(Photo: Kreklau Barth.)

Hop cones – the spice of beer.

Hops – the spice of beer

How the cultivated hop has transformed our favourite beverage

If malted barley can be described as the 'body and soul' of a beer, providing flavour and colour, then hops are its 'spice' providing bitterness and aroma. The introduction of hops to early brewed ales was the start of a brewing revolution.

by ***Steve Curtis***

Beer is one of the world's oldest alcoholic drinks. Its development can be traced back to the early cereal farming with the production of beer-like beverages from the natural fermentation of starches or sugars. Over the next few thousand years the development of these early drinks into 'beer' closely followed the growth of population, the growth of industry, and latterly the growth of the entertainment and leisure industries.

Early beers are believed to have developed independently throughout the world as soon as the local culture had mastered the growing of cereals. These beers were often consumed using straws and were possibly more akin to a thin porridge than the beers we know today. By the Middle Ages, beer in a more familiar form had become one of the most common drinks and was consumed daily providing two important benefits; the provision of calories and, most importantly, a safe source of water due to boiling being part of the brewing process.

The association of hops with beer is believed to have started as early as the 9th century but these hops were probably collected from hedgerows rather than being cultivated and were being used to add flavour to the beer, their properties as a preservative being unknown. At this time many substances were being experimented with in order to provide beer with bittering and flavour. Prior to the wide-scale use of hops a combination of herbs in the form of 'gruit' was prevalent. Species such as mugwort (common wormwood), sweet gale, yarrow, horehound, as well as ivy, heather, juniper, ginger, and hops (in small proportions), were all commonly used as gruit. Some of these herbs are more associated with early medicines and have since been found to be mild preservatives as well as having some narcotic properties.

The rise of the hop

The first incidence of cultivated hops occurs in Germany with records showing a mention of a hop garden in the Hallertau district in 736. The use of hops in beer, along with commercial hop cultivations, did not become common place until 11th or 12th centuries. These early 'hopped beers' were initially greeted with mistrust by the drinking public and were often avoided by some brewers (especially those influenced by their gruit supplier!). The distinction between 'ale' as un-hopped, and 'beer' as hopped became prevalent in the Middle Ages. The Brewers Company of London stated that: "No hops, herbs, or other things be put in any ale....but only liquor, malt and yeast."

The widespread use of hops was resisted... *"Ale is made of malte and water; and they which do put any other thynge to ale than is rehersed, except yest, barme, or goddesgood doth sophysticat there ale. Ale for an Englysshe man is a naturall drinke. Ale muste haue these properties, it muste be*

fresshe and cleare, it muste not be ropy, nor smoky, nor it must haue no wefte nor tayle. Ale shulde not be dronke vnder .v. dayes olde …. Barly malte maketh better ale than Oten malte or any other corne doth … Beere is made of malte, of hoppes, and water; it is a naturall drynke for a doche man, and nowe of late dayes it is moche vsed in Englande to the detryment of many Englysshe men … for the drynke is a colde drynke. Yet it doth make a man fatte, and doth inflate the bely, as it doth appere by the doche mennes faces and belyes."

A Compendyous Regymentor a Dyetary of Helth. Andrewe Boorde (1557)

...but it soon became apparent that there were particular advantages to using hops and producing 'beer' rather than 'ale'. What probably kept the preservative properties of hops from being understood for so long was the need to boil the wort for extended periods, isomerising and solubilising the hop resins which give their bittering and preservative qualities. Prior to this, un-hopped ales were mashed at lower temperatures, with any gruit or flavourings being steeped, and the boiling of wort may well have been seen as an unnecessary waste of energy. This boiling to bring about the release of the hop's preservative qualities was ultimately to give 'beer' its huge advantage over 'ale'. Before hops, alcohol in the form of higher strength was the only way to keep beer more than a few days. Hops allowed beer to be weaker and kept longer, were found to aid clarification and improve foaming, and as a consequence the hopped beers began to flourish. In perhaps the first incidence of the marketing of hops, Reginalde Scot, an English hop grower, in his 1574 book *A Perfite Platforme for a Hoppe Garden* stated that: "Whereas you cannot make above 8–9 gallons of a very indifferent ale from a bushel of malt, you may draw 18–20 gallons of a very good beer."

The age of the hop had arrived, along with the importance of shelf-life, freshness, and quality control!

The modern hop market

Hop cultivation likely began in Eastern Europe around Bohemia, Slovenia and Bavaria and from there spread to the rest of Europe. Once the thirst for hopped beer had reached England, firstly via imports of beer and then of hops from Europe, commercial hop production arrived in the early 1500s when cultivation practices were adopted from Flemish growers. There followed an expansion of Europeans across the globe carrying the tradition of hop cultivation with them to the overseas colonies. English settlers introduced hops into the Southern Hemisphere in South Africa, New Zealand and Australia in the early 1800s. The Japanese

The hop from an old herbal treatise.

World hop acreages and yields 1910–2010

Europe	1910 acreage and yield		1960 acreage and yield		2010 acreage and yield	
	Ha	Mt	Ha	Mt	Ha	Mt
Germany	27466	19700	9828	17439	18386	34234
Austria	6344	3550	100	143	218	368
Belgium	1940	2900	961	1534	183	300
Bulgaria					160	183
Czechia	14715	11300	8206	7300	5238	7772
UK	13319	14800	8140	12608	1080	1608
France	2741	2700	1559	2380	433	790
Poland			2273	1585	1840	2688
Romania			501	400	240	207
Russia	9068	2900	12009	6000	220	160
Slovakia			1451	1911	235	205
Slovenia			2399	4060	1217	2400
Spain			840	400	480	1037
Turkey					350	390
Ukraine					950	750
Rest of Europe			682	185	185	302
Total Europe	**75593**	**57850**	**48956**	**55945**	**31415**	**53374**
Rest of the world						
USA	**18428**	**20000**	**11826**	**20855**	**12647**	**29707**
Argentina			255	192	1291	85
Australia	740	500	769	1589	448	1099
China			100	45	5028	10150
Japan			909	1551	190	420
New Zealand			239	408	400	793
South Africa			107	100	481	913
Rest of World			848	628	60	40
World Total	**94761**	**78350**	**64005**	**81313**	**50798**	**96680**

	1910	1960	2010
World hop yield (Mt/ha)	0.83	1.27	1.90
World beer production (mhl)	293	417	1837
Hop usage (g/l beer)	2.67	1.95	0.52

began cultivating American and German hop varieties as late as the 1870s.

Due to the hop's requirement for a winter dormancy period and for long summer days for adequate flowering, cultivation is been restricted to areas between 35° and 55° latitude. Attempts have been made to grow hops in latitudes below 35°. Cape Providence in South Africa has successful commercial hop-yards, producing just less than 1,000 Mt in 2011, however attempts to cultivate hops in other countries in lower latitudes, including India, Mexico, Kenya and Burma, have been largely unsuccessful. The use of artificial light to extend day length has added too much cost to the hop's already costly requirements.

For those IBD examination candidates looking for more on hop market trends, the information published by the two global hop merchants, Hopsteiner and Barth-Haas, on their websites goes into great detail and need not be expanded on here. The *Brewer & Distiller International* also carries annual crop reports from both Northern and Southern hemispheres. The changes to the hop market over its more recent history can be summarised as follows:

- Yield of hop per hectare is increasing through improved agricultural processes and control of disease and pests.
- Beer production is increasing. Despite stagnation in mature beer markets, global beer volumes continue to increase at over 2% per year.
- Alpha acid yield per hectare for bittering hops has almost trebled in the last 20 years. The amount of resin responsible for bitterness in the hop has increased through selective breeding of high and super-high alpha varieties.
- Hopping rates falling. There is a trend for lower bitterness beers, requiring lower amounts of alpha acids.
- World hop crop is currently steady, fluctuating around 96,000 Mt per annum, whilst acreage of commercial hop farms continues to slowly decline.

Hop Growing

The hop's cone, or more correctly its strobilus is the productive female flower. It is made up of valueless bracts and seed bearing bracteoles, both attached to the central strig. The lupulin glands are located at the base of the bracteoles, where the seeds also develop. It is the lupulin glands that provide all of the bittering and aroma compounds utilised in brewing – the bitter hop resins and aromatic essential oils. See Figure 1.

As a perennial crop, hops are grown from rootstocks that remain in the ground all year round. They can be propagated from cuttings taken from this rootstock, from underground rhizomes or from softwood cuttings. See Figure 2.

Cultivation practice varies widely, but a typical schedule (Northern Hemisphere) is as follows:

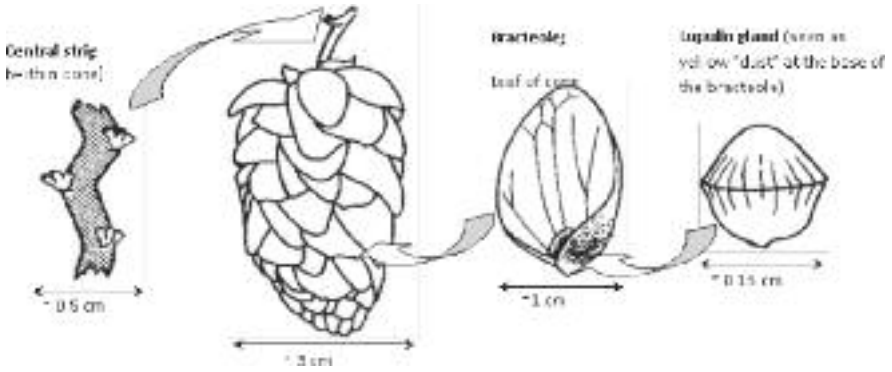


Figure 1: Anatomy of he hop cone.

- March: Shallow ploughing to reduce weeds, mulch in last year's leaves and vines and add base fertiliser.
- April: Stringing from overhead wires to rootstock.
- April/May: Training of new shoots onto strings.
- June: Ploughing between rows for irrigation and weed control.
- July/August: Pest control as necessary.
- August: Harvest.

The harvesting steps are as follows:

- The bines are cut down and transported to a picking machine, which strips the cones from the bine.
- The cones are separated, the debris screened and removed. The picked hops are dried from ~80% to 10% moisture in kilns. Drying prevents deterioration.
- The whole hops are then compressed and baled to reduce storage requirements and costs. The whole hops can then be used as is, or after processing as pellets, powders or extracts.

Hop Breeding

Hops grow as male plants or female plants. Hop breeding takes the form of classic crossing of two species and growing out the hybrids. As such, all male hop plants are destroyed within a three-mile radius of farms, to prevent unwanted natural pollination. Breeders are currently trying to improve their strains in many areas as follows.

Hops and their supporting framework.
Photo: Kreklau Barth.

- Disease and pest resistance
- High α-acid and β-acid varieties
- Speciality aromas
- Dwarf varieties
- Yield and agronomics

By developing dwarf varieties, the very tall frameworks currently used can be eliminated. These frameworks, although sturdy, can be demolished by strong winds and are extremely expensive to repair and replace. In addition dwarf varieties allow easier, more accessible and less expensive harvesting coupled with a reduced labour requirement.

Breeding varieties that produce higher concentrations of α-acids (bitterness) increases the yield per hectare dramatically.

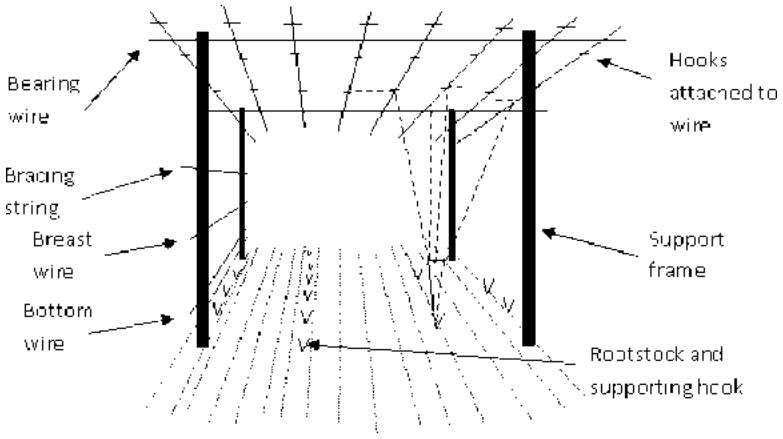
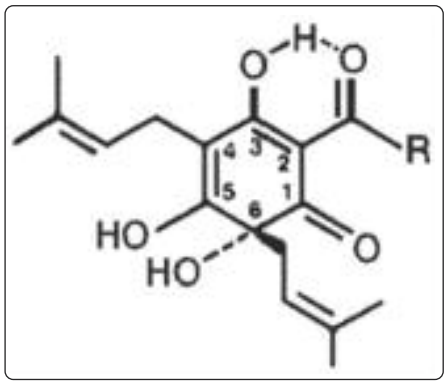
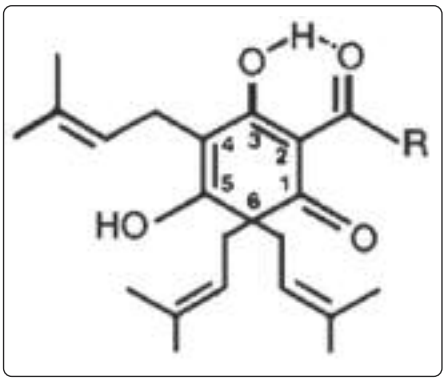


Figure 2: Preparing the frames to accommodate new growth from the rootstock.



Basic structural formula of α-acid:



Basic structural formula of β-acid:

Hop Chemistry

Two main compounds (of many) in the hop contribute to their value in brewing.

- Resins
- Essential Oils

The resins are split between alpha and beta-acids.

Alpha-acids or Humulones. These are a major component of the resins. When isomerised, these materials provide the main bittering compounds associated with beer. The α-acid content varies widely amongst hop varieties from levels of 3–4% w/w in aromatic type hops to levels of 10–16% w/w in the bitter hops.

Beta-acids or Lupulones. Another resin component, the β-acid, is not bitter in the natural or isomerised form. Some of the oxidation products do provide bitterness.

The proportion of hop resin, the α acid: β acid ratio and the quantity of different and acids present, depend on variety as well as regional and seasonal differences.

During the boil the insoluble α and β-acids change their structure, or isomerise, to produce highly soluble products. It is these iso-α-acids, or iso-humulones, which are the principal bittering compounds in wort and beer.

Hop products

The whole hop is bulky and therefore, an expensive product to transport and store. Whole hops can be processed and transformed to reduce their size, whilst providing additional benefits including:

- Increased bulk density/ decreased volume.
- Improved convenience/ storage.
- Improved stability/ shelf life.
- Increased utilisation.
- Improved consistency/ homogeneity.
- Easier, automatic addition.
- Reduced extract loss/ effluent.

Hop products are common as either pellets or extracts. The diversity of hop products within these two groups is phenomenal.

Hop Pellets:

Type 90 Standard hop pellets – comprise whole hops, which after removal of debris are dried and hammer milled. The hop material can then be compressed into the pellets and packaged.

Type 45 pellets – enriched or concentrated. The hop material is first fed through a cutting mill and the waste fraction removed before final hammer milling. This process removes the majority of the non-essential vegetative material, enhancing the -acid content.

Isomerised (iso) hop pellets – differ from type 90 as magnesium oxide is added to the hop powder prior to pelleting, during the process the magnesium oxide reacts producing the salt of the α-acids. The vacuum packed pellets are then stored at 50°C for between 10 to 14 days, the magnesium salt of the α-acid isomerising to the iso-α-acid.

The majority of hop pellets are added to the wort in the kettle during boiling. Some aroma pellets can be added straight to the beer in cask or post fermentation for dry hopping. By using pelleted hops, particularly pre-isomerised

Large scale hoperations at Bushy Park, Tasmania

The processing sheds at Bushy Park.

Hops being loading into the picking shed.

Starting to clean the stripped cones.

The kilns.

Below the kilns.

The finished bales and how they are sampled.

forms, superior α-acid utilisation and efficiencies can be achieved in the brewhouse whilst retaining most, if not all of the original hop character.

Hop Extracts

Ethanol and CO_2, both naturally occurring in beer, are the two principal solvents used to completely dissolve and extract hop oils and resins. Ethanol extraction involves a hop and 90% ethanol mix which is wet milled and passed through a continuous multistage extractor. Alcohol flows counter-currently to the hop mix, becoming enriched with the hop constituents. The hop extract is concentrated as the alcohol is evaporated before a final steam scrub. The evaporation system produces a concentrated hop extract composed of all the hop resins. For liquid CO_2 extraction (by far the most common solvent used) hop pellets are placed in an extraction chamber and liquid CO_2 at high pressure is pumped through the extraction vessel into which the hop components dissolve. The pressure in the vessel is reduced causing the CO_2 to lose its ability to act as a solvent and is evaporated leaving the hop extract. Supercritical CO_2 is also used with superior extraction properties at around 250bar and 40–50°C.

Isomerised extracts – Either supercritical or liquid CO_2 extract can be used for further processing into isomerised extract. To prepare the extract it is first warmed and mixed with deaerated water under an inert atmosphere (nitrogen gas). The extract is further heated before magnesium or potassium salts are added to induce isomerisation. The resulting isomerised extract is standardised with water to an iso-α-acid content of 20–30%. Unlike the other hop extracts, pre-isomerised extracts do not require boiling to produce the iso-α-acids, so it can be added at various stages of

Some hop varieties

Variety	Country	Alpha Acids [%]	Oil [ml/100g	Aroma
Admiral	England	13.0 – 16.0	1.0 – 1.7	Typical English aroma
Ahtanum	US	5.7 – 6.3	0.8 – 1.2	Citrus, floral
Amarillo	US	8.0 – 11.0	1.5 – 1.9	Floral, citrus
Apollo	US	15.0 – 19.0	1.5 – 2.5	Aromatic, pleasant
Brewer's Gold	England	5.5 – 6.5	1.8 – 2.2	Blackcurrant, fruity, spicy
Cascade	US	4.5 – 7.0	0.7 – 1.4	Floral, citrus, grapefruit
Centennial	US	4.5 – 7.0	0.5 – 2.3	Medium intense floral, citrus
Challenger	England	6.5 – 8.5	1.0 – 1.7	Mild to moderate, spicy
Chinook	US	12.0 – 14.0	1.7 – 2.7	Spicy, piney, grapefruit
Citra	US	11.0 – 13.0	2.2 – 2.8	Strong citrus, fruity
Cluster	US	5.5 – 8.5	0.4 – 0.8	Floral, spicy
Columbus	US	14.5 – 16.5	2.0 – 3.0	Pungent
Crystal	US	3.5 – 5.5	1.0 – 1.5	Mild, spicy, floral
Delta	US	5.5 – 7.0	0.5 – 1.1	Mild, pleasant, slight spice and citrus
First Gold	England	.5.6 – 9.3	0.7 – 1.5	Spicy, similar to Golding
Fuggles	England	3.0 – 5.6	0.7 – 1.4	Mild, pleasant (UK), woody, fruity (US)
Galaxy	Australia	13.5 – 15.0	1.7 – 2.7	Intense, pleasant, unique
Galena	US	11.5 – 13.5	0.9 – 1.3	Citrus
Glacier	US	5.5 – 8.2	0.7 – 1.6	Pleasant hoppiness
Goldings	England	4.0 – 6.0	0.7 – 1.0	Mild, delicate, classic English type
Hallertau Mittelfrüh	Germany	3.0 – 5.5	0.7 – 1.3	Mild, pleasant
Hallertau Merkur	Germany	10.0 – 14.0	1.4 – 1.9	Spicy, floral
Hallertau Taurus	Germany	12.0 – 17.0	0.9 – 1.4	Noble, aromatic
Hallertau Tradition	Germany	4.0 – 7.0	0.5 – 1.0	Fine noble
Herkules	Germany	13.0 – 17.0	1.4 – 2.4	Spicy, powerful
Hersbrucker	Germany	1.5 – 4.0	0.5 – 1.0	Mild to medium, pleasant
Horizon	US	11.0 – 13.0	1.5 – 2.0	Floral, spicy
Liberty	US	3.0 – 5.0	0.6 – 1.2	Mild, slightly spicy
Lublin	Poland	3.0 – 4.5	0.5 – 1.1	Very fine
Magnum	Germany	11.0 – 16.0	1.6 – 2.6	Hoppy, fruity, flowery
Millennium	US	14.5 – 16.5	1.8 – 2.2	Mild, herbal, similar to Nugget
Motueka	NZ	6.5 – 7.5	0.6 – 1.	0New world noble
Mount Hood	US	4.0 – 7.0	1.2 – 1.7	Mild, somewhat pungent
Nelson Sauvin	NZ	12.0 – 13.0	1.0 – 1.2	Unique fruity, white wine
Newport	US	13.5 – 17.0	1.6 – 3.4	Mild
Northdown	England	7.5 – 9.5	1.5 – 2.5	Mild, pleasant, delicate
Northern Brewer	England	6.0 – 10.0	1.0 – 1.6	Medium to strong
Nugget	U.S.	9.0 – 14.0	0.9 – 2.2	Pleasant herbal
Pacific Gem	NZ	13.0 – 15.0	1.1 – 1.3	Pleasant blackberry
Palisade	US	5.5 – 9.5	1.4 – 1.6	Good
Perle	Germany	4.0 – 9.0	0.5 – 1.5	Moderately intense and pleasant
Pride of Ringwood	Australia	7.0 – 11.0	0.9 – 2.0	Pronounced but not unpleasant
Progress	England	5.0 – 7.0	0.6 – 1.2	Moderately strong, good aroma
Saaz	Czechia	3.0 – 6.0	0.4 – 1.0	Intense, pleasant
Santiam	US	5.5 – 7.0	1.3 – 1.7	Herbal, noble hop aroma
Saphir	Germany	2.0 – 4.5	0.8 – 1.4	Spicy, fruity, floral
Simcoe	US	12.0 – 14.0	2.0 – 2.5	Unique pine-like aroma
Spalt	Germany	2.5 – 5.5	0.5 – 0.9	Pleasant, slightly spicy
Sterling	US	6.0 – 9.0	1.3 – 1.9	Herbal, spicy, floral, citrus
Strisselspalt	France	3.0 – 5.0	0.6 – 0.9	Medium intense and pleasant
Styrian Goldings	Slovenia	4.5 – 6.0	0.5 – 1.0	Delicate, slightly spicy
Summit	U.S.	13.5 – 15.5	1.5 – 2.5	Strong citrus, grapefruit
Target	England	9.5 – 12.5	1.2 – 1.4	Intense, pleasant English hop aroma
Tettnang	Germany	2.5 – 5.5	0.5 – 0.9	Mild, pleasant, slightly spicy
Tomahawk	US	14.5 – 17.0	2.5 – 3.5	Pungent
Ultra	US	2.0 – 3.5	0.5 – 1.0	Pleasant, Saaz-like
Vanguard	US	5.5 – 6.0	0.9 – 1.2	Similar to Hallertau
Mittelfrueh Warrior	US	14.5 – 16.5	1.3 – 1.7	Very mild
Willamette	US	4.0 – 6.0	1.0 – 1.5	Mild, pleasant

Photo: Kreklau Barth.

Tall hops towards the end of the growing season

the brewing process. To achieve maximum utilisation, the isomerised extract should be added after fermentation but before final filtration. The expected utilisation is approximately 95%, which compares favourably with the utilisation yields of hops, pellets and regular extracts which are normally in the range of 25–35%. Isomerised extract usage also means lower transport and storage costs and the consistency of the product gives the brewer precise control over the bitterness levels.

Hop oil extracts

These emulsions, used to impart aroma, are produced through steam distillation, allowing harvesting of the required fraction. Aroma emulsions provide the brewer with excellent control over the intensity and consistency of dry-hopping effect. Through the use of advanced physical separation technology, a range of natural hop oil extracts which are completely soluble in beer have been developed by Botanix.

Reduced iso-extracts

Light in the range 300-500nm readily passes through both clear and green bottles, and beer exposed quickly develops unpleasant off flavours which are often described as 'skunky'. This is due to a reaction with the iso-α-acids, producing iso-pentenyl mercaptan (the skunky aroma). By reducing the iso-α-acids or by direct hydrogenation, the development of such aromas can be prevented. The reduced forms of iso-α-acids are known as tetrahydro-iso-α-acids, rho-iso-α-acids and hexahydro-iso-α-acids, reflecting the number of hydrogen atoms added (that is four, two and six respectively). These reduced compounds also impart bitterness, but to differing degrees. For example, tetrahydro- forms are more bitter than α-acids, whilst hexahydro- forms are comparable and rho-forms impart a softer bitterness. Foam stability can also benefit from the use of reduced iso-α-acids.

Hop Essential Oils

The essential oils in hops are the source of their aroma compounds. These oils are volatile and will be almost entirely vaporised from the kettle if they are present from the start of a 60 or 90-minute boil. To compensate for this, many brewers who want beer with a hoppy character add selected aroma varieties into the kettle between five and 20 minutes before the end of the boil. This gives sufficient time to extract the hop aroma but ensures that not all the oil is lost in the vapour. Late hop character is often described as floral or citrus. The variety of hop, the timing of the addition, as well as the type of kettle all have a major influence on the subtlety of the final beer aroma.

Hops can also be added to beer after fermentation, to the maturation vessel or to the cask to give beer a 'dry hop' character – this is often described as resinous, spicy and citrus. As the α-acids are only slightly soluble in cold beer, there is hardly any increase in the bitterness of beer with dry hopping.

Hops produce up to 3% of essential oils during the later stages of ripening after the bulk of the resins have been formed. The composition of the oil reflects not only the variety but also the degree of ripeness. Over 300 hop oil compounds have been isolated and identified.

Loading the kiln at Pridewood in Herefordshire.

The gas burner below.

(Photo: Krekau Barth.)

Type 90 hop pellets and a look inside the machine which pelletises them.

Hop renaissance

The 2010 EBC Hop Symposium, held after a 16 year gap (and reported in *Brewer & Distiller International*, January 2011) highlighted the recent acceleration in hop research and, in particular, the rapid progress of new hop varieties. We have now reached the point where many of the genetic markers for flavour and aroma, as well as disease resistance and agronomic performance have been identified and these can be used to speed up traditional growing programs by selecting from these features in advance. Hop research continues to flourish and the development of new and exciting varieties will surely continue in years to come.

Brewers are starting to switch from the older high and super-high alpha varieties and look for something new. As a consequence hop growers are slowly starting to replace some older varieties – such as Columbus, Tomahawk, Magnum, and Taurus – with varieties such as Herkules and Apollo, as well as those beloved of the 'craft' market such as Amarillo, Simcoe and Citra.

Perhaps taking a leaf from the wine industry, terms such as *terroir* are entering the vocabulary of the marketing department. Following the success of identified grape varieties, single hop beers are all now the rage – with a whole host of brewers experimenting and producing with a base beer with different hops. The hop certainly has been brought to centre stage at the moment, promoted by a number of self-confessed hop-heads who are relishing its renaissance.

Future hop markets

The vast majority of cultivated hops are used for the production of beer. Hops add flavour and aroma to beer, they provide antibacterial and antioxidant properties as well as contributing towards flavour and foam stability. For many reasons therefore they are the ideal companion to barley, yeast and water, as enshrined in the *Reinheitsgebot* in 1516 and seem likely to remain so for the next 500 years. With a continuing decline in the amount of farmland given to hop cultivation, alternative uses for hops beyond brewing are continually being researched. Whereas in 1994 only 1% of hops were used for non-brewing purposes, this had increased to an estimated 3% in 2009.

Traditionally, the medicinal properties of the hop provided a small, secondary market. As a sleep aid – such as traditional hop pillows or 'natural' sleeping tablets, as a digestive – the famous 'Bath Oliver' biscuits, or as an anti-inflammatory small amounts of hops were grown in addition of the brewers' requirements. With continued research into these properties, future uses are foreseen in a variety of new applications.

Hop beta acids are the most antibacterial compounds in hops, working very effectively to inhibit the growth of beer spoilage bacteria over a wide pH range. To some extent brewers are fortunate that these compounds are in their beer as without them the avoidance of unwanted microbiological growth would be more difficult. Beta acids do not inhibit yeast or mould growths and as a consequence the market for hop acids for non-brewing fermentation applications is starting to open. Their antibacterial properties can be used to the benefit of production of distilled spirits and fuel alcohols, both cereal and molasses derived, as well as the production of enzymes from fermentation of moulds. The conditions for growing of yeasts are also ideal for growing bacteria, so the use of hop acids is also beneficial for the production of yeast for the food industry. Products are available now (such as Beta Bio – Steiner Hops) which are tailored to these emerging markets. Development of further uses based upon the medicinal and antibacterial properties of hops continues.

Hops provide foam stabilising properties from their iso-alpha acids and especially reduced iso-alpha acids. The development of foam is not always desirable in the brewing process, particularly during fermentation as heavy foaming can lead to capacity reductions, but the hop can be utilised as a natural foam suppressant. The lipids and waxes in the hop are embedded in the hop structure and have little or no effect on the brewing process. If isolated, these compounds show strong foam suppressant properties and are now available (Barth Haas – Lipohop C) in emulsion form for use as natural anti-foams as an alternative to silicone-based products. These have been shown to also positively influence fermentation, and have no effect on finished beer foam or flavour stability.

While compiling this article, I listened to a popular radio presenter talking about the most expensive vegetable on the market and how much the top restaurants were prepared to pay for the small shoots which are only available within a two week window every year.

Described as a cross between spinach and asparagus, with a hoppy overtone, the young shoots of *Humulus lupulus* are apparently becoming a favourite of the celebrity chef and Masterchef contestant. Perhaps if this becomes as popular as other recent food trends such as baby salad leaf or imported asparagus, then the future of the hop gardens around the world would be assured. We might even see a shortage of hops for brewing. Now that would give the brewers something to grumble about! ■

Footnote:

This article is intended as an introduction to the growing and use of hops, with a particular emphasis on whetting the appetite of IBD examination candidates at all levels towards further reading within their syllabus. I hope it will be also sufficiently interesting for other readers. Thanks to Hopsteiner and Barth Haas (Botanix) for their assistance.