



Hops

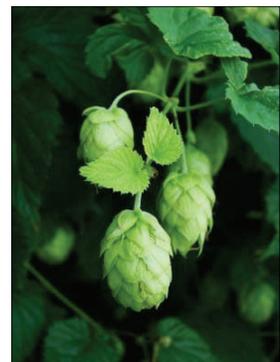
A Brief History of Hops in Beer



Hops are a relatively new addition to the brewmaster's toolkit. Prior to the widespread adoption of hops, beer was bittered and flavored with spice and herb mixtures sometimes called *gruit*. Any number of herbs and spices went into *gruit* including henbane, wild rosemary, heather, ginger, spruce, juniper, and bog myrtle, just to name a few. In parts of Europe the blending of *gruit* was the closely held province of *Gruit Guilds* that had exclusive rights and kept the specific ingredients secret. The first documented link between hops and brewing is from 822 AD when a Benedictine abbot wrote a series of statutes covering the running of the monastery that included gathering sufficient hops for making beer. Evidence suggests that commercial hop cultivation began in northern Germany during the 12th or 13th century and that the Germans were exporting hopped beer from the 13th century onward. The first evidence of hopped beer being brewed in England is from 1412 and for a time English brewers produced both un-hopped "ale" and hopped "beer." On April 23, 1516 the Bavarian *Reinheitsgebot* was put into effect declaring hops one of the three allowable beer ingredients (Yeast hadn't yet been discovered). In 1710 the English parliament banned the use of non-hop bittering agents, at least in part to prevent brewers from evading the new penny-per-pound hop tax. Thus, hops became the dominant bittering agent in beer throughout the western world.

What Are Hops?

Hops (*Humulus lupulus*) are a perennial plant of the *Cannabaceae* family that also includes the genus *Cannabis*. In beer hops provide bitterness to balance the sweetness of malt sugars, as well as flavors, aromas, resins that increase head retention, and antiseptics to retard spoilage. Often referred to as a "vine", hops are actually a "bine", using a strong stem and stiff hairs to climb rather than tendrils and suckers to attach. It is the flower of the hop plant that is used in brewing. Hop flowers or *cones* resemble pine cones but are composed of thin, green, papery, leaf-like *bracts*. At the base of these bracts are waxy, yellow *lupulin glands* that contain *alpha acids* responsible for bitterness and *essential oils* that give beer flavor and aroma. The plant has separate male and female bines, but only the female bines develop cones. If male plants are allowed to pollinate them, the flowers will produce seeds, rendering them useless for brewing. Aside from their use in beer, hops also have medicinal application as a sleep aid. Hop filled pillows were once a common remedy for insomnia.



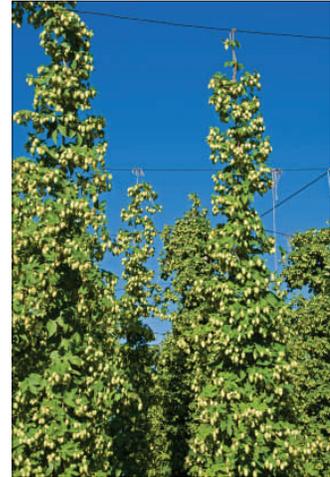


Hops Production

Day length during the growing season has a major effect on yield. For this reason the majority of the world's commercial hop production occurs between latitudes 35° and 55°, either north or south of the equator. The largest producers of hops are Germany, the United States, China, and the Czech Republic. Other important growing regions include England, New Zealand, and increasingly Argentina. Climate and soil conditions have a major effect on hops. Varieties developed in one region will have different flavor and aroma profiles when grown in another.

Hop plants sprout in the spring and die back to a cold-hardy rhizome in the fall. During peak growing season they grow very rapidly, up to twenty inches per week. Commercial hop growers cultivate hop bines on V-shaped, wire and twine trellises that are up to twenty feet tall. In spring, at the start of the growing season, two to three young shoots are trained in a clockwise direction around each horizontal length of twine. The harvest season begins in August and continues into October with different varieties of hops coming ready at different times. Harvesting machines cut the bines and twine at the top and bottom and load them onto trucks.

They then pass through a series of sorters to separate the cones from the stems and leaves. The cones are placed in a kiln where 140° air is circulated, drying the cones to about 30% of their green weight. After cooling the cones are compressed into bales or further processed into pellets or extracts.



Types of Hops for Brewing

Hops are available to brewers in whole-leaf, pellet, or extract form. American craft brewers have also started using fresh, unprocessed hops to brew "harvest" or "fresh-hop" ales. Each of these forms has advantages and disadvantages.

- *Whole-leaf Hops* – Whole-leaf hops are simply the dried hop cones that have been compressed into bales. They are believed to have greater aromatic qualities than the other forms and are easier to strain from wort. However, because they retain more of the vegetative matter greater volumes must be used. They soak up more wort than other forms resulting in greater loss to the brewer. Their bulk also makes them more difficult to store and more susceptible to spoilage.





- *Pellets* – To make pellet hops the dried cones are shredded, compressed, and extruded into pellets that resemble rabbit food. The shredding process exposes the lupulin glands and removes a percentage of the vegetative matter, meaning smaller volumes can be used in the brewery. Their lighter weight and compressed state also makes them easier to store and less susceptible to spoilage. On the down side, they tend to lose some of their aromatic quality in processing and they create sludge at the bottom of the brew kettle that can be difficult to remove from the wort. The majority of hops used in the craft brewing industry are pellet hops.
- *Extract* – For hop extracts, the alpha acids and essential oils are pulled from the cones using heat and various solvents. These concentrated liquid extracts can be used in the brewing process just like hops. There are separate extracts for bittering, flavor, and aroma. They are mostly used by large breweries, although they are sometimes used by smaller breweries to reduce wort in highly hopped beers. Hop extracts are easy to store and can be kept for long periods of time without spoilage. Their concentrated state and lack of vegetative matter reduces the amount that must be used and eliminates wort loss. Their concentration can make them difficult to use properly in small batches however, and some claim undesirable flavors from their use.
- *Fresh or Wet Hops* – Fresh hops are green, unprocessed cones, often added to the beer within hours of harvest. Wet hops give beers an intense, bright hop flavor and aroma. However, because they lack the concentration that comes with drying, a much larger volume is needed to achieve the same result as from dried hops. The additional vegetative matter can lend beer a grassy character and results in greater wort loss for the brewer.



Hop Varieties

Hops can be generally divided into two broad categories, bittering and aroma. Those hop varieties that contain high levels of alpha acids are called *bittering hops* because a lower volume is needed to achieve high levels of bitterness. Those with lower alpha acid content but higher levels of essential oils are called *aroma hops*. Beyond this broad division, general characterizations can be made based on the traditional area of origin.

- *Continental or Noble Hops* – The *noble* hops originate in central Europe and are among the most prized of the aroma hops. There are four noble hops, Hallertau, Tettnang, Spalt, and Czech Saaz. These hops impart a smooth bitterness and spicy/floral aromas. The noble hops are often used in lagers. Common descriptors for these hops include spicy, black pepper, licorice, perfume, floral, and herbal.

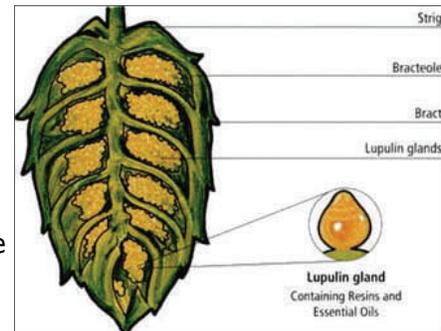


- *English Hops* – The most traditional English hop varieties fall into the low alpha acid aroma hop category. The most common are East Kent Goldings and Fuggle. Other higher alpha English hop varieties include Challenger, Target, and Progress. Common descriptors for the English hops include herbal, grassy, earthy, floral, and fruity.
- *American Hops* – Bright, fruity, and resinous, these are the signature hops of American pale ale and IPA. The United States grows a number of hop varieties that can be considered dual use hops, with high alpha acid content and pleasant aromatic qualities. Commonly used American hop varieties are Cascade, Centennial, Chinook, Willamette, and Amarillo. Common descriptors for the American hop varieties are citrus, grapefruit, resinous, piney, fruity, and spicy.

Hops in the Brewing Process

Brewers use hops primarily to get bitterness, flavor, and aroma. Hops can be added at several points in the brewing process to enhance one or the other of those things. While most hops are added in the boil kettle, they can be added at various stages prior to and after the boil as well.

- *Kettle Hops* – *Kettle hops* is the name given to those hops added to the kettle during the boil. These include early addition hops for bitterness and late addition hops for flavor and aroma.
 - *Bittering Hops* – Bitterness from hops comes from alpha acids found in the lupulin glands of the hop flowers. The main alpha acids are *humulone* and *cohumulone* and *adhumulone*. In order to become bitter these acids must be chemically altered, isomerized, by boiling. *Isomerization* is a chemical process in which a compound is changed into another form with the same chemical composition but a different structure. The percentage of the potential alpha acid that is isomerized is referred to as *utilization*. Because the length of the boil determines degree of utilization, bittering hops are usually added at the beginning of the boil or with at least 60-minutes of boiling time remaining.
 - *Flavor Hops* – Hop flavor and aroma are derived from essential oils found in the lupulin glands. These oils include *humulene*, *myrcene*, *geraniol*, and *limonene*, among others. The flavors are released as these oils become dissolved into the wort during the boil. However, these oils are highly volatile and are to a large degree lost to evaporation. For this reason flavor hops are added with twenty to forty minutes remaining in the boil. This provides a compromise between isomerization of the alpha acids and loss of essential oils.





- *Aroma Hops* – Because the aromatic essential oils are highly volatile, aroma hops are added in the last minutes of the boil to minimize their loss to evaporation.
- *Other Hop Additions* – Hops can be added at other points in the brewing process to enhance the flavor and aromatic qualities of beer.
 - *Dry Hopping* – Perhaps the most common non-boil use of hops is *dry hopping*. In this process hops are added to beer in the conditioning tank after fermentation is complete. The hops are left in the beer for a week or two allowing the essential oils to dissolve. Dry hopping provides a very bright and fresh hop aroma with slight enhancement of flavor.
 - *Hop Back* – Another process for increasing hop aroma is to use a *hop back*. A hop back is a small tank that is placed between the kettle and the chiller in a brewing system. The hop back is filled with hops and the hot wort is run through it on the way to the chiller.
 - *First Wort Hopping* – *First wort hopping* is a pre-boil addition of hops to the hot wort as it runs into the kettle from the mash/lauter tun. This is said to give a smoother hop aroma and flavor without significantly increasing bitterness.
 - *Mash Hopping* – *Mash hopping* is the addition of hops in the mash tun. This is a controversial practice said to increase hop flavor without significantly affecting bitterness.
 - *Randall* – A few years ago the Dogfish Head brewery in Maryland was looking for a way to inject their beers with more hop flavor and aroma. They invented *Randall the Enamel Animal*, an “organoleptic hop transducer module.” Basically a Randall is a plastic filter housing that is filled with hops and inserted in the draft line coming from the keg. As the beer passes through the Randall on its way to the tap faucet, the alcohol dissolves the essential oils providing a fresh burst of hop character.





Hops Vocabulary

Alpha Acids – The chemical compounds in hops that, when isomerized by boiling, give bitterness to beer.

Essential Oils – The volatile compounds in hops that, when dissolved into beer, provide flavors and aromas.

Gruit – A beer that is bittered with a mixture of herbs and spices. Also refers to the spice mix.

Hop Back – A vessel filled with hops that acts as a filter, removing hot break material from wort on the way to the chiller.

International Bittering Units (IBU) – A chemical measurement of the actual bitterness in beer. An IBU is defined as one milligram of isomerized alpha acid per liter of beer. May be different from perceived bitterness.

Isomerization – A chemical process in which a compound is changed into another form with the same chemical composition but a different structure.

Lupulin Glands – Small, bright yellow nodes at the base of each hop petal that contains the alpha acids and essential oils utilized by brewers.

Randall – A hop-filled vessel that is placed in the draft line between the keg and the faucet.