



## What is beer?



**Beer** \bi(ə)r\ n **1**: an alcoholic beverage usually made from malted cereal grain (as barley), flavored with hops, and brewed by slow fermentation. *Synonyms*: ale, brew, brewski, brown bottle, cold one, pint, hops, lager, malt, malt liquor, oil, stout, suds, liquid bread. As defined by *Webster's Ninth New Collegiate Dictionary* and *Thesaurus.com*.

At one time the words *beer* and *ale* were not synonymous. In the days before hops became ubiquitous, *beer* referred specifically to a fermented cereal beverage brewed with hops, while *ale* was brewed without hops. Today the most commonly used designations are *ale* and *lager*, referring to beverages brewed with differing strains of yeast. But both *ale* and *lager* are *beer*.

## What is beer made of?

The Bavarian *Reinheitsgebot* (purity law) of 1516 stated that beer could only be made from three ingredients, water, barley and hops. Yeast was added in the 19th century after Louis Pasteur identified it as the agent of fermentation. For the most part beer is still made from only those four ingredients. But that list is not now and has never been complete. Prior to the widespread adoption of hops in the fifteenth century, beer was bittered with an herbal mixture often called *gruit*. Besides *gruit*, a host of other ingredients have long been a part of the brewmaster's toolkit, including other grains, sugars, fruits and vegetables, and spices.



### **The Big Four Beer Ingredients**

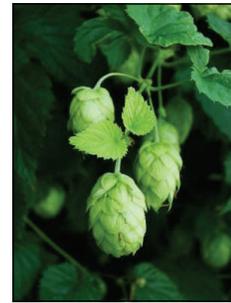
- **Water** – Beer is up to 97% water. It only makes sense then that the quality of the water would have a significant impact on the quality of the beer. In fact, because of the chemical processes involved, the mineral content of the brewing water is important to the brewing process. Certain historical beer styles evolved in the places they did in large part because of the water. The hard water of Dublin necessitated the acidity of dark-roasted grains to maintain proper ph, thus the area produced stouts. It is a good bet that wherever darker beers were brewed, the water was at least moderately hard. The nearly mineral free water in Plzen, Czechoslovakia allowed brewers to use very lightly kilned malts to create Pilsner. Today brewers treat their brewing water to get the specific mineral profile they desire for the beer they are brewing.



- **Grains** – Malted Grains are the meat and potatoes of beer. They provide the sugars that are fermented by yeast to produce alcohol and CO<sub>2</sub>. They also provide the essential nutrients yeast need to reproduce. They are the primary source of color and body in beer. Malted grains are a major contributor to the flavor and aroma profiles of beer. The malting process is simply a controlled sprouting and kilning of the grain. The sprouting begins to break down starches contained in the grain making them accessible to the brewer and the kilning provides color and flavor. Grains kilned at higher temperatures or longer periods of time are darker. Malted barley is by far the most widely used grain in beer making, but it is not the only one. Other malted grains commonly used in brewing include wheat, rye and oats.



- **Hops** – Hops are the spice of beer. They provide bitterness to balance the sweetness of the malt, as well as flavors and aromas ranging from citrus and pine to earthy and spicy. Hops are the cone-like flower of a rapidly growing vine (a *bine* actually) in the *cannabis* family. Waxy yellow *lupulin glands* hidden within the leaves of the flower contain the acids and essential oils that give hops their character. Bitterness comes from *alpha acids* that must be chemically altered through boiling in order to be utilized. Hops more than any other brewing ingredient are subject to the phenomenon of *terroir*, as different growing regions produce hops with different flavor and aroma characteristics. The chief hop growing regions are the Northwestern US, Southern England, Germany, Czech Republic, and China.



- **Yeast** – It is said that brewers make *wort* (the word for unfermented beer) and yeast makes beer. Yeast metabolizes the sugars from the grains and produces alcohol and CO<sub>2</sub>. Yeast also produces an assortment of other fermentation by-products such as *phenols* and *esters* that add significant flavor and aroma character to beer ranging from delectable fruitiness to peppery spice. There are two main types of yeast, typically called *ale* and *lager*. *Ale* yeast ferment at higher temperatures between 65° F and 75° F. Higher fermentation temperatures encourage the production of greater amounts of *esters* and *phenols*, resulting in beers with more yeast derived flavor and aroma. *Lager* yeasts ferment colder, between 45° F and 55° F. Colder temperatures inhibit the production of the various fermentation by-products resulting in beers with a “clean” yeast profile. Certain beer styles are fermented with an assortment of wild yeasts and bacteria that produce a range of funky flavors from sour to barnyard.





## Other Common Beer Ingredients

- **Unmalted Grains** – In addition to the malted grains listed above there are a number of unmalted *adjunct grains* that are commonly used in beer. These grains are used to add flavor, improve mouthfeel, lighten body and color, and to make gluten free beers. The adjunct grains include corn, rice, wheat, rye, oats, and some lesser used grains like sorghum. Perhaps the most common example of the use of these grains is the International Lager style that typically contains up to 30% rice or corn. Others include Oatmeal Stout (oats) and Belgian Witbier (wheat).
- **Other sugars** – The use of non-grain sugars in beer is probably as old as brewing itself. While yeast cannot ferment all sugars derived from grain, these other sugars are often fully fermentable. For this reason they can improve drinkability in very strong beers by lightening the body without sacrificing the desired alcohol content. This is a common practice in Strong Belgian Ales and English Barleywines which can become thick and cloying when made entirely from grain sugars. Non-grain sugars are also used to enhance beer flavor and color. Common brewing sugars include brown sugar, cane sugar, molasses, honey, and the caramelized sugar syrups employed by Belgian brewers. Some American craft brewers are experimenting with more exotic sugars like Thai palm sugar.
- **Spices** – The use of spices in beer goes back to the days before hops. As mentioned above, before hops became the preferred bittering agent for beer, brewers used a mix of herbs and spices called *gruit*. Using herbs and spices to add flavor and aromatic qualities continues to be popular today. Possibly every spice in existence has found its way into beer at some point. Common spices used in brewing include cinnamon, nutmeg, allspice, coriander, grains of paradise, ginger, orange peel, heather and anise, just to name a few. Use of spices is common in holiday ales and winter warmers. Belgian brewers are known for their subtle use of spice in beers such as Saison and Belgian Witbier which is flavored with coriander and bitter orange peel.
- **Fruits and Vegetables** – Fruits and vegetables are used in beer to provide flavor, aroma, color, and fermentable sugars. Fruits like berries, apricots, and cherries are most commonly used in wheat beers and Belgian sour Lambic beers. However they are sometimes also used in other styles including porters and stouts. American craft brewers have been experimenting with a wide variety of vegetables in beer, including pumpkins, sweet potatoes, beets, and chili peppers.





## The Brewing Process

Beer is an industrial product. A brewery is literally a beer factory in which the brewer takes advantage of and manipulates natural processes to create the perfect growth medium for yeast. On the surface the brewing process is simple. But if you look a little deeper you find that there is a complex set of chemical reactions at work in the creation of beer.

- **Milling** – The first step of the process is crushing the malt. This breaks apart the grains, exposing the starchy ball inside and making it accessible to the brewer. The grains are only lightly crushed, leaving the hulls intact to serve as a filter bed for the *lautering* process later on.
- **Mashing** – *Mashing* is the process by which the brewer extracts fermentable sugars from the grain. Basically it consists of steeping the grains in water at temperatures between 140° and 160° Fahrenheit for a period of sixty to ninety minutes at a thickness similar to porridge. This activates naturally occurring enzymes in the grain that convert the grain starches into sugars, like maltose, that yeast can metabolize. This process occurs in a vessel called a *mash tun*.
- **Lautering** – During *lautering* the fermentable sugars are rinsed from the grains. As the sugary liquor from the mash, now called *wort*, is slowly drained from the bottom of the *mash tun*, heated water is pumped in from the top at the same slow rate. As the water flows through the grains, it raises the temperature to about 170° Fahrenheit, making the sugars more soluble and easier to remove. As mentioned above, the intact grain hulls form a natural filter, removing bits of grain and proteins from the *wort*. In some brewing systems lautering occurs in the *mash tun*. In others the entire mash is pumped to a special *lauter tun*.
- **Boiling** – From the *lautering* stage, the *wort* is pumped to the *kettle* where it is boiled. A vigorous boil is maintained for sixty minutes or more. During the boil the *wort* is sterilized and concentrated to the proper sugar density, haze causing proteins are removed (*hot break*), and light caramelization occurs that deepens the flavor and color of the beer. One of the most important things to occur during the boil is the addition of hops. Hops for bittering are added early in the boil, while those for flavor and aroma are added later.
- **Cooling** – Following the boil, the *wort* is pumped through a heat exchanger to cool it as quickly as possible to fermentation temperature. Rapid cooling minimizes the danger of bacterial contamination and causes more haze causing proteins to precipitate out of the *wort* (*cold break*).





- **Fermentation** – Yeast is added once the *wort* has reached the desired temperature for fermentation. Brewers call the addition of yeast *pitching*. Once the yeast has been *pitched* the *wort* can properly be called *beer*. Fermentation can last a few days or a few weeks depending of the strain of yeast and the strength of the beer. During the process the yeast reproduce and then metabolize the sugars, making CO<sub>2</sub>, alcohol, and a host of other flavorful and aromatic compounds that add complexity to the beer. During the height of fermentation the beer is capped by a thick creamy foam called *kreusen*. Once the available sugars have been consumed the yeast cells clump together or *floc* and fall to the bottom of the fermenter.
- **Conditioning** – With fermentation complete, the beer is removed from the yeast and pumped to a conditioning or *bright tank* where it is stored at near freezing temperatures that cause most of the remaining yeast to drop out of suspension. Hops can be added at this point as well, a step known as *dry hopping* that lends the beer additional hop flavor and aroma. Once the beer is clear it is ready to filter and package.



Making beer is easy. Using the proper ingredients and following the steps outlined above will result in beer. Making good beer is hard. Brewers make choices at every step of the process, from ingredient selection to determining mash and fermentation temperatures, that all have significant effects on the quality of the end product. It takes skill, scientific knowledge, and a certain amount of intuition to put all the pieces together in the production of great lagers and ales. Brewing really is a craft.