

# BICEP #5

This session covers hops, bitter, cheesy and light struck off-flavors and Categories 9, 10B, & 11 - Scottish & Irish Ales, English Brown Ales (5, 3).

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## Key to Abbreviations and Text

**Bolded Text (except for headers) is important information which you should know for the exam.**

*Italic Text is “just for fun” and won’t be covered on any of the exams.*

\* This material might appear on the Online Qualifier Exam.

† This material might appear on the Tasting Exam.

‡ This material will be (or might be) tested on the Written Proficiency Exam.

## Part 1: Hops\*‡

**History:** *Hops (Humulus Lupulus) have been used as medicine since ancient times. Brewers have used hop cones to bitter beer since the Middle Ages. Hop cultivation was first recorded in 736 (near Hallertau, Germany) and hops were first mentioned as a bittering agent in 1079 (in Bavaria). From there, hop use spread northwest, reaching Northern Germany and the Netherlands by the 13<sup>th</sup> century. Because local authorities usually had either a trade monopoly or a heavy tax on traditional bittering herbs, hops were an attractively cheap, if illegal, alternative. Hops only became widely accepted when brewers noticed that they helped keep beer from spoiling (due to gram-positive antibacterial chemicals within the hop resins). Flemish immigrants and merchants introduced hopped beer to England in the 14<sup>th</sup> century, but production of hopped beer was banned in England until the early 1500s. For a time, the English referred to traditionally bittered beers as “ales” and beers bittered with hops as “beer,” and brewers specialized in one or the other.*

*Dutch colonists first cultivated European hops New Amsterdam in 1629 and hops were cultivated throughout northern North America by the middle of the 17<sup>th</sup> century.*

*At one time, New York State was a major hop growing region, but at the beginning of the 20<sup>th</sup> century, fungus infections, Prohibition and competition from growers in the U.S. Northwest killed the trade. Today, Western Washington, Western Oregon and Northern California are the main U.S. hop-growing regions. Worldwide, the U.S. ranks 2<sup>nd</sup> in hop production. Germany is first. Other major hop-growing countries are China (Xingjian province), the Czech Republic (Saaz region), Poland, Australia, England (Kent & Worcestershire), North Korea, Slovenia, France, Belgium, New Zealand and Canada (British Columbia).*

**Biology:** The hop plant (*Humulus Lupulus*) is a *bine* (a plant which climbs using its stem rather than tendrils or suckers), native to the northern latitudes (35-55° latitude) of the northern hemisphere. They require long growing days and mild temperatures so they can’t be grown at low-latitudes. Hops grow rapidly in the spring from rhizomes which have survived the winter. By late summer they can reach heights of up to 45 feet high. They require well-drained soil of 5.0-7.0 pH and are quite vulnerable to various types of mold, so they do well in drier climates. Terroir (growing region) has an effect on hop characteristics, due to different soil and climatic conditions. Farmers in more tropical latitudes, such as South African, must

grow hops under artificial light, although they are attempting to breed strains which need less daylight.

Unlike many plants, hops come in male and female varieties. Only the unfertilized seed cones of the female plant are used in brewing. Since fertilized cones produce undesirable seeds and keep the plant from producing hop resins, growers destroy male plants except as breeding stock. Hops are botanically related to marijuana and some chemicals found in hops are similar to chemicals found in cannabis. Part of the historical controversy over hops as a bittering agent might have been because hops are a relaxant and sedative while many of the older bittering agents were stimulants. Alpha acids, responsible for hop bitterness, have a mildly bacteriostatic action on gram-positive bacteria, meaning that they have a preservative effect on beer.

**Processing:** Hops are picked in late summer or early fall when the cones (technically, strobiles) have dried sufficiently. When picked, they should have a slightly papery texture. **They are dried at warm (90-100 °F) temperatures in a kiln** (traditionally, a building called an oast), **then packed in airtight packages and kept refrigerated to prevent degradation of oils and resins.**

**Chemistry:** Hops produce many compounds with medicinal, aroma and flavoring characteristics, but brewers are mostly interested in **Alpha Acids (AA)**, a group of phenolic-like compounds (humulone, co-humulone and adhumulone). Professional brewers and hop breeders are particularly interested in the ratio of humulones to cohumulones, since cohumulones produce a harsher bitterness.

**1. Lupulin.** The active ingredient in hops, produced by glands within the strobiles of female plant. Lupulins appear as a powdery, sticky yellow resin.

### 2. Soft Resins

**A. Humulones and Cohumulones.** These are the source of alpha acids, which contribute bitterness to beer. **In order for alpha acids to be soluble in liquid, they must be isomerized by boiling.** Alpha acids constitute 3-10% of dry weight of the hop cones, although some modern varieties can have upwards of 15% Alpha acids. Cohumulones are said to impart a harsher bitter. Alpha acid levels drop as hops age, especially if they are exposed to air or are stored at warm temperatures. Alpha acid percentage in poorly stored hops can drop by up to 60% within a year. For this reason, hops are stored cold and are packed into vacuum-sealed, oxygen barrier packages.

**B. Lupulones and Colupulones.** These are the source of beta acids. **Beta acids don’t isomerizes or contribute bitterness, but do contribute to hop aroma.** As hops age, oxidation turns soft resins to into minimally-soluble hard resins and turns soluble AA into less-soluble beta acids. While the original ratio of AA to beta acids within a particular hop cultivar doesn’t seem to be important, ratio of alpha to beta acids within a particular batch of dried hops can be an indicator of freshness, since AA degrade easily, even under refrigeration. Beta acids (lupulone, colupulone and adlupulone) impart minimal flavor but have an effect on a beer’s bitter aroma, so high beta acid

hops are often added near the end of the wort boil. Oxidized beta acids produce “cheesy” odors and flavors which are reminiscent of Camembert or Roquefort cheese.

**3. Essential Oils.** These are volatile compounds detectable as hop flavors and aromas. They are easily lost during boiling, but can be retained by adding aroma and flavor hop additions late in the boil, as well as dry hop additions late in the fermentor or cask. Dry hopping works because essential oils can be extracted by alcohol and carbon dioxide.

**A. Hydrocarbon-Based Oils:** Monoterpenes & sesquiterpenes. They represent about 75% of essential oils. Aroma and flavor hops have low monoterpene to sesquiterpene ratios. Humulene to caryophyllene ratios are used to distinguish between varieties of “noble” hops. The distinctive American hops (e.g., Amarillo, Cascade) have high concentrations of both.

I. Monoterpenes.

a) Humulene has a delicate, refined flavor and oxidizes to produce spicy notes. “Noble” hops have high humulene levels.

b) Myrcene is more pungent, and is higher in U.S. hops. It oxidizes to produce citrusy or piney notes.

II. Sesquiterpenes: Farnesene & Caryophyllene. They oxidize to compounds with “grassy” aromas.

**B. Oxygen-Bearing Oils:** Also called essential alcohols, they represent about 25% of essential hop oils. Linalool has a hoppy aroma. Geraniol has a floral, perfumy aroma like geraniums. All oxygen-bearing oils degrade with age and are believed to be sources oxidation products in beer. Once oxidized, they have “grassy”, “hay,” or “sagebrush” notes which some people find objectionable.

**4. Sulfur Compounds:** While not particularly desired by brewers, hops also contain sulfur-bearing compounds which can contribute sulfur (DMS) notes to finished beer. They are also responsible for the skunky (mercaptan) odor of light-struck beer.

**Terminology:** “Bittering,” “boiling” or “kettle” hops refer to strains with high AA levels, especially those with high cohumulone levels. They can be added early in the boil since they have few aroma compounds and the longer boiling time helps to isomerize more of the available AA. They traditionally give a harsher bitterness.

“Aroma” or “flavor” hops have lower AA levels (especially low cohumulone levels) and higher concentrations of hydrocarbons. They are added near the end of the wort boil to improve beer taste and aroma without increasing bitterness.

“Dual Use” hops are strains suitable for use both as kettle hops and flavor/aroma hops, especially modern strains with high levels of AA but low levels of cohumulone (e.g. Simcoe, Amarillo). Commercial brewers like dual use hops because they are more versatile and can be less expensive than traditional aroma hops. (Since most hops grown go into minimally-hopped light lagers, the big brewers can get away with using hops with a harsher bitterness and less flavor and aroma.)

“Noble” hops are traditional flavor/aroma breeds with very low cohumulone and adhumulone levels and the highest concentrations of aroma chemicals, especially humulene. They are particularly prized in pilsner-style beers. Technically, only German or Czech hops strains grown in near their place of origin can be considered noble (e.g. Tettnanger hops grown near Tettnang, Germany), but, in a broader sense, any German-grown Tettnanger, Spalter or

## Hop Utilization and Kettle Utilization Rates (KUR)

Sometimes called Kettle Utilization Rates (KUR), hop utilization is a measure of the amount of alpha acids isomerized during wort boil, as measured in International Bitterness Units (IBU). That is, how much hop bitterness actually gets into your beer. Hop utilization varies from 0% for hops added at the end of boiling or used for dry hopping, up to a maximum of 25-33% after a 2 hour boil.

There are several different formulas for determining hop utilization rates, devised by homebrew gurus such as Jackie Rager, Glenn Tinseth, Randy Mosher and others. All work equally well and give approximately similar values. When brewing, you should choose one formula and stick with it. One formula is given below:

IBU extraction formula:  $W \times A \times U \times 7489 / V \times C$

Where: W = oz. hops, A% = Alpha Acid %, U = Utilization % (at best 30% for homebrewing, often lower), V = wort vol. in gallons, C =  $1 + ((O.G. - 1.050) / 2)$  - a correction for wort gravity. 7489 is a conversion factor from mg/l to ounces per gallon.

**Calculating Total IBU:** To figure the total IBU extraction for a beer, you must calculate the IBU extraction for each hop addition, as described above, and sum the results.

IBU measurements are imprecise, since methods used to determine IBU measure soft resins as well as dissolved iso-alpha-acids, meaning IBU tend to run 5-10% higher than actual hopping levels. Furthermore IBU do not correlate perfectly to taste perceptions, nor do they capture the quality of bitterness.

**Factors that aid KUR:** Alpha acid extraction depends on a number of factors:

\* **Lower wort concentrations.** Higher OG wort makes it harder for isomerized alpha acids to go into solution.

\* **Longer boil times (up to a maximum of 2 hours).** Longer boil times give alpha acids more time to isomerize and get into solution. By contrast, flavor and aroma hops don't add as many alpha acids because they are exposed to heat for a shorter amount of time.

\* **Sulfate additions.** Sulfate helps isomerize alpha acids.

\* **Hop form:** Hop plugs and liquid alpha acid extract have slightly better utilization than whole hops.

\* **pH:** Highly basic wort helps isomerize alpha acids, but at the expense of interfering with yeast health and beer flavor.

**Hallertauer hop, or any Czech-grown Saaz hop, can be considered “noble,” regardless of its place of origin.**

Hops are sold as whole cones, plugs (pressed cones), pellets (produced from ground and pressed cones) or hop oils. All these products have strong and weak points. Major commercial brewers prefer hop oils for aroma and flavor additions; craft brewers prefer pellets for dry hopping.

**Measuring Bitterness:** Hop bitterness is typically measured in non-scientific units of measurement called

**International Bitterness Units (IBU), or just BU (bitterness units).** The lower threshold for detecting hop bitterness is about 10 IBU, the upper threshold for detecting hops is about 60-100 IBU, the degree of resolution is about 5 IBU (that is, the average person wouldn't be able to tell the difference between otherwise identical beers where one had 20 IBU, but the other had 18 or 23 IBU, but they would be able to do so if the beer had 15 or 25 IBU). Beer with less than 20 IBU is considered to be lightly hopped. Beer with more than 50-60 IBU is considered to be heavily hopped. Since the typical maximum human threshold for perception of hop bitterness is about 60 IBU (although some people have much higher thresholds - up to above 100 IBU), hop rates above that level won't contribute much to a beer's perceived bitterness. That said, the estimated maximum possible IBU rate is somewhere over 100, and some Imperial IPA, Barleywines and Imperial Stouts push the upper limit!

**HBU:** This is a rule of thumb measurement used by some homebrewers to calculate hop bitterness. It consists of alpha acid % x ounces of hops. For example, 2 oz. of hops at 5% Alpha Acid would count as 10 HBU. HBU is a very simplified form of figuring Hop Utilization.

**BU:GU Ratio:** Since hop bitterness is balanced by alcoholic strength, malt bitterness, yeast character and other factors, a useful method of determining relative bitterness is by calculating the beer's Bittering Unit to Gravity Unit (BU:GU) ratio. This is a subjective measurement invented by Ray Daniels, which is a ratio of the beer's IBU level against the last two digits of its Original Gravity. For example, an Imperial IPA with 100 IBU, but an O.G. of 1.050 would have a BU:GU ratio of 2:1 (extremely hoppy), while a Weizenbock (20 IBU, O.G. 1.070) would have a ratio of 1:3.5 (very malty).

**Primary Methods of Extracting Hop Compounds:** Hops are boiled in the wort to release soft resins contained within the cones and to isomerize AA within the resins making them water-soluble. Cohumulones are more soluble than humulones, so excessive boiling times can produce harsh bitterness even from hops with low cohumulone levels. Because essential oils are volatile, convention wisdom demands that flavor and aroma hops be added near the end of the wort boil.

**Bittering/Kettle Hops:** These hop additions are responsible for most of the alpha acids in beer. Kettle hops are boiled in wort for 60-120 minutes. Maximum bitterness utilization is 25-33%. Only humulones and cohumulones (IBU) are gained using this method; more volatile compounds are boiled away. The lovely hop aromas you get from the boiling wort represent flavor and aroma that isn't going into your beer!

For this reason, commercial brewers prefer high alpha acid varieties with relatively few essential oils as kettle hops. Higher alpha acids means fewer hops are needed, which helps to cut costs and also means that fewer polyphenols are extracted from the hops (although this is a relatively minor problem). Maximum IBU extraction is obtained after about 120 minutes of boiling; there is no need for longer boil times.

**Flavor Hops:** Added 15-40 minutes before wort boil ends. IBU utilization is 5-15%, some volatile compounds are preserved, mostly the less volatile compounds which are only detectable in flavor. Flavor hops walk the line between adding IBU and adding flavor and aroma additions to the beer. Brewers often use lower alpha acid hops, with higher levels of essential oils, as flavor hops.

## Noble Hops

The term "noble hop" is used to describe certain traditional varieties of German or Czech aroma/flavor hops. Generally accepted noble varieties are Hallertauer Mittelfrüh, Spalt(er), Saaz (AKA Zâtec) and Tett nang(er).

\* **Terroir counts!** Noble varieties are only considered "noble" if they are grown in the area for which the hop variety is named. (i.e., noble Hallertauer can only come from the Hallertau valley in Germany). A U.S.-grown noble hop isn't noble!

- **Hallertauer Mittelfrüh:** Grown in the Hallertau (AKA Holledau) region in central Bavaria in Germany.

- **Spalt:** Grown in the Spalter region south of Nuremberg, Germany.

- **Saaz:** Grown in Bohemia in the Czech Republic.

- **Tett nang:** Grown around the town of Tett nang in southern Baden-Württemberg in Germany.

\* **Chemically described as:**

- 1:1 alpha : beta acid ratio.

- 2-5% alpha acid.

- low cohumulone & myrcene content.

- high humulene content.

- >3:1 humulene : caryophyllene ratio.

\* **Prone to oxidation:** All noble hops have poor storage stability.

\* **Consistent bittering potential even when aged.**

\* **Debatably noble:** Certain hops have similar chemical profiles to the accepted noble varieties. For this reason, some brewers, scholars and beer writers argue that they should be considered "noble" as well. Debatably noble varieties include East Kent Goldings, Fuggles, Hersbrucker and Styrian Goldings, as well as modern descendents of the noble varieties grown in the traditional regions (e.g., Hallertauer Gold, Spalt Select).

**Aroma Hops:** Added 0-5 minutes before wort boil ends, or allowed to steep in hot wort after flameout. IBU utilization is 5% or less. Aroma hops impart just the most volatile essential oils to the beer, typically those found in the aroma. As with flavor hops, brewers often use lower alpha acid hops, with higher levels of essential oils, as aroma hops.

**Other Methods of Extracting Hop Compounds:** While the techniques of hop extraction given above generally work well, there is evidence that longer boiling times drive out or alter certain desirable compounds, so special techniques are used to get even more hop aroma and flavor.

**Mash Hopping:** Hops are added to the mash. Very little hop bitterness is extracted, but hop aroma and flavor compounds somehow survive the wort boiling process. Mash hopping is said to result in a smoother bitterness, but hop utilization is reduced by about 80%. Mash hopping is traditionally used when making Berlinerweisse.

**First Wort Hopping:** A portion of the hops, possibly even hops normally added as flavor additions, are added to the first runnings in the lauter tank during wort run-off and allowed to steep before being boiled. As with Mash Hopping, hop aroma and flavor compounds somehow survive the wort boil, but hop utilization is reduced. It is said to produce a more pleasant hop flavor, aroma and bitterness. Traditionally, this method was sometimes used when making German and Bohemian

Pilsners, but homebrewers and some craft brewers have adopted this technique for other beers styles.

It is believed that the higher pH helps extract oils from the hops and that the temperatures encountered at mash runoff help form stable hop oil compounds and perhaps even esters. It is also believed that the long boiling time drives off or alters undesirable flavor and aroma compounds. Many brewers have reported a smoother, more pleasant bitterness and a fresher hop aroma using First Wort Hopping. It is still unknown how hop aroma from this technique compares to dry hopping.

**Hopback Filtering:** Hot wort is run from the kettle to the fermentation tank (or to the cooling tank or heat exchanger) through a filter or strainer filled with hops. This gives an effect very similar to aroma hopping, since the hops in the hopback only add hop aroma. A hopback also serves to partially filter the wort. Running wort through a hopback is a common English brewing technique.

**Dry Hopping:** Hops are added to the secondary fermenter or to the cask. Alcohol in the beer extracts the essential oils, which increases hop aroma without greatly increasing bitterness. This is a common American and British brewing technique, which is less commonly encountered in German and Belgian brewing.

Practically, very few bacteria survive on hop and even fewer survive once the hops get in contact with the alcohol in the beer, so there is very little risk of infection from this technique.

Leaving the drop hops in a beer for a long period of time (months), or using massive amounts of hops might extract polyphenols (astringency, protein haze) or impart grassy or hay-like notes. Beers dry hopped with fresh (green) hops will often have notes reminiscent of fresh-cut grass.

**Hop Fractions:** Hop oils and alpha acids can be chemically extracted from hops and separated into individual compounds. A variety of hop oils are available, as are extracts of alpha acids. These are rarely available to homebrewers, but are sometimes used by large commercial brewers to standardize their products or to achieve a particular aroma or flavor profile. Hop fractions are also used to keep beer from becoming lightstruck, since the sulfur-bearing precursors to the lightstruck phenomenon are removed during the extraction process.

**Hop Terroire:** As with grapes, the place where hops are grown affects their flavor, which is why hops are often labeled by their place of origin. For example, Goldings, Styrian Goldings, Kent Goldings, and East Kent Goldings all refer to the same general variety of hop; the only difference is that Kent Goldings and East Kent Goldings are grown in the County of Kent (just East of London) while Styrian Goldings are grown in Austria.

Hop producers have confused the issue by growing traditional breeds far from their place of origin and by developing new hop cultivars with similar-sounding names. For example, Hallertauer Mittlefrüh hops are particularly difficult to grow, so modern German growers often grow a hardier modern strain called Hallertauer Tradition which doesn't have quite the same characteristics as the original. American growers also produce Hallertauer hops, but these also differ from original German Hallertauer. While they are all good hop strains, if you're fussy about getting an "authentic" flavor for a particular beer style, beware the differences!

**Hop Flavors and Aromas:** Hop flavors and aromas are described using terms such as "grassy," "floral," "citrus," "spicy," or "earthy". Pilsner beers showcase the flavor and aroma

characteristic of noble hops. Look for "spicy" Saaz notes from Czech Pilsners, and flowery, spicy or grassy aromas from the other noble hop strains in German Pilsners. British beers, especially IPA show off hop bitterness and to a lesser extent the flowery, spicy and citrusy notes of English hops such as Fuggles or Goldings. American craft beers are noted for citrus, piney, resinous or spicy aromas provided by distinctively American hop breeds such as Cascade, Centennial, Chinook, Columbus, Amarillo or Simcoe.

### Important Hop Varieties

Hop Variety	Origin	Characteristics	Styles
Hallertauer Mittlefrüh, Tettnang, Spalt	German	"German Noble hops" with low bitterness, but complex, "elegant" spicy, floral notes. Used for flavor/aroma only. Often low IBU.	Munich Helles, Dortmunder Export, German Pils, Bock
Saaz	Czech	"Noble" hop with mild floral notes. Used for flavor/aroma only.	Bohemian Pils
Goldings, Kent Goldings, Fuggles	U.K.	Earthy, floral, spicy, woody notes. Medium IBU. Used for bitter, flavor & aroma.	Eng. Pale Ale, IPA & Barleywine
Cascade, Centennial, Columbus, Chinook, etc.	U.S. Pacific NW	Nicknamed "C" hops. Citrusy, grapefruity, piney. Medium to high IBU. Developed quite recently (early 1970s). Includes recent proprietary varieties (e.g., Amarillo, Citra, Warrior). So called "dual use" hops - can be used bitter & flavor/aroma.	American Pale Ale, IPA & Barleywine
Bittering Hops (e.g., Perle, Bullion, Galena, etc.)	All	High-alpha acid hops with lower levels of essential oils and/or "rougher" flavors & aromas. Mostly used for bittering.	All, esp. IPA, Barleywine

### Other Hop Varieties

While these hop varieties aren't particularly important in themselves, they provide distinctive character to certain styles of beer described in the BJCP Guidelines:

Hop Variety	Origin	Characteristics	Styles
Cluster	U.S.	An old (19 <sup>th</sup> century) American variety with a somewhat "rough" aroma and flavor. Mostly used for bittering.	Classic American Pilsner
Lublin	Poland	Polish-grow Saaz hops. Used for flavor & aroma.	Baltic Porter
Northern Brewer	Europe, America	Rustic, minty, woody. Used for bitter, flavor & aroma	California Common

Styrian Goldings	Belgian	Spicy. Used for bitter, flavor & aroma.	Witbier, Belgian Pale Ale
Strisselspalt	France	Similar to some German noble hops.	Saisons, Bière de Garde.

## Part 2: Off-Flavors

### Alpha Acids (Bitter)

**Detected in:** Flavor, mouthfeel.

**Described As:** Hoppy bitterness. Some hop varieties produce a “clean” bitterness, while others produce a harsher, “coarser” bitterness. Extreme levels of hop bitterness can impart a drying, harsh resinous and/or tongue-coating mouthfeel.

**Typical Origins:** Hop additions during wort boil. Additions of hop extracts to wort or beer.

**Typical Concentrations in Beer:** 0-140+ mg/l, 0-100+ IBU, depending on style.

**Perception Threshold:** 5-7 mg/l, ~5 IBU.

**Beer Flavor Wheel Number:** 1200.

**Discussion:** Hop bitterness is imparted to beer by isomerization of humulones during wort boil, converting them to soluble iso-humulones. Alpha acid utilization rates (AKA “Kettle Utilization Rates” or KUR) are determined by original gravity of the wort, alpha acid percentage of the hops, freshness of hops & boil time, to a maximum of about 25-33%. Hop bitterness is measured in terms of International Bitterness Units (IBU) or just Bitterness Units (BU), although this also measures soft hop resins in the beer overstating actual alpha acid concentrations by 5-15%.

Iso-alpha-acids derived from hop resins. There are 6 different variants and they all differ in relative bitterness. Of these, cohumulones are the most easily isomerized. Hop bitterness in beer is first detected at about 10 IBU. Thereafter, changes in hop bitterness can typically only be detected in changes of +/- 5 IBU. Conventionally, the maximum threshold for perception of hop bitterness is about 100 IBU, although some people might be able to detect higher levels of bitterness.

Despite IBU levels, the character of hop bitterness is somewhat subjective. Cohumulones are said to produce harsher, coarser bitterness than humulones, which are believed to impart a mellower, pleasanter bitterness. Perception of hop bitterness is also influenced by mineral additions, malt selection, alcoholic strength and other aspects of the finished beer.

Unlike bitterness from phenolic compounds, hop bitterness is generally described as being “cleaner” and much more pleasant, with much less lingering aftertaste.

Perception of hop bitterness is increased by the presence of high concentrations of sulfate and magnesium ions. Sulfate ions also aid in extracting alpha acids from hops. Excessive levels of these ions can impart an unpleasant bitterness and aftertaste on their own, however. While higher (more basic) pH conditions aid in the extraction of alpha acids, hop resins extracted at lower pH conditions (5.2 pH) is said to give a finer, more balanced bitterness.

In addition to providing bitterness, polyphenols and hop resins from hops adsorb to the hot break during boiling, helping it to precipitate. Unfortunately, some isohumulones (isomerized alpha acids) are precipitated with the hot break rather than going into the beer.

**To Increase:** \* Increase bittering hops to suit your recipe. Increase boil time - a minimum of at least 1 hour to a maximum of 2 hours for maximum IBU extraction. Use hops with a higher alpha acid percentage. Use hops with a higher cohumulone level. \* Use fresher hops. Keep hops fresh by storing them in cold conditions in vacuum-sealed, airtight packages. Decrease wort gravity. \* Add hop fractions (artificially extracted alpha acids). \* Add magnesium and sulfate-containing salts (e.g., “Burton salts” or gypsum - calcium sulfate) to mash or wort. Boil hops at a higher pH. \* Boil hops at a higher pressure and temperature; at 140-145 °C (285-293 °F) hops are isomerized in just 3-5 minutes. (But be careful, since alpha acids are quickly degraded if you boil at too high a temperature and pressure or you boil too long!)

**To Reduce:** \* Reduce bittering hops to suit your recipe. \* Decrease boil time. Use hops with lower alpha acid content. \* Decrease boil time. \* Reduce sulfate or magnesium salt additions to mash water. \* Extract hops at lower pH. \* Use hops with lower cohumulone levels.

**When Are Alpha Acid Notes Appropriate?:** To some degree, hop bitterness is expected in virtually all beer styles, with the exception of American lagers, Scottish ales and lambics. Extremely high levels of hop bitterness are expected in American pale ales, American stout, Russian imperial stout, IPA and barleywines.

#### Relative Bitterness of iso-alpha-acids

Compound	Typical % in Beer	Bitterness Rank
Trans-isocohumulone	7	1 (least bitter)
Cis-isocohumulone	30	2
Trans-isohumulone	10	2
Cis-isohumulone	40	4 (most bitter)
Trans-isoadhumulone	3	?
Cis-isoadhumulone	10	?

### Butyric (Fatty Acid, Sulfury - Cheesy)

**Detected in:** Aroma, flavor.

**Described As:** Baby sick, butyric acid, putrid, rancid/spoiled butter, rancid/spoiled milk, vomit.

**Typical Origins:** Microbial contamination, aging.

**Typical Concentrations in Beer:** 0.5-1.5 mg/l.

**Perception Threshold:** 2-3 mg/l.

**Beer Flavor Wheel Number:** 0614.

**Discussion:** Butyric and 2-methyl butyric acids are produced by bacterial infections, usually *Clostridium* spp., either during wort production or after packaging. *Clostridium* can also infect sugar syrups used in brewing, as well as sour mashes exposed to aerobic conditions. All butyric compounds produce distinct, pungent unpleasant rancid odors. Flavor and aroma activity of butyric acid compounds is heavily dependent on pH - their flavors are more intense at lower pH levels.

**To Avoid:** \* Practice good sanitation. \* Make sure that sugar syrups aren’t contaminated. \* When sour mashing, make sure that mash is kept above ~90 °F and isn’t exposed to outside air.

**When Are Butyric Notes Appropriate?:** Never.

### Isovaleric Acid (Fatty Acid, Sulfur - Cheesy)

**Detected in:** Aroma, flavor.

**Described As:** Blue cheese, cheesy, hydrolytic rancidity, old hops, rancid, Rochefort cheese. Less commonly described as

dirty laundry, dirty socks, goaty, putrid, stale cheese, stinky feet, or sweaty.

**Typical Origins:** Hops, aging, process faults.

**Typical Concentrations in Beer:** 0.2 - 1.5 mg/l.

**Perception Threshold:** 0.7-1 mg/l. While everyone can taste isovaleric acid, perception threshold levels can vary by several orders of magnitude.

**Beer Flavor Wheel Number:** 0613.

**Discussion:** Caused by oxidation of alpha acids in hops, usually during storage, which produces valeric, butyric and 2-methyl butyric acids. All of these produce distinctive "blue cheese" notes. Somewhat related to Caprylic (q.v.). Often accompanied by Grassy (q.v.) notes. The intensity of this characteristic decreases with time, both in aged hops and beer made with aged hops. Cheesy notes can also be produced by bacterial infections.

**To Avoid :** \* Use the freshest hops possible. Store hops in vacuum-sealed, oxygen-free containers at low temperatures (e.g., in your freezer). Don't buy hops which haven't been kept under refrigeration. Don't buy hops which you suspect are old or have been improperly stored. Badly treated hop cones will often be papery and pale, with no residual greenness. Badly treated pellets or plugs will lose their greenness and might be brown or buff colored. In all cases, they will have significantly less aroma than they would if fresh. \* Allow beer to age; cheesy notes will recede with time.

**When Are Isovaleric Notes Appropriate?:** Never. While "suranne" (literally, "superannuated") hops are used in lambics, these should be aged for long enough that any cheesy notes are long gone.

## Lightstruck (Sulfury)

**Detected in:** Aroma, flavor.

**Described As:** Catty, farty, fecal, mercaptan, polecat, skunky, sulfury, sunstruck. Inaccurately described as methane or natural gas.

**Typical Origins:** Mishandling.

**Typical Concentrations in Beer:** 1-5 ng/l for beer kept in the dark. 0.01-1.5 µg/l for beer exposed to light.

**Perception Threshold:** 4 ng/l.

**Beer Flavor Wheel Number:** 0724.

**Discussion:** Lightstruck character is caused by a photochemical reaction where visible or ultraviolet light (wavelengths below 520 nm) makes riboflavin in the beer react with and break down hop-derived, sulfur-containing isohumulones (isomerized alpha acids). This liberates 3-methylbut-2-ene-1-thiol, a mercaptan, a compound detectable at just a few parts per billion, which is similar to the active ingredient in skunk musk. For this reason, mercaptans are added to natural gas (methane), which is naturally odorless, as a safety precaution. This leads some people to wrongly assume that household natural gas naturally smells like mercaptans.

The wavelengths of light responsible for triggering the lightstruck reaction are found in both sunlight and ordinary fluorescent lightbulbs. They readily penetrate all but dark brown "amber" glass, causing the contents to become "skunky" in as little as 30-120 seconds. Amber glass bottles allow about 5% of ultraviolet light (below 400 nm) to pass, while green glass allows about 80% .Between 400-520 nm (violet to green light), amber glass lets 5-30% of light pass (depending on frequency), while green glass allows 50-80% to pass. Clear glass and glass allows about 90% of all wavelengths to pass.

Some large commercial brewers avoid the problem of lightstruck beer in their signature products (e.g., Corona, Miller Highlife) by using a chemically modified form of isohulone which doesn't react with riboflavins. This allows them to ship their beer in cheaper, more attractive green or clear bottles.

**To Avoid:** \* Store beer (including fermenting beer) and hopped wort in containers which block light, ideally ones which are opaque. \* Bottle beer in amber glass bottles. \* Cover clear or green glass containers (including fermentors) which might be exposed to light. \* Reduce the level of bittering hops (to reduce isohumulones, hence potential mercaptan precursors).

**When is Lightstruck Character Appropriate?:** Lightstruck character is never appropriate. Sadly, it is so common in mishandled, badly-packaged, imported European and Mexican "green bottle" beers, especially light lagers, that many people believe that the beers were intentionally brewed that way!

## Part 3: BJCP Category 9 - Scottish and Irish Ales

**Introduction:** Of all the styles in the BJCP Style Guidelines, no other styles have had so much misinformation printed about their history as the Scottish and Strong Scotch Ales. As with most other modern beer styles, Scottish and Irish Ales were developed in the 19<sup>th</sup> century and were modified throughout the 20<sup>th</sup> century until they reached their present form. With the exception of "Wee Heavy," the strongest type of Scottish Ale, all beers in this category are for "present use," not designed to survive extended aging.

**History of Scottish Ales:** *Far from being "traditional" styles produced from time immemorial by small brewers nestled in the Scottish highlands the Scottish Ales are modern products which were developed after World War II and which reached their present form in the 1950s. Strong Scottish Ale (AKA "Wee Heavy") is only slightly older, being a 19<sup>th</sup> century creation.*

*Also, contrary to popular myth, Scottish beers could be quite hoppy. Scottish brewers regularly used hops in large quantities (in the 19<sup>th</sup> century Scottish brewers were leading producers of IPA!) and peat-flavored water was never used, and peat-smoked malt was never used on a large scale; it was certainly never used by commercial Scottish brewers after the 17<sup>th</sup> century.*

*The numerical designations for the various shilling ales styles are taken from an obsolete method of indicating a beer's strength in terms of its wholesale price per barrel in shillings, described in the accounting shorthand of the time as, "X /-" where "X" was the price in shillings and "/" meant "and no pence."*

*This method of indicating strength was used by some British brewers in the 19<sup>th</sup> century and was retained as brewery jargon for particular brands of beers even as actual prices rose and beer strengths dropped. While originally the "shilling" system could be use to describe any type of beer and was used by both English and Scottish brewers, by the 20<sup>th</sup> century only the Scottish brewers retained it. And, by the end of World War II, it was mostly applied to Scottish or Strong Scotch ales, thus making Scottish ales synonymous with the shilling designation.*

*For this reason, Scottish ales are sometimes referred to as "shilling ales." Even so, most breweries dropped the shilling designations for their products after the war, preferring to refer to them as simply "Light," "Heavy," and "Export." The use of the shilling system was revived, during the 1970s when Scottish*

brewers used the shilling names to differentiate between kegged and "real ale" cask versions of the same beers.

As with other styles of British beer, the two World Wars, the Great Depression and changes in consumer tastes, led to a considerable decrease in alcoholic strengths. The strength of Scottish Light is comparable to that of a typical modern English Mild, while the ABVs for Heavy and Export roughly correspond to those of modern Bitter and Best Bitter.

Before World War I and even into the 1920s, many Shilling ales produced by Scottish breweries were hoppier and stronger and lighter in color than products produced in the latter half of the 20th century. In some cases, Scottish brewers actually carried both "mild" and "bitter" beers (i.e., Scottish ales and pale ales). After World War II, the various strengths of Scottish ale replaced the bitterer versions (or lines of bitter beer were dropped) in some Scottish breweries' product line-ups.

While Scottish brewers in the 19<sup>th</sup> and 20<sup>th</sup> centuries were more likely to have low alcohol beers in their portfolios (possibly due to a more active Temperance Movement in Scotland), there is no evidence that Scottish ales were any weaker than their English counterparts.

For much of the post war period, Scottish Light was exclusively a draught product, while Scottish Heavy and Export ales were available in both draught and bottled form, although they were often sold under different names when bottled. Since 2000, Light has become virtually extinct as a style, accounting for less than 3% of beer consumed in Scotland.

In many ways, Scottish "Shilling" ales are synonymous with English Mild Ales, and many English beer writers don't recognize the Scottish Ales as a unique style. In many cases, there is overlap between the shilling ales produced by Scottish brewers and amber or light mild ales produced by brewers elsewhere in the UK.

Since the 1990s, especially in the U.S., understanding of the shilling ales has been heavily influenced by the writings of Michael Jackson and Greg Noonan, which confused legend and early 19<sup>th</sup> century writings on Scottish brewing history with late 20<sup>th</sup> century (1950-1990) Scottish brewing practice. This has led serious misunderstandings about Scottish brewing in general and Scottish ales in particular. The notions that Scottish brewers only used local malt, that they didn't like to use hops (whether for political or economic reasons) and that their beers were always malty, cool-fermented ales made using hard water are all myths.

The truth is that, since the middle of the 18th century, the cities of Edinburgh, Glasgow and Alloa have been major brewing centers, with much of their production intended for export. Brewers often had access to both hard and soft water (due to wells bored into different layers of rock strata), allowing them to brew both light colored, heavily hopped beers and sweet, malty ales in the same brewery. For example, from the middle of the 18th century, the brewers of Scotland were in competition with the brewers of London for the export porter and stout trade, and in the middle of the 19th century they second only to Burton-on-Trent in the production of IPA!

While Scottish brewers preferred to use locally-grown barley to make their malt, since it was a premium product, they regularly made their own malt using barley obtained from overseas, including India, the United States and the Mediterranean, or imported English or European malts. Furthermore, Scottish brewers regularly used hops from Europe

and America, as well as English hops, and had no reservations about using large amounts of hops when the style demanded it.

While early 19th century Scottish "Edinburgh" ales were malty, dark colored and fermented at cool ale temperatures, evidence from brewing logs from the middle of the 19th century until the first half of the 20th century indicates that most products of Scottish breweries were very similar to English styles of beer and were produced in much the same way. Specifically, they could be quite hoppy and they were fermented at typical ale temperatures. Post-war Scottish ales were merely weakened versions of stronger pre-war brands of Scotch Ale or local interpretations of dark mild or brown ale, rather than being intentional throwbacks to extinct early 19th century styles.

Since the 1990s, some brewers in Scotland, as well as North America, have created "historical" Scottish ales using peat-smoked malt and/or extensive kettle caramelization. Despite this, there is no evidence that the major Scottish brewers used peated distiller's malt (AKA whisky malt), nor water, with a peaty flavor at any time since the 18<sup>th</sup> century, especially during the post-war period when the modern Scottish Ale style emerged. Likewise, there is no evidence that 19<sup>th</sup> century Scottish brewers were using particularly long boil times for their products, and during the post-war period only one of the major Scottish breweries (Caledonian) retained its direct-fired coppers.

Peaty malts in "traditional" (i.e., late 20<sup>th</sup> century) Scottish or Strong Scotch Ale are due to yeast character and/or oxidation.

**History of Irish Red Ales:** Irish Red Ale was first identified as a unique style by Michael Jackson in his *World Guide to Beer* (1977), and on the strength of his research adopted by the BJCP Guidelines. From there, a number of American craft brewers adopted the style as a late winter season timed for release before St. Patrick's Day.

Before Jackson identified the style as being unique, it was just described as "ale," was seen as being synonymous with draught bitter ale. Some British and Irish beer writers still refuse to recognize it as a distinct style, and it certainly shares many similarities with English bitters. Despite the hype in North America, Irish Red Ale was, and is, a minor style in Ireland, where Stouts and light lagers are dominant (as exemplified by Guinness Extra Stout and Harp Lager).

There is very little history about Irish Red Ales. Presumably, they developed in the early 18<sup>th</sup> century, at the same time as modern English Pale Ales and were influenced by the same trends as other English ales. Smithwicks brewery (pronounced "Smitticks"); the classic producer of this style only dates back to 1710.

Contemporary Irish Red Ale, as served in Ireland, can actually be slightly lower in strength (not exceeding 3.8% ABV) as opposed to the BJCP Guidelines' floor of 4% ABV.

Some American interpretations of Irish Red Ales are nothing more than bland pale ales (or pale lagers) with a bit of caramel color or Sinamar added to get the proper color.

**Strong Scottish and "90 Shilling" Ales:** Strong Scottish "Edinburgh" Ales were first mentioned in the 18<sup>th</sup> century, but only developed in their modern form in the late 19<sup>th</sup> century. They are essentially even stronger, more complex and malt-focused versions of Scottish Ales. Historically, they were made from virtually identical ingredients. Most of the discussion of the history of Scottish Ales applies to Strong Scottish Ales.

The name "Wee Heavy" comes from the fact that the strongest Scottish ales were once served in small "nip" bottles.



*For this reason, customers referred to a big beer in a small bottle a “wee heavy ale.”*

*More recently, a number of American craft breweries have developed stronger ABV interpretations of the shilling ales which don't quite have the malt complexity of the traditional Wee Heavy ale. These are referred to in the BJCP Guidelines as being “90 Shilling ales. They straddle the line between the Scottish “shilling” ales and the Strong Scotch ales both in flavor and in alcoholic strength.*

**Brewing Scottish Ales:** Much like English Bitters, Scottish Ales are mostly distinguished from each other by percent ABV; with IBU rising in the higher gravity beers to match the higher malt content and ABV. They should be smooth, malty, easy-drinking beers, with little to no hop flavor or aroma.

They are all brewed using English pale ale malt as a base, with differing levels of amber crystal malts (e.g., Munich, Crystal 40-120 °L, Honey malt) and a small amount of dark malt (200 °L Chocolate malt) for color and flavor.

If you use the right malts, extended boiling times aren't necessary for this style. If you do decide to caramelize the wort, it is easier to boil just a gallon of wort down until it begins to caramelize and then add it to the main wort. Intense toffee notes from caramelization can be interpreted as excessive levels of diacetyl, however.

Remember: peat notes are inappropriate to this style, so don't use smoked or peated malt!

Hops are mostly used for bittering, with small amounts of flavor hops. Hop bitterness should be just enough to balance the malt and keep it from being cloying. UK varieties are traditional, but any low-humulone, moderate alpha acid hop can be used for bittering.

Water used for Scottish ales was, and is, very soft or moderate hardness to accentuate the malt character of the beer. Water profiles are typically that of Edinburgh, or more rarely, Alloa, Scotland.

Yeast is any clean-fermenting, neutral ale strain. Scottish Ale yeast is traditional but California Ale or American Ale yeasts can be used as well with good results. Start fermentation on the lower side of the recommended range for the strain and let it warm slightly as fermentation progresses. This will limit ester, diacetyl, acetaldehyde and higher alcohol formation.

Carbonation is on the low side at 1.5-2 volumes of pressure.

Scottish Ales were, and sometimes still are, brewed using a “parti-gyle” infusion mash, where the same very thick mash was used to make different batches of beer. The liquor from the first infusion is run off into one kettle to make the strongest beer, the liquor from the second infusion (or the first spargings) run off into another kettle to make a beer of middling strength, and the liquor from the last infusion or spargings run into yet another kettle to make a weak beer. “Two-Penny” beer, made from the very last runnings, and was reportedly extremely weak and highly astringent due to husk tannins leached into the beer due to oversparging.

**Brewing Irish Red Ales:** Irish ale is “similar to Scottish ale . . . somewhere between a too clean, not bitter enough English Bitter, and a little too hoppy, too dry Scottish ale.” Its distinctive dry finish, toasted malt and reddish color comes from the use of a small amount of roasted, unmalted barley added to the mash.

Balance is critical with this style, since if any element of hops, malt or yeast character it will be both obvious and unbalancing. While diacetyl is allowed in this style, it should be restrained.

Base malt is English pale ale malt, with some crystal (40-120 °L) malt and roast barley added for color and flavor.

Hops are mostly used for bittering, with small amounts of flavor hops. Hop bitterness should be just enough to balance the malt and keep it from being cloying. UK varieties are traditional, but any low-humulone, moderate alpha acid hop can be used for bittering.

Water used for Irish Red Ale is moderate to moderate-high hardness, typically with the water profile for Dublin.

Yeast is traditionally Irish Ale yeast, but any English ale yeast will work just as well. Start fermentation on the lower side of the recommended range for the strain and let it warm slightly as fermentation progresses. This will limit ester, diacetyl, acetaldehyde and higher alcohol formation.

Carbonate to 2-2.5 volumes of pressure.

**Strong Scottish Ale:** The higher starting gravity of this beer makes it much sweeter, more estery and complex than its lower alcohol cousins. Malt choice or oxidation might give it dark fruit or even sherry-like character. Common faults are excessive sweetness and harsh alcohol notes.

The grist bill is virtually identical to that of Scottish ale, as is the hop bill, although a small amount of hops can be added for flavor. Water profile is identical.

A long boil time or caramelization of some of the wort will add further complexity to the malt.

Yeast is Edinburgh Ale or Scottish Ale yeast, with at least 2 quarts of starter per 5 gallons, as appropriate for the starting gravity. A period of cold conditioning (up to 2 months) will help to smooth out flavor.

## Part 4: BJCP Category 11 - English Brown Ales

**Introduction:** English brown ale is a traditional English style, which, like Porter, has been sadly neglected in its home country. Brown Ale has had a reputation as a workingman's drink for much of the 20<sup>th</sup> century. The beer's popularity declined with England's industrial base and the fortunes of England's working class. While Mild and Brown Ales were quite popular as late as the 1950s, but, since then, sales have plummeted making the style fairly rare today. The exception is Northern English Brown Ale, which is still holding its own, especially in its native region. In the 21<sup>st</sup> century, if you ask the average pub-goer in the U.K. to think of a brand of brown ale, they would be hard-pressed to think of even one, whereas fifty years ago there were dozens of well-known brands.

**History:** *As with other English ale styles, brown ale's true origins are lost in antiquity. By default, most ancient and historical styles of beer were likely to be at least amber in color, but “brown beer” isn't identified as a style until the 17<sup>th</sup> century. By that time, records describe brown beers in a variety of strengths, including “stitch” which was a strong brown beer, perhaps more like an Old Ale or Barleywine.*

*In the early 19<sup>th</sup> century, brewers defined a brown beer as a porter (AKA Stout) made without using patent (roasted) malt, and, to some extent, modern brown ale is related to porter and Stout. Confusingly, however, at the time, the styles now known as brown beer and mild were indistinguishable, since brown*



beer was made in a variety of strengths and the term “mild” was used to describe any freshly-brewed, or “running” beer (as opposed to “stale” or “keeping” beer which had been aged in a cask).

Equally confusing, a 19<sup>th</sup> century brewer might refer to any lightly hopped beer darker than light amber color as a “brown ale” while dark brown or highly-hopped beers were referred to as stouts or porters. (In the 18<sup>th</sup> century, because they were more highly hopped, Porter and Stout were always referred to as Beers, while more lightly hopped beers of any sort were referred to as Ales.)

By the late 19<sup>th</sup> century, English brewers frequently called their cask brown ale a “mild”, while the bottled version of the same product was considered to be “brown ale.” The National Guild of Beer and Wine Judges, which organizes beer and wine judging in England and Wales, defines Mild as being a cask version of London, or Southern, English Brown Ale. (This is similar to the traditional distinction between Extra Special Bitter and Pale Ale – ESB was a strong bitter served from the cask, while Pale Ale was the same beer in bottled form.) In 19<sup>th</sup> and early 20<sup>th</sup> century English brewer’s jargon, “X” or “LM” generally represented a mild, while “XX” indicated a brown ale.

By the end of the 19<sup>th</sup> century, the term “Mild” usually referred to a moderate to low-alcohol, lightly hopped, fresh amber beer. Only in the early 20<sup>th</sup> century, did Mild become darker - brown to dark brown - in color. In its broadest modern sense, the term “Mild” can refer to any low-alcohol, lightly-hopped English ale, and there are rare examples of pale and ruby-colored (red) mild ales, as well as original amber-colored milds.

For clarity, some beer writers specify the color of a particular mild ale, although “dark mild” ale can be assumed when a modern writer doesn’t use a color descriptor.

Bottled English Brown Ales, as we know them today, are 20<sup>th</sup> century inventions. Southern English Brown was invented in 1902 by Thomas Wells Thorpe, managing director of Mann, Crossman and Paulin, and first brewed at the Albion Brewery in the Whitechapel district of London. Billed as “the sweetest beer in London” with an ABV of only 2.7%, it became extremely popular during and after World War I. Wartime-era beer was extremely weak and thin-bodied, so a popular beer cocktail of the time was Mann’s Brown Ale mixed with some form of cask ale. Due to the popularity of Mann’s Brown Ale, competitors released their own variants.

A generation later, Newcastle Brown, the quintessential Northern English Brown Ale, was developed in northeast England. Created in 1927 by Colonel Jim Porter, a brewer and executive at Scottish & Newcastle Brewery at Newcastle-on-Tyne, it was stronger, lighter-colored, drier and slightly hoppier than Mann’s product. From its introduction, “Nookie Broom” has proven to be a reliable seller, especially in its hometown. Today, it is one of Scottish & Newcastle’s flagship products and is probably the best-known example of an English brown ale. By contrast, Mann’s Brown Ale is now a rare specialty item, brewed under contract by Thomas Hardy Brewery at Burtonwood and often used to flavor gravy and plum puddings.

Between these three iconic English beers, there are a number of other brown ales available in the UK, some of which blur the distinctions between dark Mild, Northern English Brown and Southern English Brown.

**Telling English Brown Ales Apart:** Mild Ales are defined by low levels of alcohol and hop bitterness, although more

alcoholic and more highly-hopped examples exist. Southern English Brown Ale (AKA London Brown Ale) is darker colored and sweeter compared to the lighter, drier and slightly hoppier Northern English Brown Ale. The increased sweetness of Southern English Brown can come at the expense of higher alcohol, occasionally giving it the same level of alcohol as a Mild Ale.

As a rule of thumb, if an English brown ale is low in alcohol, body and hop bitterness, it’s a Mild Ale. If it’s dark brown and sweetly malty with dark fruit and caramel notes it’s a Southern English Brown Ale. If it’s amber or copper-colored, not as sweet, with nutty and biscuity malt flavor, it’s a Northern English Brown Ale.

No English Brown Ale is particularly hoppy – significant hop bitterness, or a marked degree of hop aroma or flavor in a brown ale is a signature difference between American Brown Ale (BJCP Category 10C) and English Brown Ale.

**Brewing English Brown Ales:** All English brown ales emphasize English malt, especially the character of English specialty malts, such as biscuit and chocolate. As low- to moderate-strength beers, both Southern and Northern English Brown Ales need a certain amount of melanoidin malts to improve body while keeping alcohol levels in check. By contrast, Mild Ale should have a fairly thin body while emphasizing the flavor of dark specialty malts, but low levels of dextrin malts help to round out the flavor. Some recipes for Southern English Brown suggest pasteurizing the beer or adding non-fermentable sugars to keep increase sweetness. Other recipes suggest adding a bit of brown sugar or molasses to provide caramel and toffee notes.

**Malt:** Typically, English pale malt makes up 65-80% of the grist, with English crystal malt and roasted and toasted malt making up the rest. Some commercial brewers use up to 20% adjuncts, usually some combination of sucrose or dextrose (cane or corn sugar, respectively), caramel syrup or corn, which replaces a portion of the base malt. Malt proportions are roughly as follows:

Mild: Pale malt (and adjuncts), 80%; Crystal malt, 15%; Dark malts: 5%.

Southern English Brown: Pale malt (and adjuncts), 65%, Crystal malt, 25%, Dark malts: 10%.

Northern English Brown: Pale malt: (and adjuncts), 75-80%, Crystal malt, 5%-10%, Dark malt, 10%.

Maris Otter is an excellent base malt since it imparts nutty flavors, which are especially desirable in Northern English Brown Ales. Dark malts should be brown or toasted malt, Biscuit (Victory), Special Roast, Pale Chocolate or Chocolate, although tiny amounts of Patent malt can be used to adjust color. Award-winning recipes use a mix of specialty malts to give the beer a complex malt flavor. Mash temperatures should be low (149-153° F) for Mild and Northern English Brown, higher (up to 158° F) for Southern English Browns.

If making a brown ale or mild using extract, start with English pale malt extract, such as Munton’s LME and then do an infusion of specialty grains in order to get the proper nutty, toasted and biscuity flavor notes.

For Mild or Northern English Brown Ale, home-made toasted (or brown) malt can impart bready or toasted flavors, especially if you can’t get the right blend of flavor malts commercially. A simple recipe is to roast uncrushed pale malt in the oven at 350 °F for 30-45 minutes. Spread the malt thinly on a clean cookie sheet, and, if necessary, shake the sheet gently so

that the grains roast evenly. Remove the grains once they reach a pale copper color. Darker colors produce sharper roasted notes which are inappropriate for brown ale. Once your malt is roasted, let it sit for at two weeks, so that harsh flavor compounds generated during the toasting process have a chance to mellow.

**Hops:** Hops in brown ale are there for balance and little more. Hop bitterness should be present, but hop flavor should be minimal and there should be little or no hop aroma. Due to low hopping requirements, it is possible to use low alpha-acid varieties (e.g. Goldings, Fuggles) for bittering, although commercial producers use bittering hops of moderate alpha acid levels (e.g., Challenger, Northdown). Where flavor hops are appropriate, any low-alpha English hop variety can serve. Typical hopping levels are 1/2-2 oz. per 5 gallons, with hop additions split between bittering and flavor hops. Aroma hopping and dry hopping are inappropriate for the style – a quick way to turn an English Brown Ale recipe into an American Brown ale recipe is to increase the hopping levels by 50-100%, with the extra hops going to flavor and aroma additions.

**Yeast:** Any English Ale yeast variety will provide suitable flavor. Recommended types include Munton's Windsor Ale Yeast, Wyeast #1028 London Ale or Wyeast #1098 Whitbread, but any similar variety will serve. Fermentation temperature should be in the middle to high end of the yeast's range, at about 68° F, for Mild or Northern English Brown, lower (at about 64° F) for Southern English Brown.

**Water:** Water chemistry can be adjusted to match some form of London water for Southern English Brown Ale. Any moderately hard water will work when brewing Mild Ales or Northern English Brown Ales. Water profiles for the north of England vary widely depending on location, but are generally moderately hard, with low sulfate levels. High sulfate water, like that found in Burton-on-Trent should be avoided, since high sulfate levels can increase hop bitterness. Moderate levels of sodium can increase malt flavor, but too much can also cause bitterness. The following parameters can be used as a very rough rule of thumb when brewing brown ales: Calcium: 25-50 ppm, Magnesium: 10-20 ppm, Sulfate: 80-170 ppm, Chloride: 50-60.