61-113 AD). Discusses hops in his study of natural history. To the Romans, it was *Lupus Salictartius*, from the way they originally grew. As the ancients said, hops grew "wild among willows, like a wolf among sheep," hence the name *Humulus Lupulus*. (9)



BJCP - Hops Introduction - History

- First recorded...
 - Harvesting: 750AD
 - Use in beer: approximately 1000AD
- German acceptance 1500s, documented in the 1517 purity law, the Reinheitsgebot. (1)
- Introduced into British Isles from Holland in 1500s.
 - They were not well accepted under Henry VIII and were not in widespread use until the 1600s. (1)
 - Hopped beer of the Middle Ages was extremely heavily hopped. 7 lb. to the hogshead (63 gallons). (4)
 - Hodgson's India Ale hopped at a rate of 10.5oz. Per US 5 gallons, approximately 70 ounces per US barrel (3.5 lb per). (4)



BJCP Hops – Intro

Active Ingredients

- What are the active ingredients in hops?
 - Soft resins found in the lupulin gland of the flower.
- α & β acids. Bacteriostatic against gram+ bacteria. (1)
- α acids: primary humulone, also cohumulone, adhumulone.
 - Total α acid content ranges from 2-20%.
 - Cohumulone, humulone – 15-50% each. Variety specific. (11)
 - Adhumulone – 15%. (11)
- β acids: lupulone, colupulone, adlupulone. (11)
- Essential oils: ~.5-3% volume by weight. Extremely volatile.
 - Can increase perceived bitterness & enhance mouthfeel. (11)
 - 80% hydrocarbons. Primarily Faresene, humulene, myrcene, caryophyllene. (11)
 - Remainder oxygenated sulfur containing hydrocarbons. (11)



BJCP - Hops Introduction

Hop Acids

- Soft Resins (α & β) extracted by boiling. each contribute bitterness.
- α acids isomerized during boil. Chemical structure re-arranged into a more stable form.
- Approximately 25-30% alpha acids utilized during a typical bittering charge in a 60-90 minute boil.
- Extraction influenced by density of wort and length of boil.
- β acids are poorly soluble in wort and contribute only about 10% of bittering. (11)
- β acids Higher bacteriostatic effect than α acids. (9)
- Highly oxidized β acids can have a spoiled vegetal taste. (11)



BJCP - Hops Introduction Varieties

- ~100 varieties of hops are available commercially.
 - Cluster original American hop
 - 70% of all U.S. hops grown/used in 1978 . Very small percentage now.
- Key varieties to know for BJCP exam: Noble hops and signature varieties for hop forward styles.
- Noble hops are the most ancient land races of hops.
 - German Tettnang
 - German Hallertau Mittelfruh
 - German Spalt
 - Czech Saaz
- Noble hop common traits:
 - Flavor & Aroma: spicy and floral
 - Low alpha acid %, nearly equal beta acid.
 - Low myrcene content, low cohumulone content and high humulene content.
 - Store poorly.



BJCP - Hops Introduction

Varieties important for BJCP exam

Name	Alpha Acid %	Flavor and Aroma	Associated Styles
Cascade	4.5-7	Flowery, citrusy, grapefruit	American ales
Centennial	9.5-11.5	Floral and citrus	American ales
Chinook	12-14	Spicy, piney, distinctive grapefruit. Coarse	American ales
Fuggle	4-5.5	Earthy, woody, fruity	British ales
Hallertau Muttelfrueh	3-5.5	Mild, pleasant, slight spicy	German lagers
Kent Golding	4-5.5	Gentle, fragrant	British ales
Czech Saaz	3-4.5	Mild, slightly Spicy, herbal, flowery	Bohemian Pilsner
German Spalt	4-5	Mild, pleasant, slightly spicy	German lagers, ales
German Tettnanger	3.5-5.5	Mild, pleasant, slightly spicy	German lagers, ales
U.S. Northern Brewer	6-10	Woody, Minty	California Common



BJCP - Hops Introduction

Brewing Process

- Hop formats: Whole flower, pellets, plugs. Each has different storage and utilization characteristics.
- Whole Flowers: Unruptured lupulin glands, most perishable, bulky storage.
 - Some brewers insist on them. Sierra Nevada is one example.
 - Higher quantity of vegetative matter = lower batch efficiency.
 - Often have lower kettle utilization than pellet hops, up to 25% less (10).
 - Soft, even, gentle extraction of acids & oils over a longer period of time. (5)
- Pellets: Ruptured lupulin glands, most stable, space-efficient storage.
 - Direct, more immediate, “in your face” dissolution of acids & oils. (5)
 - T90 pellets: Powderized whole flowers at a 90% recovery of whole flowers by weight.
 - T45 pellets: Powderized lupulin glands with vegetal material separated mechanically from resins/oils at -35 degrees C. 45% recovery of whole flowers by weight. (7).
- Plugs: Compressed flowers. .5oz units. Designed for British cask ales. (11).
- Extremely perishable product. Freshness is important for all styles with 1 big exception.



BJCP - Hops Introduction

Brewing Process

- Brewers commonly add hops at 4 possible times during the brewing process: At 60, 30 and 0 minutes left in the boil and post fermentation (dry hopping).
- All have different effects on hop bitterness, flavor and aroma in the finished beer and not all beers will utilize each addition point.

Boil time, min.	Bitterness contribution	Flavor contribution	Aroma Contribution
60	High	Low	None
30	Low	Moderate	Moderate
0	None	Low	High
Dry Hop	None	Low	Highest



BJCP - Hops Introduction

Measuring bittering

- Percentage of bittering extracted from hops into a finished beer is commonly referred to as IBU, International Bitterness Units. (1 IBU = 1ppm, or 1 mg per Liter)

$$IBU = \frac{(W \times U \times A \times 7,489)}{(V \times C)}$$

- W=weight in ounces, U=utilization in percent, A=alpha acids in percent, V=volume in gallons, C=gravity correction factor $1 + [\text{gravity} - 1.060 / .2]$ (10)
- American Light Lager: 8-12IBU, close to flavor threshold. Some English pale ales can have up to 45IBU in a beer starting at the same original gravity as the American Light Lager. (10)
- Measured IBU level does not always translate to the perceived bitterness. (1)
- Higher gravity wort can lower kettle utilization as much as 15%. (10)
- The ionic makeup of the brewing water, particularly carbonate and sulfate levels, directly affects the perception of bitterness. (11)
- Any post-fermentation filtering, fining, centrifuging can also lower measured IBU and/or perceived bitterness. (10)



BJCP Exam – Hops

BJCP Sensory Perception Language

- flavors/aroma/appearance/mouthfeel, good and bad
- Acceptable flavors/appearances, within a range:
 - Bitterness - isomerized hops.
 - Cloudiness/haziness - hop polyphenols, acceptable in some styles (14C, Imperial IPA for example.)
 - Grassiness - appropriate in small levels in some styles: American Pale ale, all of category 14 (IPA). possible source=over dry hopping, hop varieties (Cascade).
 - Head retention - high alpha acid hops can help contribute to good head retention.
- Off flavors/aromas/mouthfeel, always:
 - Cheesiness - oxidized, old hops.
 - Skunkiness/lightstruck - Ultraviolet light reacting with isomerized hop alpha acids.
 - Astringency - excessive hopping can be a source.



BJCP Exam

Style Questions & Hops

- S1-S7 “Style Questions” - “For each style provide a statement describing the style as well as the differences and similarities between the styles by addressing the following topics”. Use knowledge of hops to help you on these questions.
- *S1. Identify three top-fermenting beer styles where the minimum original gravity is 1.070 or higher. Compare & contrast is key. Pick one hoppy beer in this range to differentiate the other two. Imperial IPA, 14C, a good one for this question. Aroma & Flavor: Intense complex citrus, resin, pine; bitterness: Strong hop bitterness, but not astringent.*
- *S2. Identify three distinctly different German bottom-fermented beer styles. All german noble hops. Hop aroma: spicy & flowery, if appropriate (German Pils); hop flavor, spicy noble, if at all.*



BJCP Exam

Style Questions & Hops

- *S3. Identify three distinctly different beer styles that contain wheat as 25% or more of the grist.*
 - American Wheat a good one to include for for S3, don't forget that the hop flavor for this is different than other wheat: low to moderate citrus hop.
- *S4. Identify three distinctly different Belgian beer styles.*
 - hop flavor: spicy, earthy, sometimes fruity. styrian goldings.
- *S6: Cities question. Know the signature hops of specific cities/styles.*

Possibilities:

- Dusseldorf - Alt is the hoppiest of all german ales, mention spicy german noble hops (Spalt, specifically),
- San Francisco - California Common. Northern Brewer. Hop flavor descriptors: woody, minty.
- Burton-on-Trent – Extra Special Bitter (English Pale Ale), Bass Ale. EK Goldings. herbal, earthy.
- Senne Valley – Lambic/gueuze. No hop flavor/aroma and very low hop bitterness.



BJCP Exam – Hops – Recipe Question

- Calculating IBUs for all recipe questions

$$IBU = \frac{(W \times U \times A \times 7,489)}{(V \times C)}$$

- American IPA most complex, but keep it simple. Example recipe

STYLE	MALT (TYPE / %, ORIGIN)	HOPS (BITT. vs. AROMA)	YEAST (STRAIN, KIND, #)	CO ₂ VOL.	NOTES (OG, PROCESS, etc.)
American IPA	11# Domestic 2-row pale 1# Domestic 40L	1oz. 13%AA Horizon, 60m (52IBU) .5oz 13%AA Horizon , 30m (6.5IBU) .5oz Centennial, Cascade, 0min. .25oz Centennial/Simcoe, .5oz. (DRY)	1 Pint California Ale yeast slurry Pitching temp: 68F 1 week ferment 68F 2 day 70F diacetyl rest 2 week dry hop 68F	2.7	OG: 1.060 FG: 1.012 IBU: 59 SRM: 7 Water salts: 1tsp CaSO4 10qt. H2O mash Mash temp: 152F 60min., Mash out: 165F 7pH H2O 60 min. sparge Collect 6.5 gal., boil 90 min., wort chiller & irish moss added w/ 15 min left CCE: RR Blind Pig

- Classic American Pilsner: Cluster hops.
- Tripel: Styrian Goldings or stick to noble hops.



BJCP Exam – Hops

T4, The Big Recipe Question

- Discuss hops, describing their characteristics, how these characteristics are extracted, and the beer styles with which the different varieties are normally associated.
 - Slides 2-18
 - See additional Handout



BJCP Exam – Hops

Other Written Questions

- T1, j) bitterness *example answer*
 - A basic flavor sensation perceived on the back of the tongue/mouth having an acrid, sharp, strong, and perhaps pungent taste that may be pleasant, or it can be harsh. Hops are the most traditional way of controlling bitterness through the boiling of hops infused in wort for a period of 60 to 90 minutes. The employment of dark, roasted grains can also enhance bitterness and the perception of bitterness can further be controlled by water chemistry. Bitterness can be increased or decreased by increasing or decreasing AA% selected in hops, hop boil time, roasted malts usage %, amount of magnesium sulfite used in water. Bitterness is a common component of many styles such as IPA, American Barleywine, American Pale Ale, English Pale ale, German Pils .



BJCP Exam – Hops

Other Written Questions

- T8, water *example answer*
 - Sulfate (SO₄) can influence the mash by assisting in protein and starch degradation. It can also lend a dry, crisp flavor to the finished beer, accentuating hop bitterness. Excessive levels of SO₄ can have an unpleasant drying and astringent effect in the finished beer, especially in the presence of roasted grains (12).
 - Higher boil pH results in better isomerization but the bitterness at lower pH considered finer and more balanced (11).



Summary & Hops beyond the BJCP exam.

- New high alpha cultivars have a common lineage:
 - BB1: Obtained in 1916 rhizome taken from a wild hop in Morden, Manitoba.
 - Brewer's Gold → Crossed with other hops: Magnum, Chinook, Centennial, Nugget Horizon.
- Yakima Chief, Hopunion, USDA variety databooks and websites.
- Newer cultivars with ancestry and characteristics of common hop varieties.
 - Santiam: Tettnang, Sterling: Saaz, Mt. Hood: Hallertau, Willamette: Fuggle.
- Other tasting ideas:
 - Orval to highlight Styrian Goldings in balance with esters and brett.
 - La Rulles Tripel or Houblon Chouffe to show American Hops in a Belgian Ale.
 - Firestone Walker Double Barrel to show balance of American Hops + American Oak.

BJCP Exam Preparation: Hops

Credits and References

- 2008 BJCP guidelines, and BJCP Study Guide. www.bjcp.org
- Brewer's Association <http://www.beertown.org/events/gabf>
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- "Humulus Lupulus: Hopping for Flavor and Aroma" Matthew R. Brynildson, Michigan Brewers Guild and MBAA District Michigan Winter Conference
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- Principles of Brewing Science. George Fix, Ph. D. Brewers Publications, 1999.

BJCP Exam Preparation: Hops

Further Reading

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- Jim Busch, "How to Master Hop Character--Exploring Hop Flavors and Aromas for More Targeted Recipe Formulation," *Brewing Techniques*, vol. 5, no. 1, 30-33 (1997).
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