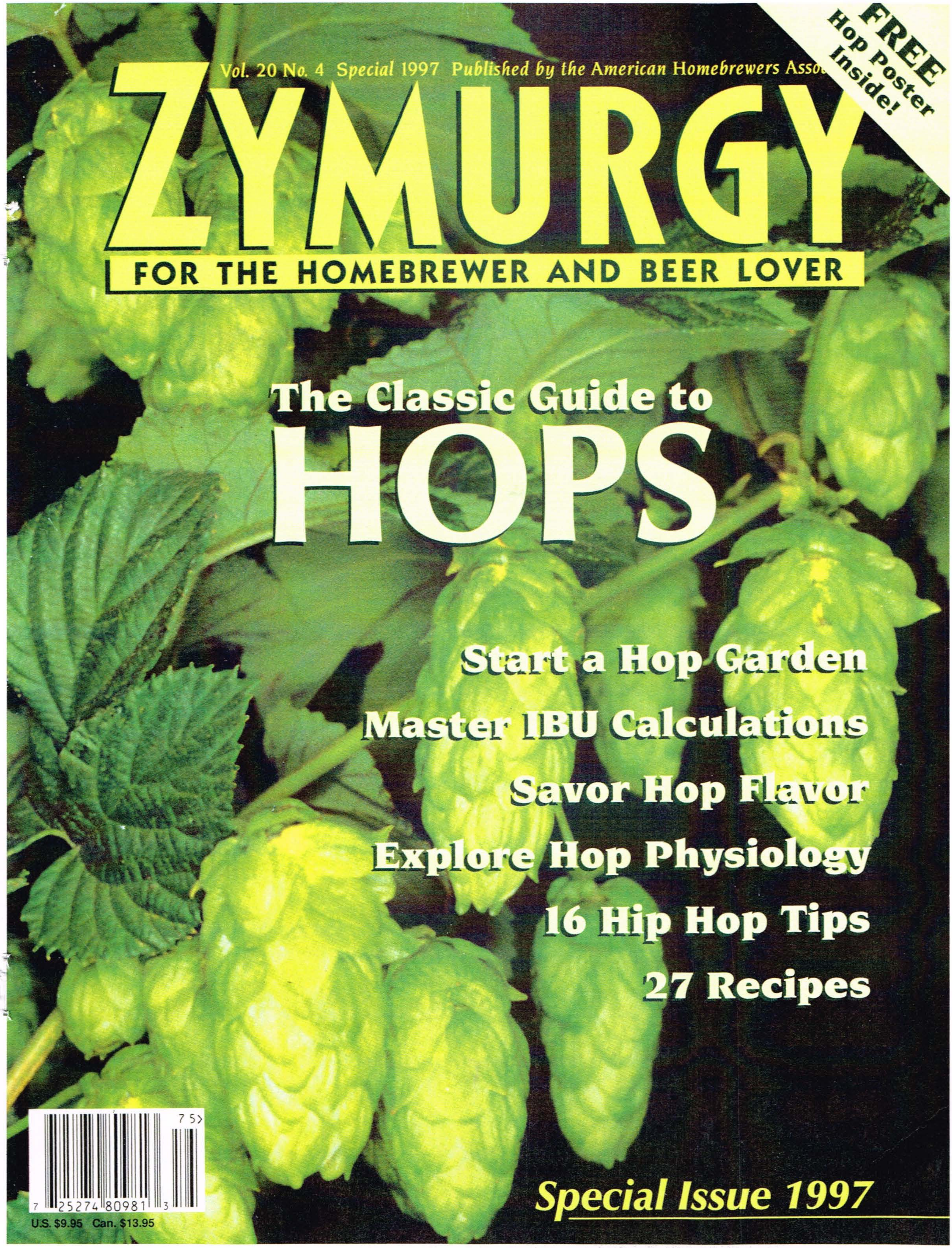
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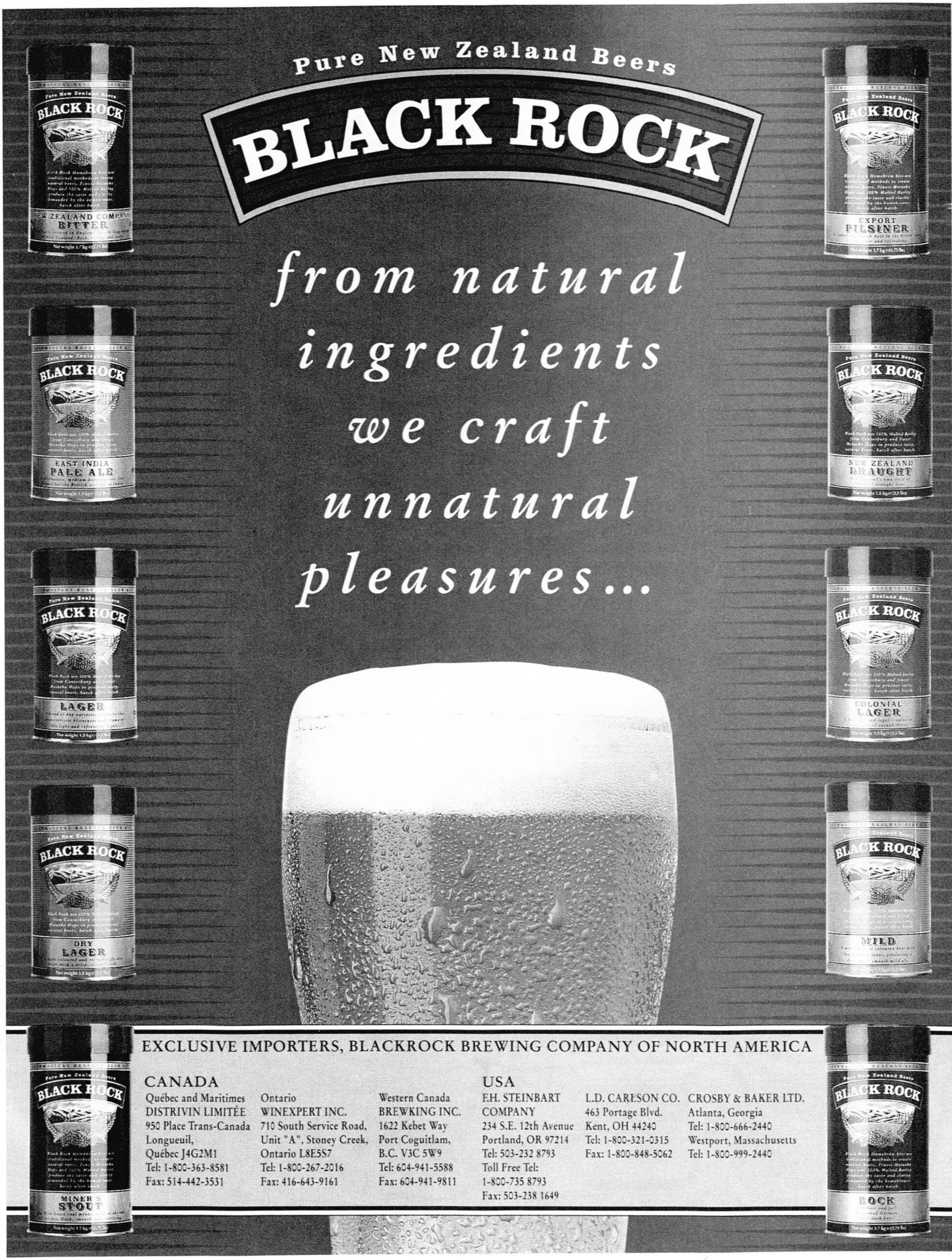
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FOR THE HOMEBREWER AND BEER LOVER

Journal of the American Homebrewers Association®

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To promote public awareness and appreciation of the quality and variety of beer through education, research and the collection and dissemination of information; to serve as a forum for the technological and cross-cultural aspects of the art of brewing; and to encourage responsible use of beer as an alcohol-containing beverage.

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VOLUME 20, NUMBER 4

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CLASSIC GUIDE TO HOPS

SPECIAL ISSUE COLUMNS

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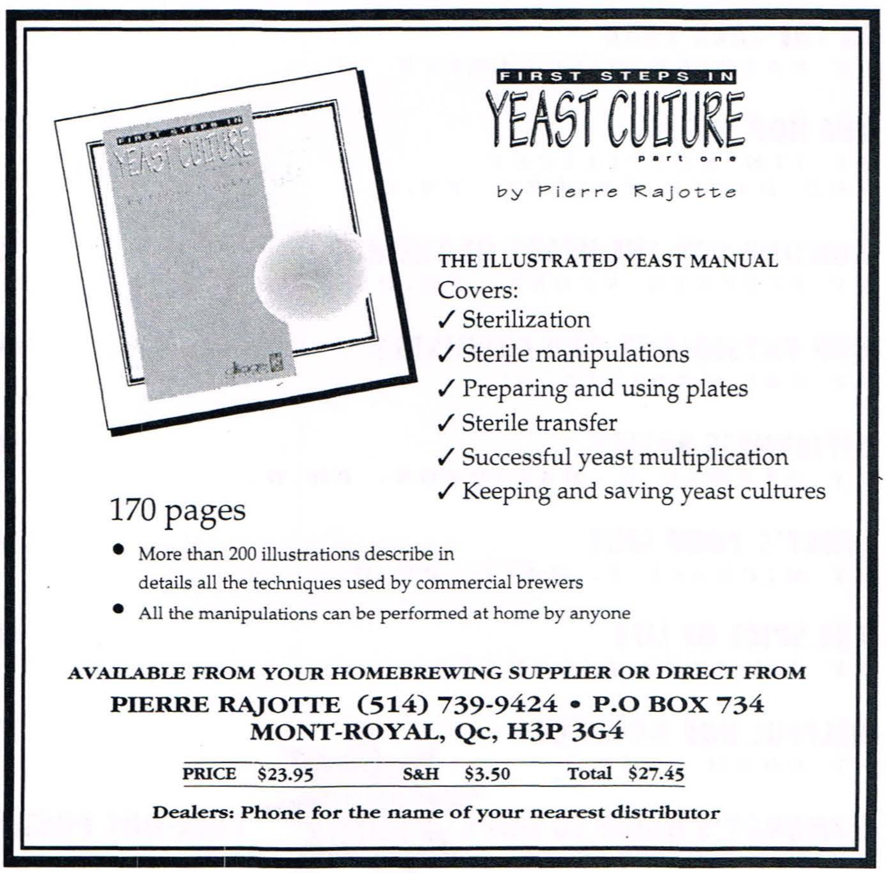
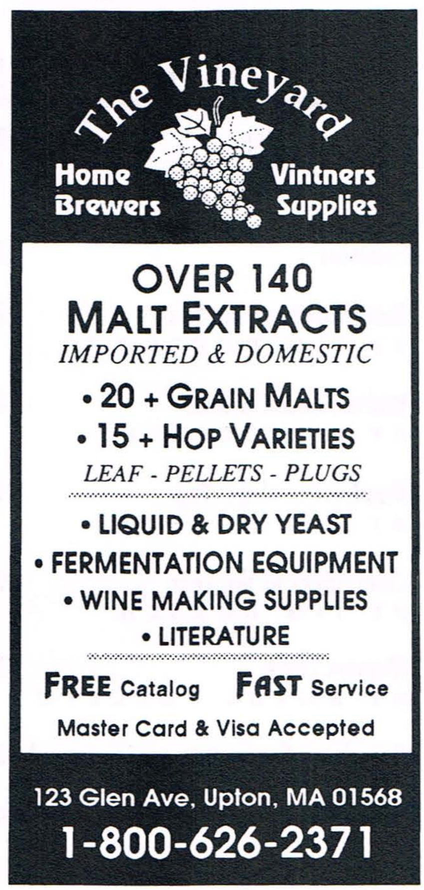




The Spice of Choice

By Charlie Papazian

"Come see my hops. They're loving life." My friend Mike drags me to the side of his barn where he had planted some root cuttings I gave him two years ago. "I don't know why more people don't plant them, they're hardy, look really neat, grow like crazy and *you* can make beer with them." He emphasized "you." Mike isn't a homebrewer, but he enjoys the mystique of growing something that loves to grow (hell, you can't help but want to put something like that in your beer).

I, too, grow hops just for the hell of it, mostly because I enjoy the spirit with which they grow. They make me thirsty just watching them climb, spread and blossom. While not all of us have the plot of earth needed to grow these beer vines, all of us have the time and space to brew beer if we so choose. And when we do, hops often become the subject of passionate discussion.

Quality hops are a treasure. They haven't always been available to homebrewers. Veteran homebrewers need only recall the early 1980s and shiver at the thought of having to use brown, crispy hops wrapped in pink paper available year-round on the display shelves of your local supply shop – right next to the malt extract.

Homebrewers and homebrew shop owners got smart. We learned our hobby well by recognizing the difference between fresh, quality hops and floor sweepings. We demonstrated our preference with a passion. Packaging was developed, care in handling was learned and soon thereafter the pipeline was built and filled with quality hops and information. Without that information and our quest for understanding this ingredient, I'm quite confident homebrewers would never have been offered the really great stuff we can now choose from.

Homebrewing continues to evolve. Our knowledge and appreciation of great stuff evolves. New varieties of hops are being developed, new and old methods of using them are explored, techniques for processing the essence of hops continue to improve the quality and enhance our ability to utilize them. Each one of us has our own preferences: whole hops, pellets or extracts. Knowledgeably considering our own set of economics, brewing conditions, equipment configuration, ease of handling, storage and location we make our choices. With the right information our choices are always the best and so is our beer.

Hops are a living thing. They are a people thing, grown by people in many parts of the world. They have personality. Just like people they evolve. Our hobby evolves. Our beers evolve. It's always a pleasure to befriend hops. They comfort our beers. They comfort us. Hops as an ingredient arguably contribute more to the personality of beer than any other ingredient.

It's been seven years since our last special issue on hops. Now as we revisit the subject in this year's Special Issue of ***Zymurgy***, let's not forget the never-ending journey we're on as brewers. Our knowledge makes the beer. It shapes trends, fermentation and the course of things to come.

Hops have certainly been our spice of choice. Pour yourself a tall dark or golden glass of your favorite brew. Set your roots in your favorite easy chair. Feel the hop vine curl toward the sky to reach the top of the trellis, pause and bloom. Appreciate the landscape. Below, behind and in front of you continue great opportunities to brew and enjoy your own homebrew. Above you the sky is the limit. It's where we all want to go, brewing forever. Open these special pages of ***Zymurgy*** and revisit with me the spirit of hops. Continue to make the choice to brew and enjoy the best beers possible.

Charlie Papazian is founder of the American Homebrewers Association and president of the Association of Brewers.

PHOTO BY MICHAEL LICHTER

Hops – The Vine That Binds

By Dena Nishek

This issue consumed the ***Zymurgy*** staff in much the same way the hop vines took over the side deck of my house. We worked with authors, technical editors and industry experts, we selected hop images, we churned out hop puns (don't worry, you'll only be subjected to a few here) and dreamed in that pale green color of a fresh, dried hop. We drank aggressively hopped beers, we dry hopped and first-wort hopped. I watched as my three vines raced to the roof, generated bushy side shoots, tried to pry open the sliding screen door – eventually I saw the most perfect of all green flowers emerge.

Work on a project of this scope began more than a year ago when I visited Yakima, Wash., for the American Society of Brewing Chemists hop technology course. Plenty of ideas for features came from those classes. Contacts for technical editors and authors also were established. Less tangible, but probably more important, came inspiration. Experiencing the hop harvest, if only for a day, was invaluable. From the minutia of coconut coir (it takes about seven miles of coir to string one acre of hop vines) to the historic details of hop harvesting in the 1800s by Native Americans, the story of hops was entrancing. Breathing in the hop-saturated air in the kilns and cooling rooms bordered on intoxicating.

As brewers, whether dealing in IBUs per pound or hand selecting your whole hops, this vine binds us all. This year we've arranged for a special print run so all North American professional brewers can receive this ***Zymurgy*** Special Issue. For some of you pros, reading an issue of ***Zymurgy*** may be nostalgic – taking you back to your homebrewing roots. For others who regularly read ***Zymurgy*** (and who still homebrew!) you can add this issue to the stacks of ***Zymurgys*** we regularly see piled in breweries across the country.

At Homebrew Rendezvous, the AHA National Homebrewers Conference in Cleveland in July, quite a few professional brewers were in attendance. They said they attended because they love good hand-crafted beer and wanted to focus on beer with others who share their love of the beverage. I'm sure this interaction of homebrewers and professional brewers was mutually inspiring.

The information in this issue, presented by hop-industry experts and enthusiasts alike, should provide inspiration and a ready reference on hops and hopping for years to come. The last Hops Special Issue was in 1992 and a lot has changed since then. Several new varieties are available to homebrewers and craft brewers along with new products and new and rediscovered hopping techniques. Brewers are exploring single-hop brews, akin to single-malt Scotches, to emphasize a hop variety. Many brewers are trying hop oils to refine aroma and flavor. And the historic first-wort hopping technique is receiving new attention.

Whether you are brewing an IPA for home or for hundreds, we hope this issue will inspire you.

Don't forget, you are always welcome to write to me with feedback and article ideas at PO Box 1679, Boulder, CO 80306-1679; FAX (303) 447-2825 or dena@aob.org via E-mail.

PHOTO BY ROBERT GOLDMAN

Once Upon a Vine

A Brief History of Hops

By Greg Kitsock

During the last 10,000 years, a veritable witches' brew of ingredients has been used to flavor malt beverages: birch, spruce and oak, ginger, gillyflower, black pepper, wormwood, capsicum, juniper berries, heather, bog myrtle, ground ivy, lemon and orange peel, cardamom, mace, sage, date juice, honey, ginseng, gentian root, nettle, dandelion, pennyroyal, wintergreen and mint, garlic and horseradish, just to name a few.

But not one has attained the universality of hops in Western brewing. Hops are enshrined in the German *Reinheitsgebot* as an integral ingredient of beer. In the United States the Bureau of Alcohol, Tobacco and Firearms has ruled that a beverage must contain at least 7 1/2 pounds of hops per 100 barrels to be considered a beer for tax purposes.

Hops are believed to be native to Asia. In fact, several wild varieties of the genus *Humulus* grow throughout China and Japan. According to one view, waves of Asiatic invaders brought hops to Europe. The Roman historian Pliny the Elder, writing in the first century A.D., mentions hops as growing wild among the willows "like a wolf among sheep." This may have inspired the current botanical name, *Humulus lupulus*, or little wolf plant.

The Romans consumed the tender young shoots of the hop plant as a delicacy, much like we do asparagus today. The cone-shaped clusters of flowers – the part that interests brewers – probably were used in medicines long before beer. Michael Jackson, in *The New World Guide to Beer* (Running Press, 1988), cites a *sicera ex lupulis confectam* (strong drink made from hops) used by Jews to treat leprosy during their Babylonian captivity.

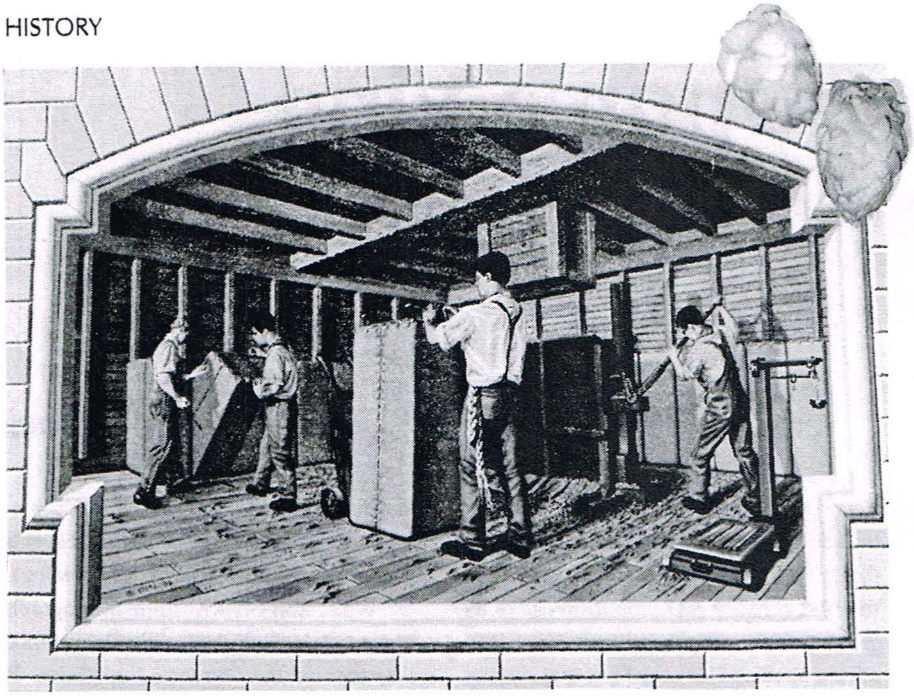
Physicians through the centuries have prescribed hop potions as a diuretic, preventative against kidney and bladder stones, remedy for dyspepsia, a mild laxative and even to prevent premature ejaculation. According to Dr. Wakeman Bryarly in his monograph, *Inaugural Essay on the Lupulis Communis of Gaertner, or the Common Hop* (John. H. Oswald, 1805), lupulin, the aromatic secretion of the hop glands, is a natural sedative. Pillows stuffed with hops were used to induce sleep long before commercial sleep aids. Bryarly also recommends tincture of hops as "an excellent substitute for opium."

Church documents from the eighth and ninth centuries refer to hop gardens in northern France and Bavaria. Some also mention malt. It is probable that Benedictine monks in the cloister at Freising were hopping their beer as early as the eighth century. However, the earliest unequivocal discussion of hops in brewing usually is attributed to St. Hildegarde in 1071. Hildegarde was a

This 1904-era hop harvest scene is depicted in a mural adorning the American Hop Museum in Toppenish, Wash.

From their introduction to brewing in the middle ages, hops have revolutionized beer as we know it.

PHOTOS BY DENA NISHEK
SPECIAL THANKS TO THE AMERICAN HOP MUSEUM



The 200-pound bales were packed with a jack press and hand sewn into burlap. This jack press, originally from New York, now resides in the Museum.

remarkable woman. Initiated into the Benedictine order at the age of 15, she became Abbess of Rupertsberg near present-day Bingen in southwest Germany. Hildegarde experienced mystic visions throughout her life, which she recorded in her theological writings. She also composed hymns (words and music), wrote two books on medicine and natural history, corresponded with popes and potentates and, just for fun, invented her own language composed of 900 words in an alphabet of 23 letters.

In her *Physica Sacra*, Hildegarde writes, "If one intends to make beer from oats, it is prepared with hops, but is boiled with grug, and mostly with ash-leaves." Hildegarde did not consider hops much of a health tonic: "It is not very salutary to man, because it makes him melancholy, dejects the spirit and, owing to its heat, is injurious to the intestines." (*100 Years of Brewing*, 1974) She did, however, observe that beer made with hops stays preserved longer than unhopped beer.

Bohemia, now part of the Czech Republic, became famous for its hops during medieval times. As early as 1101, Bohemian hops were shipped by way of the river Elbe to the Forum Humuli, the hop market of Hamburg. So important were hops to the economy that in the 14th century King Wenceslaus IV (later to become emperor of Germany) issued an edict banning the export of hop cuttings. Wenceslaus may have imposed his monopoly on hops for personal reasons: it is said he was an alcoholic who neglected duties of state for the drinking cup.

Hops spread from Central Europe outward into Northern Germany, Scandinavia and the Low Countries. Almost everywhere hopped beer appeared it encountered resistance. Archduke Vassili II of Russia banned the use of hops. The Archbishop of Cologne tried to do the same. In the Netherlands the brewers of gruit (also known as grout and grug) – an ale flavored with a mix of herbs and spices – attempted to tax hops out of the market. In many areas, church authorities held a monopoly on the sale of gruit and were reluctant to lose this source of revenue. Eventually the demand for bitter beer forced them to adapt alternative methods of tithing.

There is some evidence that hops were grown in England before the Norman invasion in 1066. Anglo-Saxon deeds refer to the modern town of Himbleton as Hymel-tun, meaning hop-yard. (Baker, 1985) An Anglo-Saxon version of the Herbarium of Apuleius even refers to "hymele" being mixed into beverages. For some reason, however, hop cultivation died out and had to be reintroduced by Flemish and Dutch immigrants to East Anglia.

Hops proved to be a hard sell the second time around. A bit of doggerel coined about the year 1525 states:

"Hops, Reformation, bays and beer
Came into England in one bad year."

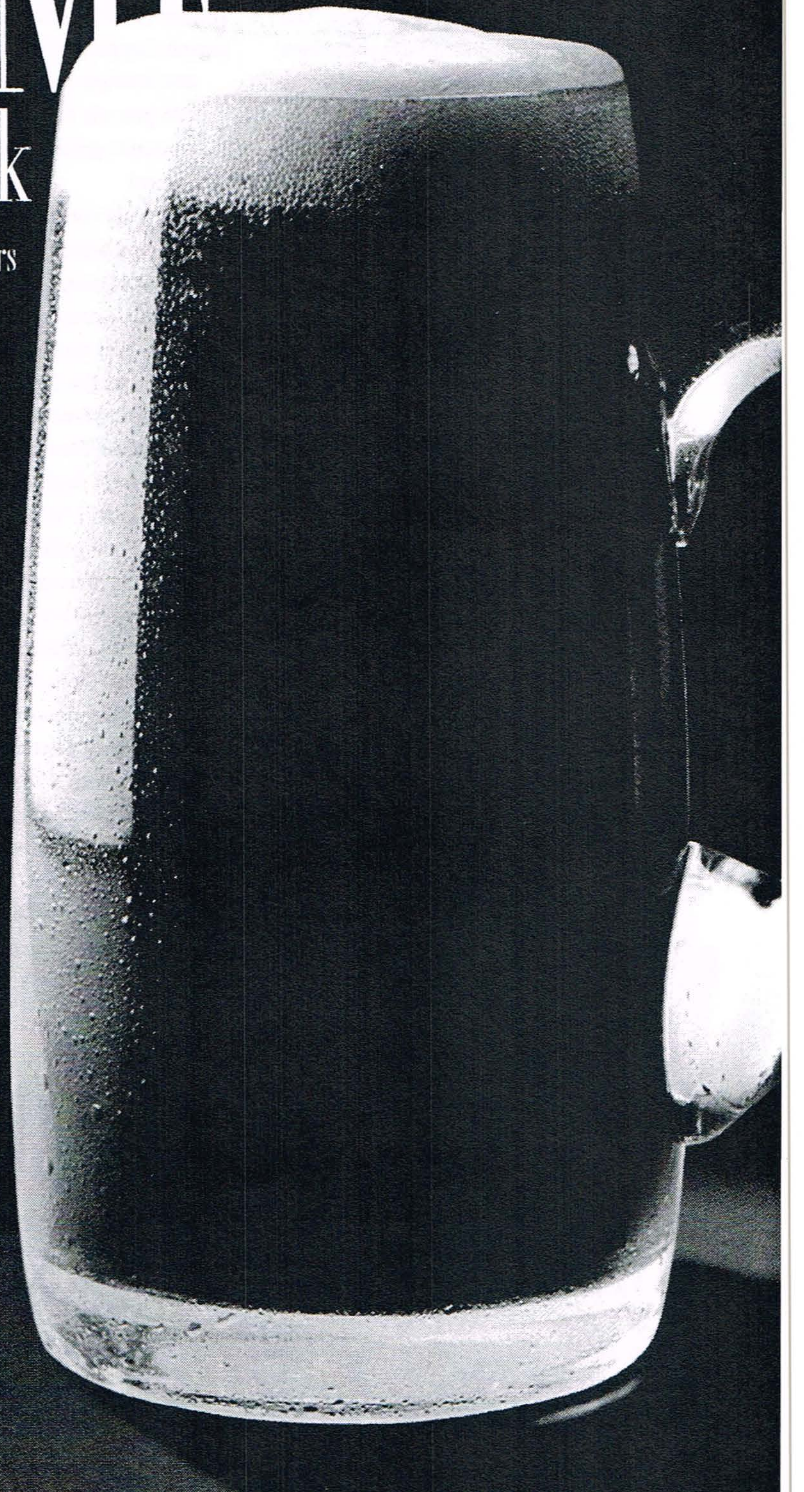
Like lager in America, hopped beer originally was brewed by immigrants for fellow immigrants. King Edward III (1327-1377) brought Flemish weavers to England to develop an independent textile industry. These immigrants first imported beer from the mainland, then brought in hops for their own brewing efforts, and finally planted their own hop yards. Occasionally, the Flemish brewers inspired bouts of xenophobia. The city of London tried to outlaw hops as a poisonous weed in 1436, and Norwich and Shrewesbury enacted temporary bans. Henry VIII is supposed to have given strict orders in 1530 that the royal libation contain no hops or brimstone. As late as the mid-17th century the celebrated "water poet" John Taylor, who sang the praises of good ale in verse, called beer "a boorish Dutch liquor, a thing not known in England ... till such times as hops and heresies came amongst us, it is a saucy intruder into this land." By that time a dichotomy had crept into the language. The term "ale" referred specifically to sweet unhopped malt beverages, while "beer" denoted bitter hopped ones.

Hops added a new step to the brewing process: a prolonged boil during which the cones were steeped in the wort to extract the bitter resins. In those days malt was of variable quality and the boil may have served to break down additional starches into fermentable sugars. Records from the late 16th century suggest beer brewers were getting a much better yield from their grain than ale brewers, which is perhaps another reason why the use of hops caught on.

Most important, the hops acted as a natural preservative, giving beer the edge over ale in what we now call "shelf life." Victualers could supply beer to His Majesty's Army or Navy reasonably certain the beverage would reach the troops in drinkable condition. (To give an idea of how lucrative the military trade could be, the average English sailor, at the time of the Spanish Armada, consumed a gallon of beer a day). By the 16th or 17th century beer was regarded as a sophisticated urban beverage, while ale was pigeonholed as the drink of country bumpkins and invalids.

TALL, DARK & HANDSOME

Briess Traditional Dark



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In her well-researched *Ale, Beer and Brewsters in England* (Oxford University Press, 1996), Professor Judith M. Bennett of the University of North Carolina argues that the introduction of hops signaled a major turning point in English brewing history. Before then, brewing was a cottage industry done mostly by women. After hops became prevalent, men dominated. Brewing in continental Europe was a male bastion. The Flemish immigrants were loathe to share their trade secrets with females, or admit them to guilds. Male brewers had better access to capital to upgrade equipment and hire assistants. The English alewife fell behind on the learning curve and eventually disappeared during the Industrial Revolution.

Hops grew wild in North America and the earliest European colonists raised them in their herb gardens. As early as 1628, the Endicott expedition brought hop roots to the Massachusetts Bay colony. But the supply was erratic, and for a long time American brewers before the 18th century had to rely on imports or their own ingenuity. Common substitutes for the hop included ginger, sassafras, walnut bark, birch and spruce. Spruce beer, rich in vitamin C, was taken on sea voyages to ward off scurvy. A recipe for spruce beer originally published in *The American Economical Housekeeper* in 1850 and reprinted in *Early American Beverages* (Bonanza Books, 1966), reads:

"Take three gallons of water, lukewarm, three half-pints of molasses, a tablespoonful of essence of spruce, and the same quantity of sugar; mix all together, and add a gill of yeast; let it stand over night, and bottle it in the morning. It will be ready for use in twenty-four hours."

Of course, even when hops were available many brewers continued to use other spices. A recipe for a "London ale" appearing in *The American Practical Brewer and Tanner* (Van Winkle and Wiley, 1815) by Joseph Coppinger calls for:

200 bushels pale malt
206 pounds hops
4 pounds grains of paradise, pounded or ground
4 pounds coriander seed
1 pound orange powder

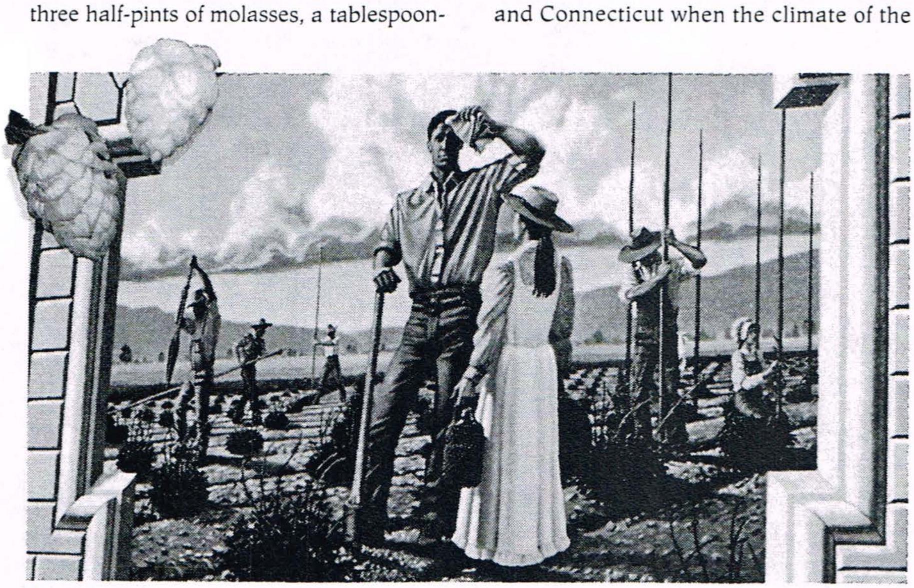
Pennsylvania, Maryland and Virginia all tried in vain to encourage hop growing. Massachusetts was the first state to make hops a cash crop. By the 18th century the Bay State was exporting the cones not only to its sister colonies but to Newfoundland, Germany and France. When Paul Revere carried news of a British invasion "to every Middlesex village and farm," he galloped through the No. 1 hop-growing area in America.

Coppinger describes the art of hop growing in considerable detail. He mentions a variety called "long white" yielded the most cones. (An alternate strain called "red bine" was less highly esteemed.) Coppinger complains that New York brewers should be forced to import hops from Massachusetts and Connecticut when the climate of the Empire State was perfectly suited to hop growing. He laudes hops as "one of the most profitable crops that can be raised, bringing in a net profit of $80 an acre." Coppinger also suggests that "much of [the labor of hop-picking] may be performed by women and children." It wasn't simply that women and children would accept less pay – hops are delicate so supple fingers and a gentle touch are more important than big muscle.

Coppinger doesn't seem to have been aware of it, but in 1808 a Massachusetts native named James D. Cooledge had bought a farm in Madison County, N.Y., and was soon peddling his hop crop to big-city brewers. Hop culture prospered in New York, thanks in part to the opening of the Erie Canal, which made shipping easier, and a hop blight in England. By mid-century, a 200-mile swath bounded by Albany in the east and Rochester in the west lay dotted with stone oast houses where hops were cured and tepee-shaped collections of hop poles.

The harvest, which generally took three weeks in late August and early September, had all the character of a modern-day block party. The farmer's neighbors and townsfolk helped with the picking, the women and families lodging in the farmhouse and the single men bunking in barns or camping out. In 1881, an immense "Hop City" was erected on the road between Cooperstown and Phoenix. This village of 1,000 even had its own cobbler and blacksmith shop! The days' work was often followed by singing, dancing and gospel revivals.

All was not sweetness and light in the hop fields. As the annual yields increased (New York hop production peaked in the early 1880s at more than 21 million pounds), farmers were forced to recruit hop pickers from outside the immediate community. Many were urban laborers who regarded their sojourn in the hop fields as a vacation from the soot and grime of the city, but their numbers included some petty thieves and tramps. Locals began to eye all outsiders with suspicion. James Fenimore Cooper, in *Reminiscences of Mid-Victorian Cooperstown* (Otsego County Historical Society, 1936), writes that during the hop harvest the two-man police force – "one with one arm and the other with one leg" – patrolled the streets until 1 a.m. instead of the customary 11 p.m.



Hop plants were trained up poles in the days prior to the current wire system. Planters used dibbles to replace poles at the plants' roots each spring.

Street lamps were allowed to burn until midnight, an hour later than normal.

Wildly exaggerated rumors of an immense hobo jungle on the outskirts of town plagued Utica residents in the late 1870s. In 1878, writes Tomlan, author of *Tinged With Gold* (University of Georgia Press, 1992), a Cooperstown grocer decided to take advantage of the paranoia by running an ad in the local paper urging residents to "Buy a revolver and shoot the tramps." Evidently the grocer had some misgivings about lawsuits, as he appended the ad with a line in smaller type reading, "if they need it."

In the West, the hiring of Native Americans and Chinese immigrants sometimes sparked racial tensions. Occasionally a stern overseer would stir up trouble by docking the pickers part of their wages for mixing too many stems and leaves with the cones. Avenues of retaliation included tearing down the vines before the hops had ripened and setting fire to the newly kilned cones, which are highly flammable. The worst violence took place in 1913 at the Durst Hop Ranch in Wheatland, Calif. Complaining of low wages and squalid living conditions, a mob of hop pickers, egged on by an Industrial Workers of the World agitator, attacked a sheriff's posse. When the violence was over, the local district attorney, a deputy and two laborers lay dead. Two ringleaders of the uprising were sentenced to life in prison.

Hop growing was something of a crap shoot for the farm owner. In a good year the fragrant cones were green gold, but if supply exceeded demand the bottom would drop out of the market and the farmer might be left bankrupt. Between 1880 and 1910 the price of hops seesawed wildly between $1.13 and three cents per pound. Pests and diseases such as aphids and mildew could decimate a crop. Hops wore out the soil quickly and needed intensive fertilizing.

No wonder the hop farmer was a restless soul. Like the center of population, the hub of the hop-growing industry shifted ever farther westward. Massachusetts and the New England states held the lead in U.S. hop growing until about 1840, when New York growers produced almost as many hops as all the New England states combined. Wisconsin challenged the Empire State in the 1860s, but the hop craze in the Midwest petered out after 1868, when prices plummeted from 60 cents per pound to a mere nickel. "Plough them up!" exhorted a headline in the local press.

The first hops were sown in California in 1857, and by the 1880s California hop growers were beating the pants off their New York rivals in terms of yield per acre. California was the leading hop-growing state from 1915 until 1922, when it yielded to Oregon. Washington state assumed the lead in 1943 and has held it ever since, thanks to the fertile soil and long hot summers of the Yakima Valley. Washington farmers were among the first to invest in mechanical hop pickers, which harvested the cones more inexpensively and efficiently than human hands ever could. Today, Washington, Oregon and Idaho produce virtually all of the U.S. hop crop and 25 percent of the world harvest. Hop farms tend to be 200 acres and larger to take advantage of the economies of scale. The days of mom-and-pop hop farms and annual hop balls, it seems, are gone forever.

Or are they?

According to Wendy Littlefield of Vanberg and Dewulf Importers, the Farmers' Museum in Cooperstown recently planted "under an acre" of hops as an agricultural exhibit. "It's the first hop field to be planted here in 50 years," she noted. It may not be the last. A local resident is making plans to grow hops organically outside the town. As for Littlefield, she and partner Don Feinberg are launching their own operation, Brewery Ommegang, at a 136-acre former hop farm five miles outside Cooperstown. The brewery should be producing three Belgian-style ales as you read this. The 10,000-square-foot farmstead will include a reconstructed hop kiln, reception room patterned after a 16th-century Flemish hall and, yes, a small hop garden.

References

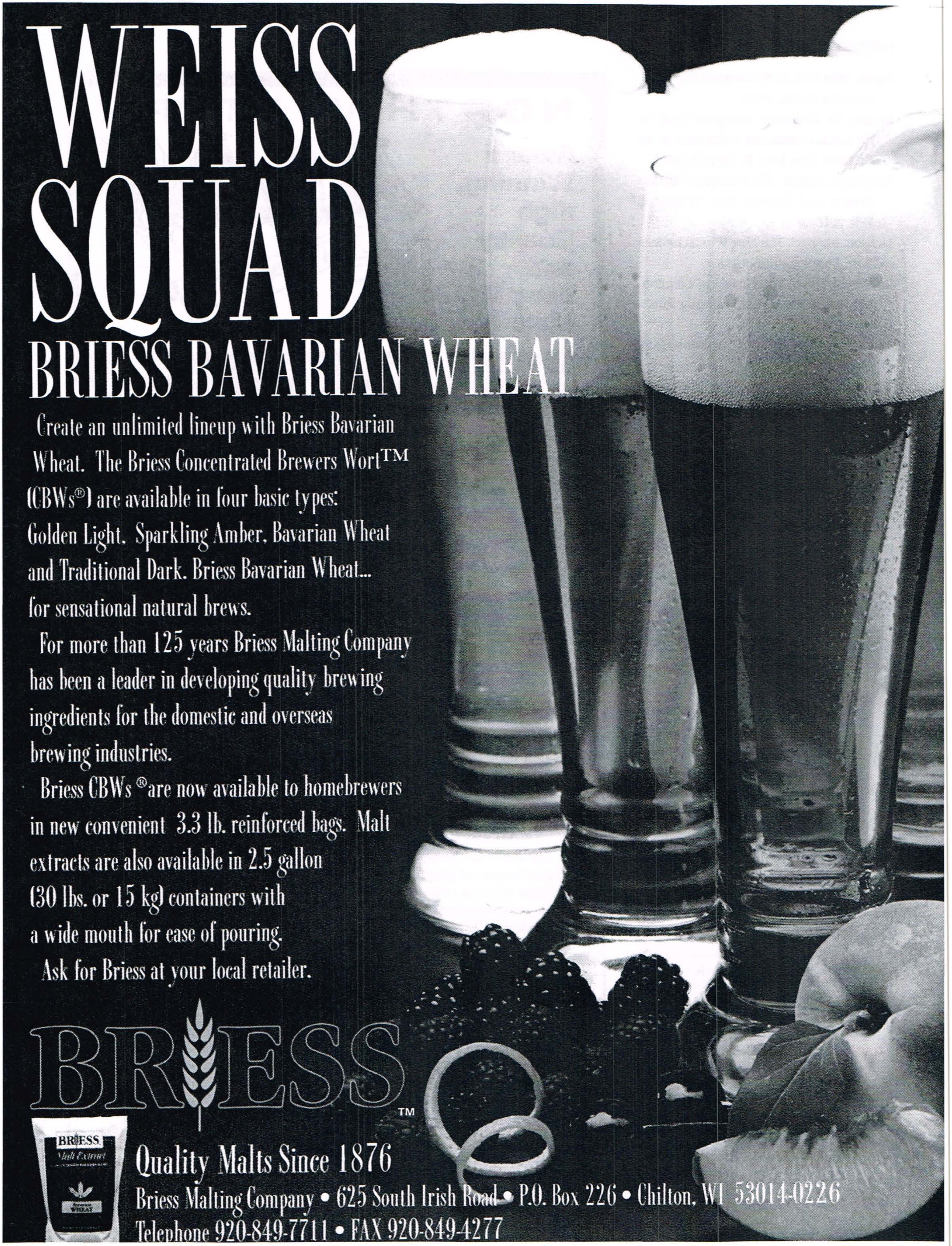
100 Years of Brewing, H.S. Rich and Co., 1903. (Reprinted 1974 by the Arno Press of New York.)

Baker, Dennis, *Agricultural Prices, Production and Marketing, With Special Reference to the Hop Industry: North-East Kent, 1680-1760*, Garland Publishing, 1985.

Baron, Stanley, *Brewed in America: A History of Beer and Ale in the United States*, Little, Brown & Co., 1962.

Barth, Heinrich J., *The Hop Atlas: The History and Geography of the Cultivated Plant*, Joh. Barth & Sohn, 1994.

Bennett, Judith M., *Ale, Beer and Brewsters in England: Women's Work in a Changing World, 1300-1600*, Oxford University Press, 1996.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Brown, John Hull, *Early American Beverages*, Bonanza Books, 1966.

Bryarly, Dr. Wakeman, *Inaugural Essay on the Lupulis Communis of Gaertner, or the Common Hop*, John H. Oswald, 1805.

Coppinger, Joseph, *The American Practical Brewer and Tanner*, Van Winkle & Wiley, 1815.

Jackson, Michael, *The New World Guide to Beer*, Running Press, 1988.

LaPensèe, Clive, *The Historical Companion to House-Brewing*, Montag Publications, 1990.

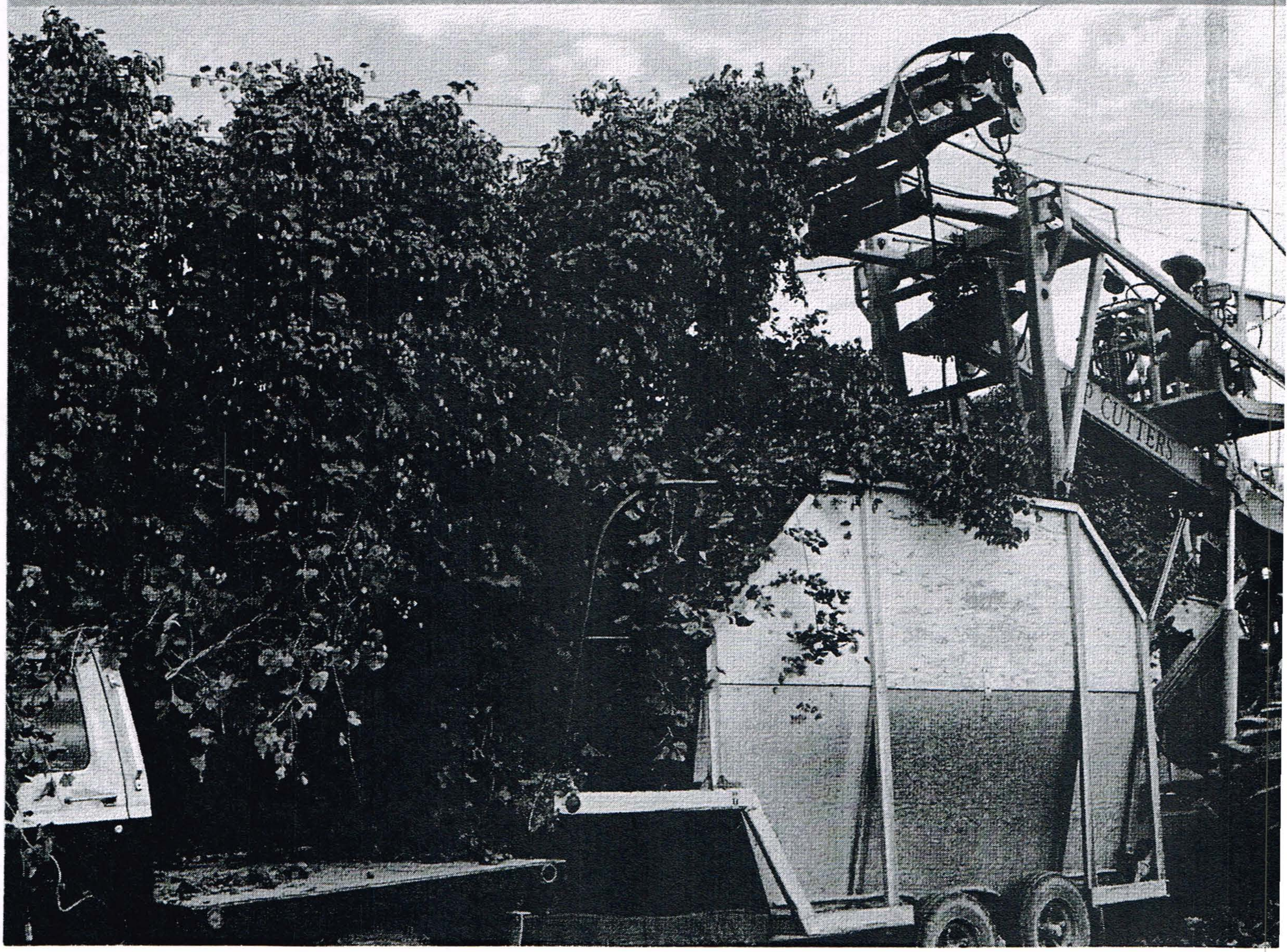
Protz, Roger, *The Ale Trail*, Eric Dobby Publishing, 1995.

Steiners' Guide to American Hops, S.S. Steiner, 1993.

Tomlan, Michael A., *Tinged With Gold: Hop Culture in the United States*, University of Georgia Press, 1992.

Greg Kitsock is the associate editor of *BarleyCorn* and a frequent contributor to other publications including *Zymurgy, The New Brewer* and *American Brewer*.

From the field to your kettle, here's everything you ever wanted to know about hop production.



HARVESTING Green Gold

By Mark Lisheron

There may not be a more fitting symbol for hop agriculture in the world than Florian Dauenhauer's prototype mechanical hop picker on the Mike Hogue Ranch in Prosser, Wash. It represents the last significant change in the field. Dauenhauer's clever variation on a Buick chassis and drive train changed forever the hop industry, at least in America. The device has done its work faithfully since 1954.

The spring-steel fingers on vertical rollers have been required to separate the delicate flowers from the twinelike vines of an increasing number of hop varieties in recent years. Now numbering more than 50, the new varieties were developed for the specialty brewing industry.

But the machine has not been called upon to harvest increasing acreage. In recent years it has had less work to do. After a generation of stagnant beer sales around the world, hop growing, harvesting and marketing are as arcane and precarious an occupation as a farmer could have.

Like that very first Dauenhauer picker, hops have one use alone – as a bittering and aromatic agent for beer. The last significant attempt to find uses as a food preservative took its place four years ago along with the mercifully brief craze of stuffing pillows with hops and substituting them for tea leaves.

During the past five years the United States has been unable to put together two straight years in which production and demand have meant growth. Production of just less than 75 million tons in 1996 was 4.9 percent less than the year before, little more than the amount produced in 1992. During the same period overall American beer production hovered around 200 million barrels a year.

And while the world's other great hop producer, Germany, has experienced wild fluctuations in production in the same period, its bulges have served only to glut the world market. In 1992, for example, Germany produced a little more than 64 million pounds of hops, followed in 1993 by 93.6 million pounds and in 1994 by a drop to 62.9 million pounds. In 1996, Germany produced 81.6 million pounds of hops. German beer production has been flat at about 100 million barrels a year.

In spite of what so far has been a good growing season in 1997, the outlook for the hop industry is much what it has been for the past decade, said Tom Frazer, Dauenhauer's grandson and president of Dauenhauer Manufacturing Inc. of Santa Rosa, Calif.

"The margins in the hop business are as bad as they have been in a long time," said Frazer, who last sold a new picking machine to the tune of $500,000 in 1992. "There are some bright spots around the world, but basically hop farmers are working within some pretty narrow boundaries. This is the craziest little business."

It is a business, at least in the United States, in which a fellow like Frazer can know almost everyone on a first-name basis. The families who control 80 percent of the hop acreage in Washington, for example, are fourth- and fifth-generation descendants of French-Canadian settlers who came to the

TOP PHOTO COURTESY OF HOPUNION USA INC.
BOTTOM PHOTO BY DENA NISHEK

region after the Civil War looking for work, according to Sean McGree, executive director of the Hop Growers of America in Yakima.

Like most farming operations, hop farms have become larger, more efficient and more corporate. As late as World War II, family farmers were hand picking their vines on tracts no bigger than 15 acres. Today it is common for a family hop farm to be 600 acres and not uncommon for it to be as large as 1,500 acres.

In Germany, the Czech Republic and Slovakia growers have stubbornly clung to the old ways, making a few mechanical picking and harvesting concessions on tracts as small as eight acres, no bigger than the fields of their forebears. The European Union, which monitors the performance of industries in member nations, subsidizes German hop growers at a rate of about $20 million a year to keep them competitive with American growers, McGree said. The wholesale price of American hops is 10 to 15 percent lower than German hops, he said, and the Germans have out produced the Americans in 10 of the last 13 growing seasons.

The Germans who settled in New York in the early to middle 19th century believed they were living in a climate similar to their homeland. Hops, the experts say, will grow well in almost any soil as long as there is a good balance between sun and rainfall.

Otsego County, west of the state capital of Albany, had such a balance, said Bob Banta, co-founder of the hop museum currently being organized near Cooperstown. There is evidence of hop growing in New York as early as 1828, Banta said. Cooperstown, where 160-year-old hop houses still stand, became the nation's first unofficial hop capital, he said.

Banta, 74, came to know hops 30 years ago, more than 60 years after the last bale of New York hops was shipped by rail to New York City from Cooperstown. Banta did a lit-

HISTORICAL HARVESTING

A single hop vine grows in Merton Eberlein's back yard in Mauston, Wis., the one tangible reminder of a kind of farming that made this rural area famous for a very short time in the early 1900s.

Ninety-four years has dimmed neither his memory of the work on the farm nor his distaste for it.

"My father was a farm foreman and my mother was allergic to hops," Eberlein said recently from his home. "My father had to take every stitch of clothing off before he could come into the house at night. Me, I wasn't allergic to hops. I just hated the farm. I wanted nothing to do with it."

Eberlein, however, is one of the last vines, if you will, clinging to a first hand remembrance of a kind of farming narrow in purpose, tethered to the plant and helpless in the face of its environment.

At the turn of the century hops were being grown in New York, Wisconsin, Oregon and Washington. The methods used varied little from coast to coast and, in spite of some technological advances, a good bit of hop farming today is much the same as it was then. Painstaking, nerve-wracking and always speculative.

Before downy mildew ruined hop farming in upstate New York, America's hop farming was handled by men, while the harvest was shared with women, according to Bob Banta, a hop historian from Cooperstown, N.Y.

"Come the end of summer, the yards were filled with ladies from Albany, Schenectady, Utica, as far away as that," Banta said. "They'd stay in town for the whole month and then be on their way."

In Wisconsin, hop pickers were women, too. Native American women were drawn by the lure of $1.25 a day, Eberlein said. On the 30-acre I.L. Allsbacher farm where his father, Fred Eberlein was foreman, about 50 women, many of them carrying what the locals called their papooses, their tiny children in a kind of swaddling backpack. While the women worked, Eberlein said, the children often slept in the carriers hung on a branch of a shady tree.

Native American women were among the first and most loyal of the hop pickers in the states of Washington and Oregon, said Tom Frazer, the president of Dauenhauer Manufacturing Inc., the world's foremost producer of stationary hop pickers.

At harvest time farm hands would cut the hop vines at their bases and lift the poles they had wrapped themselves around, usually a slender, stripped willow branch, out of the ground. The poles were carried to a common area where long benches had been set out on either side of a long wooden board or table, Eberlein said.

The pickers would gently pull the hop flowers away from the vine and drop them into a tight knit cloth bag about twice the size of a 100-pound flour sack, with a strap at the top to hang over a shoulder, Eberlein said. When full, these hop sacks would be loaded onto a horse-drawn wagon for delivery to the hop house.

"All I can tell you is it was quite a thing," Eberlein said.

While no hop houses remain in the Mauston area, Eberlein said, the Cooperstown area has some well-preserved examples, according to Banta.

The houses were two stories high, with cupolas built at the top of a steeply pitched roof with a hole in the center to allow hot, moist air to escape from the kiln area below, Banta said.

The Hands of Harvest statue is dedicated to the pioneers of the Yakima Valley hop industry and stands in Old Timer's Plaza, downtown Toppenish, Wash. Engraved on the base of the statue is "Hops-tma-nectla," which means hop picker in the Yakima Indian language.

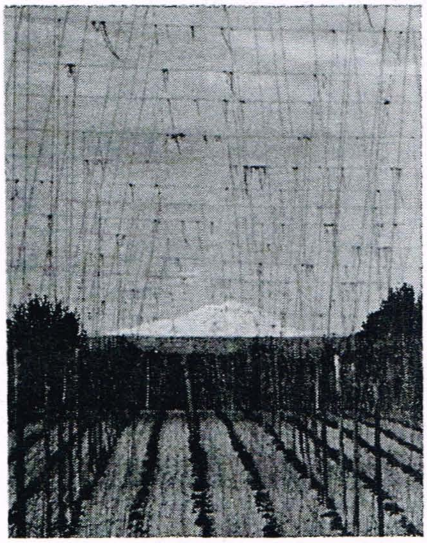
Instead of the wire mesh floors of today, the floor where muslin or cheese cloth was spread to hold layers of drying hopes were made of boards fixed one to two inches apart. This allowed the heat from a coal or wood-burning stove to go about its drying work, he said.

Much of this harvesting method remained in place until the late 1930s when Florian Dauenhauer determined to build a hop picker that not only stripped the vines but kept intact the delicate hop flowers.

The history of hops in the eastern United states will soon be opened to the public when Banta and friend, Dave Petrie open their hop museum, just outside Cooperstown. The museum will, however, be without about a truckload of hops stoves, presses, cultivators and other tools, Banta said. Before deciding the New York needed its own museum, Banta shipped off historical hop artifacts to this nation's premier museum, the American Hop Museum in Toppenish, Wash., right in the heart of the Yakima Valley.

"That's where all that stuff belongs, I guess," Banta said.

PHOTO BY DENA NISHEK



Hop farming remains a labor-intensive business. Each season fields are restrung and vines trained to a trellis.

tle research on the history of hop growing, having been impressed by an abandoned hop house up the road from his family farm.

"I guess I just thought hops were interesting," Banta said. "It's kind of funny because I don't drink beer. People kid me about it all the time. But I just never acquired a taste for it."

Banta has helped chronicle the two great periods of New York hop growing, after the Civil War and at the turn of the century. In each case, the great bane of hops – downy mildew and blue mold – wiped out the business. Those who didn't pack up and leave went into dairy farming, some to try again at the dawn of the 20th century. A few, Banta said, moved to central Wisconsin where a similar climate and the biggest beer industry in the world, in Milwaukee, was a two-hour train trip away.

"In those days there wasn't anything you could do but pull out the vines and go somewhere else," Banta said. "There was nothing to combat the mildews and the molds."

Farmers fared no better in Wisconsin. At the entry to Lyndon Station, a tiny town 75 minutes northwest of Madison, the state capital, a weathered sign proclaims the area the one-time hop-growing capital of the world. Although there are no reliable figures to back it up, Merton Eberlein, whose father was a foreman on I.L. Allsbacher's 30-acre hop farm, said that until about 1905 the claim would have been hard to dispute.

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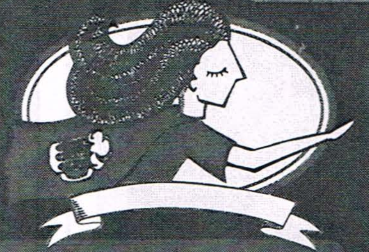

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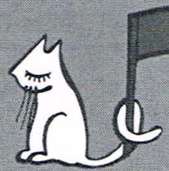

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At 94, Eberlein remembers the women of the Winnebago (now referred to as Ho-Chunk) Tribe moving into the field from their nearby homes to take part in the hand-picking. Eberlein also remembers Allsbacher, a Bavarian shoemaker, going bankrupt in 1913 with a field destroyed by mildew and aphids.

Oregon farmers nearly suffered the same fate. Blessed with abundant rainfall and rich volcanic soil, the Willamette Valley had emerged as the primary hop-growing region by the early 1920s. In 1925, the Willamette Valley was harvesting 30,000 acres of farmland, according to McGree. By 1930, downy mildew had rendered 25,000 of those acres useless for hops, he said.

Until the pesticide and herbicide advances spurred by World War II, the only thing farmers could do to stave off fungi was to grow in an arid region and irrigate. The Yakima Valley in Washington, which receives just seven inches of rainfall a year and is served by the confluence of the Yakima, Snake and Columbia rivers, was destined to become the hop capital of the United States by 1937.

Today, about 70 percent of the hops grown in this country are from the Yakima Valley, near the state's southern border, said Ralph Olson of the Yakima hop merchant, Hopunion USA. Another 20 percent are grown in the Willamette Valley south of Portland. Still another 10 percent are grown in Idaho's Boise Valley in the southwestern corner of the state, with a handful in northern Idaho near Bonners Ferry.

Olson, with Hopunion since 1978, has done virtually every job in the industry from vinedressing to marketing. He just might be the most knowledgeable hop man in the country. Hop farming hasn't changed much in 130 years, he said.

Fields are laid out in grids with 50 to 60 thin poles between 15 and 18 feet in length driven into the ground five to six feet apart. The poles support a trellis upon which the vines cling. Rootstock is planted in mounds next to each pole.

"A lot of people don't realize it, but those vines still have to be hand trained up those poles," Olson said. "It remains a labor-intensive business."

While 75-year-old vines still produce Clusters in some places in Yakima, Olson said, vines are closely monitored and the plants removed when their production begins to drop off. Farmers replace entire fields in an ongoing cycle every 10 years. In addition, the small explosion of demand by the craft-brewing industry for different hop varieties has caused farmers to diversify and rotate stock.

New plants can take as long as three years to reach full production, although Olson said conditions in Yakima allow some plants to be 80 percent productive in their first year.

In Oregon and Idaho traditional sprinkling is the primary irrigation method. Washington farmers have gone to drip irrigation to more efficiently direct water in the arid climate.

Throughout the season farm workers make applications of plant and insect preventative on the fields. McGree said Yakima farmers make about five applications a year, compared to twice that for farmers in the wetter climates in the United States and Europe.

After a series of cultivations that end in early July, the work force doubles for a harvest that typically begins in mid-August and ends in mid-September. Vines are hand cut about 18 inches from the ground and at the overhead trellis and trucked to the stationary picking machine.

Most farmers in America use a Dauenhauer picker like the prototype still found on the Mike Hogue Ranch. Vines are carried along a horizontal belt hanging upside down until they reach a series of wide, vertical belts fitted with the spring-steel fingers. As they pass between the belts, turning clockwise around a pair of long drums, the fingers gently pry the flowers from their vines and drop them to a conveyer belt. The vines are carried off to be chopped and returned to the fields as mulch. A series of belts and screened trays clean the flowers on the way to the kiln.

"What used to take hundreds of people 30 days to do 20 to 40 acres, half that many people can do 400 acres in the same time," Olson said. "That made a big difference."

In a building sometimes as long as 400 feet, hop flowers are laid three feet deep on a wire mesh floor, McGree said. Oil and gas burners below send 130-degree-F (54-degree-C) air up through the floor, dropping the moisture content from about 75 percent to 10 percent in nine hours. Conveyor belts move the dried hops to a cooling room for 24 hours and then to a baling room where a compressor squeezes them into 200-pound bales wrapped in burlap.

McGree said the prospect for the industry over the next five or six years does not appear to be any better throughout most of the world than it has been in recent years. While the craft-brewing trend has been an interesting development, it has shifted rather than boosted hop production, he said.

Brazil appears to be an anomaly. Shaking off a brutal inflation and a depressed economy, Brazil is ready for a long period of double-digit economic growth and with it a projected growth in beer consumption, according to analysts.

"So that's some good news," McGree said. "You take it where you can get it. A lot of acreage will have to be taken out of production while this glut of German hops is depleted. Right now, my crystal ball on the industry is pretty foggy."

Mark Lisheron, a reporter for the *Milwaukee Journal-Sentinel,* writes a monthly column and good beer guide for consumers. Lisheron has been homebrewing for more than three years.

In the Back Yard

A gardener's guide to homegrown hops.

By Patrick D'Luzansky

If you enjoy brewing beer and gardening, you are the perfect candidate for growing your own hops. Hops are a hardy perennial, and once established, they can be harvested for many years. As a homebrewer, you can benefit from the economic savings and increased quality control over your hops. Also, the hops' flavor and aroma are slightly affected by the local microclimate, so yours will have a unique signature. These features allow you more freedom of expression to design and brew your own excellent beer.

Hoppy Goals

The hop (*Humulus lupulus*) is a perennial twining plant with annual vines that produce flowers called cones. These cone-shaped flowers contain small lupulin glands, which in turn contain the acids, resins and essential oils we brewers use to impart the bittering, flavoring and aromatic qualities to our beer. Thus, our primary goal as hop growers is to harvest the hop cones, dry them and quickly get them into the freezer to retain peak freshness. Our secondary goal is to enjoy the pleasure of cultivating these plants. Because they grow so fast and tall (about 18 feet), hops provide a lot of visual entertainment and shade as they proceed through the fast vegetative growth, lateral growth and blossoming stages to the much-awaited cone ripening and harvesting.

Anatomy and Growth Cycle

The crown is the perennial part of the plant that grows under the soil. Each spring, warming soil temperatures cause the annual vines to shoot out of the crown, burst through the soil and race skyward. The helical structure of these shoots causes their tips to grow in a clockwise twining action, so they are called bines instead of vines. The grower must provide a structure for the bines to twine upon.

Meanwhile, underground shoots, or rhizomes, grow laterally from the plant and may emerge from the ground as basal growth. These rhizomes or slips are genetic clones of the parent plant. Other parts of the crown include fibrous feeder roots and fleshy storage and water roots. The vegetative growth of the primary bines will

AOB FILE PHOTO

GROWING YOUR OWN HOPS

In spring, plant hop rhizomes about three feet apart in well-drained soil. Cover the rhizomes with loamy soil and a layer of mulch.

Choose two or three of the strongest shoots to train up the coarse twine. Trim untrained shoots to ground level.

Hops are ready to harvest when they feel light and dry and spring back after a squeeze.

Dry the freshly harvested hops in a warm, dark place. You know they are dry when the inner stem is brittle.

normally reach heights of 15 to 20 feet. Branches or laterals will extend from the main bines upon which the cones will grow if conditions are right. Most of the cones will occur on the upper half to two-thirds of the bine.

Hops are tolerant of cold but need at least four months of frost-free days to flower and ripen. Also, hops need relatively long periods of daylight to switch from their vegetative phase to the flowering phase. These requirements limit commercial hop production to the latitudes between 35 and 55 degrees. The minimum daylight needed will vary with hop variety or cultivar, average temperature and altitude. By the summer solstice, the hop plant will have switched into its flowering phase if it's going to. If you are at a latitude where the longest day doesn't give the plant its minimum amount of daylight, the hop won't flower. Soon burrs will appear on the lateral branches of the bines. The quantity of burrs is proportional to amounts of light reaching the laterals – another reason to locate plants where they will receive plenty of sunlight. These burrs turn into green hop cones.

As the plant grows throughout the summer, the cones mature and become ready for picking. One advantage of growing your own hops is that you, like Juan Valdez with his coffee beans, can pick your hops throughout the summer just as they become ripe. This can allow the home grower two or three minicrops during the season. In contrast, the constraints on commercial growers require them to cut down the bines when the average hop cones are ready and feed them into picking machines. With home-grown hops, cones can be harvested and the plant allowed to continue growing, thereby allowing more nutrients to be manufactured in the leaves through photosynthesis and stored in the roots. The home-grown crown thus finishes the season stronger and more able to withstand the winter and get off to a better start the following spring.

In the fall, the hop plant will begin its transition into winter dormancy. The annual bines will die back to the crown, the leaves will fall to the ground and the crown's metabolism will decline along with the cooling fall temperatures. This is the time to prepare the plant for winter by cutting down the bines and covering the crown with a blanket of organic material and mulch.

Hop Yard Planning

First, remember hops will grow 15 to 20 feet, so select an adequate vertical or horizontal space. Hop crowns should not be spaced any closer than two or three feet. Select a site that will receive the most sunlight – usually with southern exposure – and that has some protection against wind. Strong winds can damage or break the bines, especially when the weather is cool and the branches are brittle.

When planning the layout, consider how you will be picking the hops. With the vertical growth method, picking can be done either from a ladder or, with a little ingenuity, the plant can be disconnected from a top wire, picked, then put back in place. Otherwise, the grower can cut the bines at the crown, lower them and pick them in a convenient location. (With a homebrew in hand, naturally!)

Go Horizontal!

A layout approach that makes picking easier is the horizontal hop yard. Here the hops are trained up a twine or pole for the first eight or 10 feet, then taken horizontally along another twine or support for eight to 10 more feet. The secondary branches with the hop cones will then hang from the horizontal supports, and picking can be done comfortably while standing on the ground or short stool. The overhead hops can be used as a shade-producing element for a beer garden – a nice place to enjoy the view of the developing hops!

Soil Needs

Hops prefer a deep, loamy, well-drained soil in the pH range of 6 to 7.5. Salty soil or soil with poor drainage is undesirable. Add sand to the soil to improve drainage and try deep irrigation to reduce saltiness. The pH can be adjusted with lime to reduce acidity

ILLUSTRATIONS BY LINDA FISHER

or sulfur to reduce alkalinity. Try to make pH adjustments in the fall, because the lime will interfere with nutrient uptake for about a month after its addition. The soil should contain 20 to 30 percent organic matter such as compost or dehydrated cow manure. Organic material plays an important role in making the soil nutrients available to the roots.

Nutrients

Hops have a very big appetite and need lots of nutrients. Fortunately, those nutrients required most – carbon, hydrogen and oxygen – are freely available through the air. The next most important nutrients – nitrogen, phosphorus and potassium, generally referred to on most commercial fertilizer sacks as "N-P-K" – are usually deficient in the soil. I use an organic 8-8-8 fertilizer applied at the rate of five pounds per 100 square feet (about one handful per plant) once in the early spring and again about six weeks later.

Watering

Hops are very thirsty plants, but their roots will rot if allowed to stand in water. This is why well-drained soil is so important. During their initial growth, frequent light waterings will be sufficient. Once the plant is established, deep, relatively infrequent waterings will encourage a strong, deep root structure and high drought tolerance. I don't recommend sprinkler systems because they tend to encourage mildew formation. A drip-irrigation system controlled by one spigot that delivers water right to the crown of each plant is a better option.

Planting

Hops are cold tolerant and can be planted in the spring as early as the ground can be worked. Hops normally are propagated from rhizomes that are available from March to May, thus planting is usually done during this time. However, you can plant rhizomes later in the season and even in the fall if you can find them. The first year's growth likely will not yield any cones and is devoted primarily to establishing the crown and root system. The rhizomes should be kept cool and moist until you are ready to plant them. Plant two to a hill or site with the buds pointing up. Orient them at a 45-degree angle with the upper end an inch or two below the soil line. The upper node will then become the annual climbing bine and the lower node will develop into the root system. Cover the rhizomes with fine loamy soil, then add a layer of mulch to retain moisture and keep the weeds down. Place a stake about six inches from the crown to mark its location and provide an anchor for the twine.

Stringing

Once the shoots have grown a foot or two, select two or three of the strongest ones to train around twine. I like to use thick plastic twine rather than paper or jute, because the plastic is less susceptible to rotting caused by sun and moisture. Make sure the twine is coarse because the bines' climbing hairs need something to cling to. Don't disturb the shoots on a cool or cloudy day, because they are brittle then and may snap when you try to train them. Fortunately, the next node down will produce another growing tip. Trim off the smaller stem and the remaining stem will develop into a new growing tip. Rather than suffer through all this trauma, you should wait to train your hops until a warm, sunny day. On that fine day, particularly in the afternoon, your hop shoots will be pliable and the risk of snapping them will be diminished.

Trimming and Tending

Trim back the untrained shoots to ground level. Alternatively, you could trim them back to a foot or so, lay them over onto the ground and cover with soil and mulch. These will become additional rhizomes you can use later to increase your hop yard plantings. As the season progresses, continue training your hops, trimming new growth and mulching to keep the weeds down. After the hop burrs have appeared, it's a good idea to remove the lower three or four feet of foliage. This helps prevent fungus and other diseases from developing by removing their easiest pathway upward from the base of the plant, and improving air circulation.

Pests and Pestilence

The best defense against attack by pests and diseases is to grow the healthiest, hardiest hops possible. Selection of disease-resistant cultivars is the first step. Next, select a sunny site with good drainage. Provide adequate spacing and support for good air circulation; proper pH, soil composition and fertilization; adequate and appropriate watering; and proper training and pruning to prevent shading and overcrowding. Despite our best efforts, hops may be attacked by diseases and pests. The diseases generally fall into two classes: mildews and wilts caused by fungi that can kill a plant quickly, and viruses that slowly take their toll through reduced plant vigor and yield. Pests generally include aphids and mites.

Downy mildew is the most common disease. Avoid the hot, moist conditions that favor spore germination. This is why it is better not to use sprinklers to water the plants. If you must sprinkle, do so in the morning so the leaves and shoots can dry.

Powdery mildew is another fungus. Systemic or spray fungicides for downy mildew and sulfur-based fungicides for powdery mildew can be used as a last resort. Follow the directions carefully and wait the prescribed length of time between application and harvest.

Verticillium wilt is a soil-borne fungal infection which may affect the plant differently over the years. There is no known control for verticillium wilt. Infected parts of the plant should be removed, and if the wilt persists over the years, remove the plants and start new plants elsewhere. Viral infections have no known cure and the best way to avoid them is to promote plant health and vigor.

The most common insect pest is the hop aphid. It is a tiny, soft green pest that sucks the juices out of the plant. Aphids tend to multiply when the weather is cool. They should be controlled before the hops produce cones, because once they get into the cones a black mold grows on their secretions rendering the cones unusable. Ladybugs (ladybird beetles) are a natural enemy of aphids and will help keep them under control. Plant flowers that attract ladybugs, such as Golden Marguerite. Insecticidal soaps and diatomaceous earth have been used successfully to control aphids. As a last resort, commercial insecticides can be used.

The next most common insect pest is the spider mite. They are found in hot, dry climates and also like to suck the juices out of the leaves and petals of the hops. Insecticidal soap solutions have proven to be effective at controlling these pests.

Harvesting

Monitor your hop cones for signs of ripeness. Give them a light squeeze occasionally and when they feel light and dry, and spring back after a squeeze, they're ready to pick. If the cones seem soft, damp and remain compressed after a squeeze, they're not yet ready. When ripe the lupulin glands at the base of the cone petals will be apparent with a golden yellow color and a fragrant, sticky residue when squeezed.

A little preparation will help your hop harvest go smoothly. First, wait for that fine day when the hop vines are pliable and the cones are dry. If you are letting your plants continue to grow after picking, don't risk breaking the vines by picking on a cool or wet day. Wear a long-sleeved shirt to protect your arms from the coarse climbing hairs of the bines. If you are cutting them down to pick, cut the lower bines first at about three feet above the crown. This will prevent damage to the crown and roots caused by tugging and preserve the lower bines for propagation. Then cut the upper bine from the top wire and lower it into position for easy picking.

Be careful with your hops to avoid getting them dirty or damaging the precious lupulin glands. If you are picking from a ladder, keep both hands free by attaching your hop sack to yourself or the ladder. A mature hop plant should produce one to two pounds of dried hops.

Drying

Once you've picked the hops, it's important to dry them right away to prevent mold or mildew from spoiling them. If you have warm, dry weather, the simplest method is to spread the hops out thinly over screens borrowed from your windows. Turn them at least once a day and they should be dry in a few days. The cones should be kept in an area protected from wind, bugs and bright light because light tends to hasten oxidation and lightens their color. You could use a food dehydrator or oven to dry the hops, but do not exceed 140 degrees F (60 degrees C). The acid test for dryness consists of bending the cone's inner stem or strig. When it is brittle and snaps, the hops are dry.

Storage

Heat, oxidation and moisture are the enemies of hops, so it is important to store them in a cool, dry, dark place such as a refrigerator or freezer. Place the cones in oxygen-barrier freezer bags, squeeze the air out, seal and place in the freezer. If possible, displace the oxygen in the bag with carbon dioxide before sealing. You can store your hops in glass jars. Don't forget to label and date your stored hops.

Estimating Hop Bitterness

The old standard method to estimate alpha-acid percentage is to make an educated guess and then modify the guess as you gain brewing experience with your hops. Because homegrown hops are fresher and have suffered less handling, they are more bitter than commercial hops. Estimating their alpha as 50 percent higher than the average alpha for the same commercial cultivar is a pretty good guess. Knowing the exact alpha of your hops is less critical if you use them only for flavor and aroma additions.

We can improve on this guess with a taste-testing technique I call "ratiometric titration." The approach here is to compare a same-cultivar hop of known alpha content with our unknown alpha hop. We compare the ratio of quantities of sugar needed to overcome the bitterness and infer that this ratio will equal the ratio of alphas. Thus, if it takes five teaspoons of sugar to offset the bitterness of our homegrown hops and three teaspoons to null the commercial hops, then our hops are five-thirds as strong, and our alpha-acid content is five-thirds the commercial alpha. If the commercial alpha is 6 percent, then our alpha is 5/3 times 6, or 10 percent.

I make up two hop tea samples – one from our unknown alpha fresh hops, and the second from commercial whole leaf hops of the same cultivar with known alpha. Stir one-quarter ounce hops plus one teaspoon sugar into two cups of boiling water (the sugar is needed because the hop resins are nearly insoluble in plain water.) Next, reduce the heat and simmer with the lid on for 30 minutes. Now add enough boiled water to each sample to bring their volumes back to two cups. Let the teas settle and cool to room temperature. Next, decant and filter the teas through a coffee filter to remove sediment.

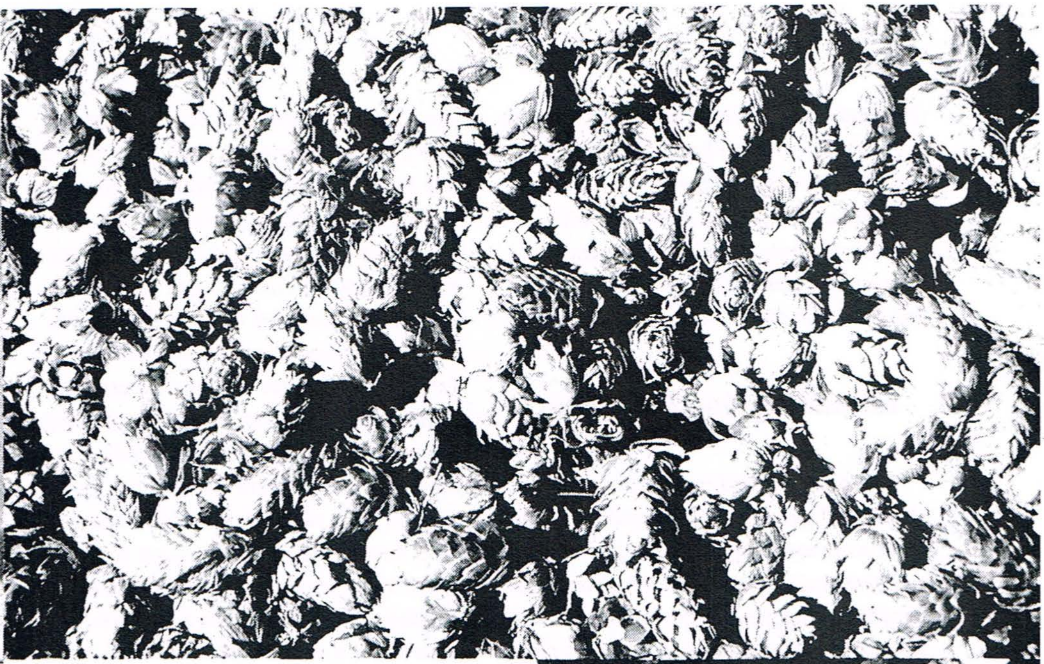
Now comes the tasting part. It's best to do the tasting in the morning when your taste buds are freshest. Measure a quarter cup of each of the hops teas. Now taste a few drops of the unknown alpha tea and rinse off your tongue. The tea will taste bitter, of course. Next, add one-quarter teaspoon sugar and taste. It will taste a little less bitter. Continue titrating the tea with the sugar in quarter-teaspoon increments (and doing a tongue rinsing between each tasting) while tasting for the point when the predominantly bitter taste finally gives way to a sweet taste (with bitter overtones). This is when the bitter loses its bite. Record the amount of sugar it took to reach this turning point. Now repeat the titration with the known alpha tea. The ratio of the titrated sugar for the unknown hops to the sugar required for the known hops is our estimate of the ratio of the alphas of the respective hops.

If this method seems too imprecise for you, send a one-ounce sample of hops to Jim Murphey at Murphey Analytical Laboratories Inc., (509) 577-8969. He will do an alpha-acid and beta-acid spectrographic analysis for about $28 and a hop oil profile analysis for $80. He also will perform an IBU analysis of your beer for $25. (Send two bottles – one for testing and one for qualitative analysis while doing the write-up — to 7 W. Mead Ave., Yakima, WA 98902.)

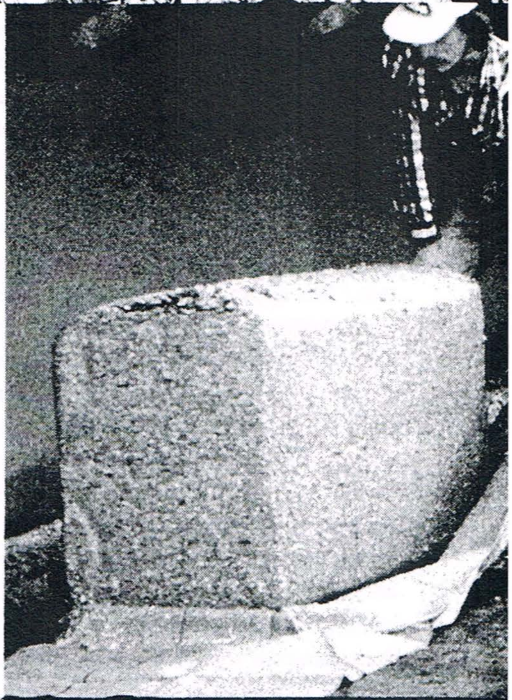
Where to Get Rhizomes

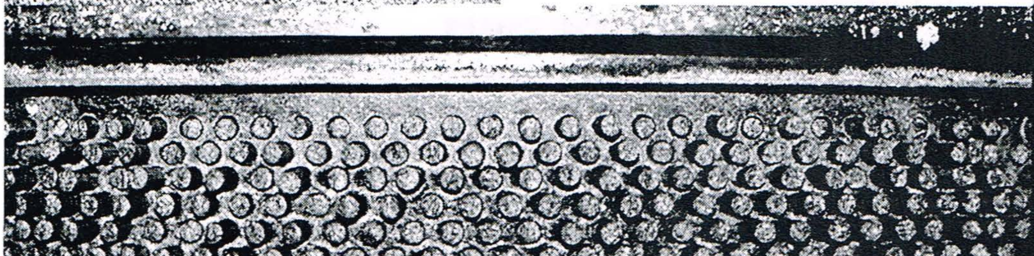
Check with your local homebrew supply shop. Most shops take orders in the fall and deliver rhizomes in the spring. If there isn't a shop in your area and you live in the East, contact Jeff Pzena at the Modern Brewer, (617) 498-0400; or in the West, contact Dave Wills at Freshops, (541) 929-2736.

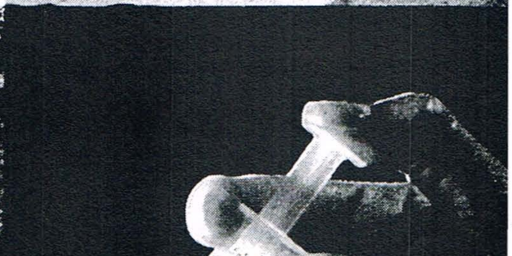
Patrick D'Luzansky is a biomedical and electrical engineer and industrial consultant for integrated circuit and sensor design. He has been brewing for 15 years and growing hops for 10 years. Patrick is the producer of the how-to video, "Secrets of Growing Your Own Hops," available from your local supply shop. His Website is http://www.netcom.com/~dluzanp or call (888) GRO-HOPS for more information.



Whether you're using cones, pellets or plugs, it all boils down to hops.







The Hop Shop

By Tim Kostelecky and David Hysert, Ph.D.

Not long ago decisions about hops were relatively simple – which varieties to use, how much and when to add them to the brew kettle. As breweries grew and competition increased, product consistency and economics played a large part in their survival. Brewers demanded better hop products both economically and in quality, giving rise to the many processed hop products available today.

In North America before the 1940s the only available form of hops were standard American bales, wrapped in burlap and weighing about 200 pounds. Now more than 25 different processed products are available, including various types of pellets and extracts.

The principal products are baled hops; plugs; pellets (regular or type 90, concentrated or type 45, stabilized and isomerized); extracts (non-isomerized, isomerized, reduced isomerized, reduced rho-iso-alpha acids, reduced tetrahydro-iso-alpha acids); and essential oils.

Baled Hops

The world's major brewers and many smaller brewers use standard baled hops. Brewers often believe switching to processed products will cause an unacceptable flavor change, that baled hops are more natural and traditional and that their advantages outweigh the disadvantages. Some of the disadvantages of baled whole hops are:

- They are perishable, bulky and expensive to store, ship and handle.
- The lupulin is heterogeneous, making sampling and bitterness control difficult.
- They give poor utilization.

PHOTOS CLOCKWISE FROM TOP LEFT COURTESY OF JOHN I. HAAS, DENA NISHEK, JOHN I. HAAS, AOB FILE, HOP UNION AND MORRIS HANBURY U.S.A. INC.

Hop Plugs

In the United States hop plugs are used primarily by homebrewers. In the United Kingdom plugs are used for dry-hopping cask-conditioned ales. Plugs are produced by compressing whole hops into one-inch by one-half-inch thick cylinders about one-half ounce in weight. They are almost never used by microbreweries or larger commercial breweries and make up only a small percentage of hop usage by homebrewers. Convenience is the primary factor in using plugs.

Hop Pellets

Processing hops into extracts actually preceded commercial processing into pellets, but pellets will be discussed first because that process represents less technical change to the hop. Significant use of extract dates to about 1960, with pellets entering the scene about 10 years later.

Regular (type 90) pellets

In the simplest process, pelletizing hops consists of breaking up the bales, separating a minor amount of extraneous material, milling in a hammer mill and passing the powder through a pellet mill. The pellets are packaged under vacuum or an inert gas atmosphere.

Concentrated (type 45) pellets

The original concept of the type 45 pellet was to enrich the hops by removing the fibrous portion of the cone, producing pellets with double the alpha and half the original weight.

Modified pellets

Two types of modified pellets are available, stabilized and isomerized. To produce stabilized pellets the hop powder is mixed with 2 to 3 percent magnesium oxide. The mixture is pelletized, packaged and vacuum sealed. With this procedure the alpha acids are converted to their magnesium salts, which isomerize more easily than the starting alpha acids, thus providing better utilization than regular pellets.

Although stabilized pellets are used by some brewers, their greatest use by far is as the starting material for isomerized pellets. To produce isomerized pellets, packaged stabilized pellets are heated in a warm room (about 122 degrees F or 50 degrees C) for seven to 14 days, which converts at least 90 to 95 percent of the alpha acids to iso-alpha acids. Isomerized pellets are considered one of the most economic hops for bittering, with utilization rates between 55 and 60 percent or more. They have excellent storage qualities with no need for cold to preserve bittering potential. However, for preservation of aroma (essential oils), cold storage is necessary. Isomerized pellets can be added at any stage of the boil and still maintain high utilization.

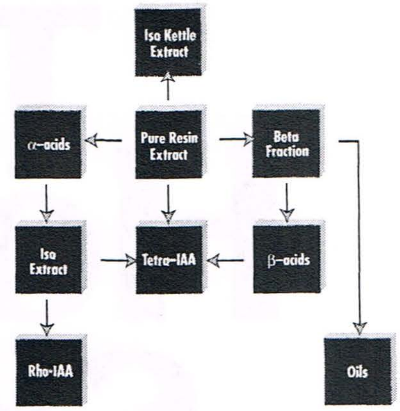


Figure 1. Extract Process

The major advantages of type 90 and type 45 pellets over baled hops are:

- Packaging in evacuated foil and film bags, or an inert gas atmosphere results in better storage qualities.
- Blending bales and lots during processing produces a uniform product.
- Shipping and storage space requirements are substantially reduced.
- Rupturing the lupulin glands in the pellet mill increases the utilization of the alpha acids compared to utilization rates of baled hops primarily because the hop substances can more readily dissolve.
- Processing removes sticks, stems, stones and other extraneous materials.

Hop Extracts

The production of hop extracts in the United States began in the early 1960s. The solvents used are hexane and carbon dioxide. In Europe, ethyl alcohol also is used. All three solvents make acceptable products for brewing, nevertheless the brewing industry is sensitive to any connotation of chemical processing and, therefore, attention has turned to ethyl alcohol and carbon dioxide.

Carbon dioxide is used as an extracting solvent in either of two forms technically referred to as subcritical and supercritical. Brewers are quite familiar with gaseous and liquid CO_2, and perhaps this is one reason CO_2 has such acceptability as an extractant for hops.

The main differences between the subcritical and supercritical processes and products are:

STORING HOPS

Hops are susceptible to oxidation that reduces bittering potential and causes degradation of aroma components, so brewers must take care in selecting and storing hops once they have been purchased.

The three components that contribute to oxidation are oxygen, heat and time. Eliminate all three and your hops will be fine, but the presence of any one component can give you trouble. The most easily controlled is heat. If you keep them frozen, whether in whole, plug or pellet form, you can greatly reduce oxidation. Shelf life can be improved considerably with the elimination of oxygen in the package, as it is when packaged under vacuum or with inert gas.

Even under ideal conditions, a minute amount of oxygen is always present in the package along with enough heat energy for oxidation to occur. Hops do not last indefinitely. Those Cascade pellets you purchased in 1993 have changed, even though they were kept unopened and frozen.

The storage container you select is important, particularly if it is plastic. Take a sniff of the empty package. If you can smell the plastic that aroma will be absorbed by the hops. This may not be an issue if you use the hops early in the boil and the volatile compounds are boiled off, but if you intend to use them for late additions or dry-hopping, a plastic aroma may linger. High-quality food-grade plastic containers and bags are usually suitable for storing hops.

- The subcritical extraction is performed in the liquid state at pressures between 300 and 700 psi. The maximum solubility of alpha acids is about 0.8 percent at 50 degrees F (10 degrees C).
- The supercritical extraction is performed in the fluid gas state at temperatures above critical 89 degrees F (32 degrees C) and pressure between 3000 and 4000 psi. The solubility of alpha acids is about 3 percent. Consequently, the supercritical process gives a higher yield in a shorter time.

Pure and diluted resin extracts (non-isomerized)

Hop resins are marketed as the undiluted resin with an alpha-acid content of 30 to 50 percent, depending on the origin of the hop. Extracts also may be standardized to any specified alpha-acid content, using corn syrup to dilute the solution.

Some of the advantages of extracts are:

- Extracts are the most stable hop product. Resin extracts can be stored for several years at ambient temperature with negligible loss of brewing value, allowing for long-term inventory.
- Extracts yield better utilization in the kettle than other types of kettle hops.
- Extracts are extremely uniform. The alpha-acid content can be adjusted to customer specifications at the processing plant and are highly uniform throughout a shipment.
- Shipping and storage weight and volume are substantially reduced.

Isomerized hop extract

These extracts, also called postfermentation isomerized extracts or fractionated isomerized extracts, are produced by separating the alpha acids from the rest of the extract. The alpha acids are purified then isomerized under controlled conditions by heating with

TABLE 1
PROPERTIES OF REDUCED ISOMERIZED HOP EXTRACTS

Product	Prevents Sunstruck Flavor	Relative Bitterness	Relative Foam Enhancement at Equivalent Bitterness
Iso	No	1.0	XX
Rho	Yes	0.6 - 0.8	XX
Tetra	Yes	1.6 - 1.8	XXX

aqueous alkali, or by heating the solid magnesium salts. These products normally contain only the purified potassium salts of iso-alpha acids in water and do not contain any essential oils or other hop constituents.

The advantages include maximum convenience, flexibility, control and the highest possible utilization of alpha acids – 95 percent or more. They can be used for partial or total replacement of bittering and for final adjustment of bitterness and offer excellent storage stability. They are the most widely available and commonly used isomerized hop product.

One disadvantage is flavor matching can be difficult with isomerized hop extracts. Some brewers believe the absence of other hop constituents produces a thinner hop character, lacking the fullness of a traditionally hopped beer. Some use beta fraction (also called base extract), which contains beta acids, uncharacterized soft resins and essential oils to obtain a fuller hop character. Isomerized extracts often are used to supplement or top off in the cellar after some other type of hop products are used in the kettle.

Reduced isomerized hop extracts

The original purpose of these extracts was to prevent the formation of sunstruck (also called lightstruck and skunky) flavors that occur when beer is exposed to light. The formation of sunstruck flavor can be prevented by making the iso-alpha acids resistant to light by reducing them chemically. With all reduced products, light stability is achieved only in the complete absence of iso-alpha acids. Their foam-enhancement properties have caused a renewed interest in these products.

The common reduced isomerized hop extracts currently available are called rho (dihydro-iso-alpha acids) and tetra (tetrahydro-iso-alpha acids).

For a light-stable beer, hop products containing alpha acids cannot be used in the kettle. Flavor matching may be a problem with reduced extracts because they provide bitterness only. Use of reduced extracts may result in change in bitterness quality, including lack of noniso-alpha-acid bitterness, flavor fullness and hop aroma.

Reduced products are very stable, provide effective light protection in the absence of iso-alpha acids and are generally provided as the aqueous solutions of the potassium salts of the respective reduced iso-alpha acids.

Rho-iso-alpha acids hop extract

This reduced product, also called dihydro-iso-alpha acids, is produced by reduction of iso-alpha acids with sodium borohydride. This reduction reduces the carbonyl groups in the side chain to an alcohol – two hydrogens are added (thus, "dihydro"). This is generally the most inexpensive reduced product because the process is simple, easy and cost-effective.

The relative bitterness in the reduced product is 60 to 80 percent of iso-alpha acids, so more must be added to achieve equivalent beer bitterness. This extract provides the same foam enhancement as the iso-alpha acids.

Tetrahydro-iso-alpha acids hop extract

This product is produced by adding four hydrogens by hydrogenation to the carbon-carbon double bonds of the iso-alpha acids side chains. It also can be produced by hydrogenation of beta acids.

Its relative bitterness is 160 to 180 percent of iso-alpha acids, so equivalent bitterness can be achieved using less tetra product than other hop products. It enhances beer foam stability compared to iso-alpha acids.

Hop Oil

Hop volatile oil, also called hop essential oil, generally is considered the source of hoppy aroma in beer, but getting and controlling the desired aroma is an elusive accomplishment. Hop oil is a complex mixture containing from one to two hundred different chemical entities. The proportions of these chemicals in the oil vary among hop varieties and lots.

One way to achieve aroma is by the traditional process of dry hopping, or adding whole hops after fermentation. Dry hopping is most common for cask-conditioned ales in the United Kingdom, where there has been a resurgence of interest and popularity. Dry-hop aroma is contributed by the essential oils and may be obtained with hop oil products, whole or pellet hops. Most hop oil products are designed to provide dry-hop aroma and include various whole hop oils, oil-rich liquid CO_2 extracts and oil fractions produced by vacuum steam distillation. There are various methods for adding hydrophobic oils to beer including dosing as emulsions or injection of the products dissolved in liquid CO_2 into the beer stream. Adding the oils as ethyl alcohol solutions also is possible.

Homebrewing Applications

Many of the hop products described here provide benefits to large brewers but are not practical or available to homebrewers. The three products commonly available to homebrewers are whole hops, type 90 pellets and plugs.

Whole hops are traditional, easily handled and easily separated from wort and beer. The main disadvantages of whole hops arise from their susceptibility to oxidation and the inconsistency of the lupulin within the hops. Pockets of high and low concentrations of lupulin are common and, when using small quantities of whole hops in homebrewing, large variations in bitterness and aroma can occur.

Whole hops may go through a tortuous path to you, involving much handling and repackaging and, consequently, oxidation and flavor degradation. In many cases the hops are packaged in clear plastic bags and stored in a refrigerator or, in the worst case, on a shelf. Be careful when purchasing hops and learn to evaluate the product and how it has been handled.

Regular (type 90) pellets are the standard ones available to homebrewers. Because the pellets are packaged in a vacuum or inert gas, their susceptibility to oxidation is greatly reduced. Repeated handling during repackaging can result in product degradation, but pellets usually don't suffer as much as whole hops.

The alpha acid and hop oil consistency of pellets is much improved over whole hops because the original hops and subsequent powder are mixed during processing. The pellets' small size also makes them convenient for homebrewing. One disadvantage is the greater challenge of separating hop residue from wort and beer.

It may seem that plugs would be a good compromise between whole hops and pellets because they usually are vacuum packed and convenient to use. The major disadvantage of plugs arises from the fact that no U.S. commercial brewers use them and, therefore, production is limited to small quantities from the United Kingdom.

Available varieties usually consist of popular U.K. hops and, if U.S. types are desired, whole hops must be shipped to England for processing and returned for sale. The additional handling causes oxidation and shipping results in some product degradation that may diminish any advantages plugs would provide.

Some inconsistencies in lupulin occur similar to those found in whole hops. Plugs are difficult to handle in quantities less than the standard one-half-ounce size because they are densely compacted and not easily broken into smaller pieces.

Although not common in homebrewing, pure hop oils are available in some supply shops for adding dry-hop aroma to beer.

These oils would be a convenient source if it were not for their highly hydrophobic nature. Special techniques must be used to add the pure hop oil to the beer, such as dispersing the oil in ethanol prior to injection or using emulsifiers to aid in dispersion.

Consistency can be achieved with large-scale operations but, because the concentration of oil for dry hopping ranges from 0.5 to 2.0 ppm, the probability for error is high for typical homebrewed beer volumes. A five-gallon batch would require only 0.01 to 0.04 milliliter, less than one drop, of pure hop oil. In the future, look for diluted emulsified oils (about 1000 ppm aqueous solutions) that will greatly simplify dry hopping both for commercial brewers and homebrewers.

Hoppy Trails

Whatever your brewing style or philosophy, hop products are available to help you brew your best. Traditionalists choose to remain loyal to whole hops, but many more brewers have discovered hop pellets can provide convenience, increased utilization and storage capability. Advanced products such as CO_2 hop extracts, reduced isomerized extracts and hop oils give the brewer flexibility in product formulations and packaging styles with the added benefit of improved utilization and consistency.

All brewers want quality beer. Careful consideration must be given to your hops – the varieties you choose and how you handle them. The chances of producing a quality beer also rely on your choice of hop providers, whether they are your local homebrew shop or the larger brokers. Do business with those who are most interested in your success as a brewer.

Tim Kostelecky was a brewing chemist for Coors Brewing Co. from 1976 to 1994, working with the hop quality program, and has been director of the Rocky Mountain Brewing Institute. He now is technical services manager for John I. Haas of Yakima, Wash.

David Hysert, Ph.D., was with Molson Breweries for 18 years in such positions as director of technical services and vice president of research and quality assurance. A former president of the Hop Research Council and current president-elect of the American Society of Brewing Chemists, he is now vice president and technical director for John I. Haas.

WHAT TO DO WITH AGED HOPS

Many brewers believe the "noble" character from some aroma hops is attributable to a small degree of oxidation of the essential oils, or even the hop acids. For this reason some oxidation may be desirable in "noble-type" aroma hops. Beyond this, oxidized hops will quickly leave you with undesirable beer.

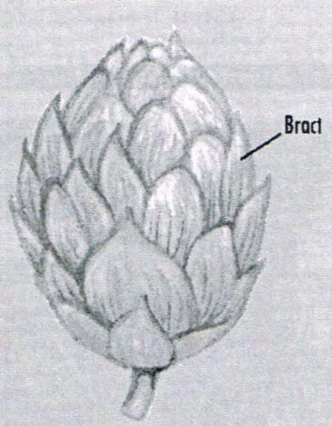
How do you know when the hops are unacceptable? Rub your hops or crushed pellets between your hands and let your nose be the judge. Good aroma hops will have various combinations of herbal, spicy, floral and fruity notes. Grassy, burnt, tobacco and cheesy aromas are the sign of hops beyond their prime. In short, if your hops stink get a fresh supply.

If you are the frugal type, be adventurous and use your old hops for brewing a lambic-style beer. You then have an excuse for – and can take pride in – the strange aromas emanating from your beer.

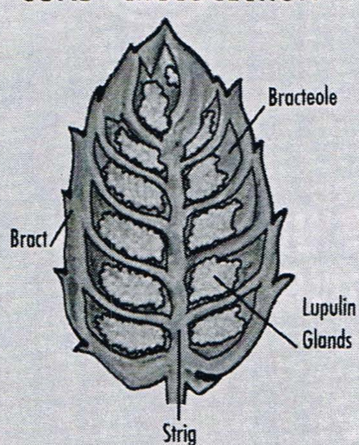
Hunting for the Heart of the Hop

By Stephen Kenny, Ph.D.

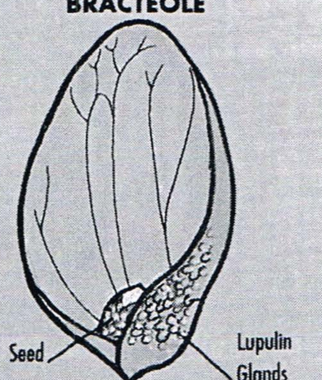
MATURE CONE



CONE – CROSS SECTION



BRACTEOLE



It doesn't take a homebrewer long to discover the heart of the hop. It is in the lupulin glands – the bittering resins and aromatic essential oils we all love in beer. Lupulin glands are found on the undersurface of hop leaves, on the anthers of male flowers and on leaflike structures, bracteoles, that are part of the cone. The cone is a group of mature female flowers joined into a structure called an inflorescence. To fully appreciate the vine running wild in your yard and the resulting nuggets of hoppiness you put in your beer, let's take a look at the hop plant itself.

Achene (seed) – a small dry fruit. The hop seed is surrounded by the pericarp, which does not burst when ripe.

Bract – a leaf on the strig that holds two bracteoles. Some lupulin glands may be formed on the bract. Bracts usually are pointed at the tip.

Bracteole – a leaf that encloses an individual female flower and protects the developing seed. Numerous lupulin glands are formed on the bracteole. For most seedless hops the bracteole is shorter than the bract, but in Cluster and Galena the bracteole is longer. In seeded hops the bracteoles extend beyond the bract. Bracteoles usually are rounded at the tip.

Burr – a stage in the development of the female inflorescence when the stigmas are exposed. The burr is about the size of a pencil eraser because the strig hasn't elongated yet. The bracts and bracteoles are microscopic, so pollen can easily fertilize the flowers.

Female (pistillate) flower – an ovary, enclosed in a perianth, with two velvety stigmas. If hop pollen lands on a stigma it can grow down the stigma to fertilize the egg in the ovary and a seed will be formed.

Inflorescence – a specialized stem that bears many individual flowers.

Lupulin – the contents of the lupulin gland. The important resin components are the alpha acids that impart bitterness to beer. The other important molecules in the lupulin are a mixture of essential oils. These molecules give aroma to beer and are valuable for dry-hopping flavor and aroma.

Lupulin glands – saclike structures containing lupulin. In seedless hops almost all the glands are on the bracteole. In seeded hops about one-third of the glands surround the seed on the pericarp. The glands also are found on the underside of the leaves and on anthers, but they are too few to be of any value in brewing.

Node – where leaves or other structures develop from the stem.

Ovary – the site of the egg cell at the base of the stigmas. If pollen falls on the stigma, it grows down to the ovary. Fertilization takes place in the ovary and a seed forms here.

Perianth – the external covering of a flower. In male flowers it is divided into five yellowish-green sepals. They are easily seen, but unattractive as flowers go. In female flowers, the perianth is very tiny unless a seed forms.

Pericarp – the ripened walls of the ovary.

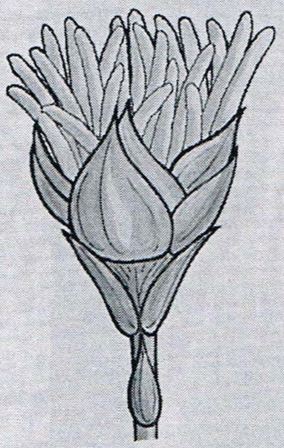
Stigma – the velvety tips of a female flower of which there are two per hop flower. This is where pollen falls and develops.

Strig (rachis or central axis of inflorescence) – the stem or backbone in the center of the hop cone. A pair of bracts originates at each node.

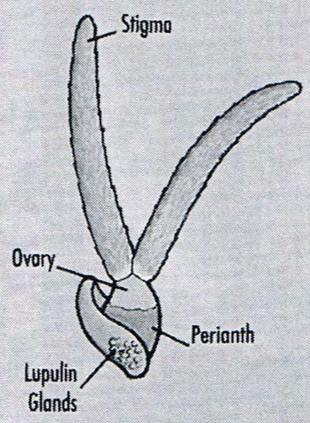
Strobile – botanical term meaning conelike. Specifically for hops it is the female inflorescence composed of papery overlapping

ILLUSTRATIONS COURTESY OF JOHN I. HAAS INC.
MATURE CONE, STRIG AND SEEDS BY RANDY MOSHER

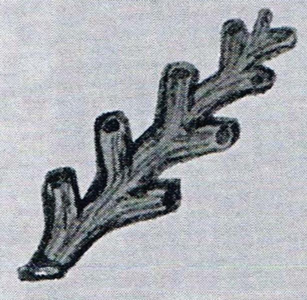
FEMALE INFLORESCENCE



FEMALE INDIVIDUAL FLOWER



STRIG



bracts and bracteoles. This the commercial product of the plant.

Cone shapes vary among varieties from conical to egg-shaped and prismatic to spherical. The presence of seeds also influences cone shape. A seeded cone is loose with a thickened and elongated strig; a seedless cone is dense and compact.

Anthers – the pollen-containing part of the male flower. A male hop flower has five anthers, each with a furrow and a few resin glands. After the anthers open and release their pollen, they quickly wither. The resin glands contain lupulin, but not enough to be useful in brewing. The average bracteole has more lupulin than an average panicle.

Bine – the twining hop stem that clings without tendrils to any support. The stem grows in a clockwise direction with the aid of hooked hairs. The hairs on some varieties are so stiff they cut skin!

Buds – location of dormant shoots. Without buds, there can be no spring regrowth.

Lateral branches – arise at leaf axil. Hop cones develop on lateral branches, but if the branches are poorly developed the yield of cones is low. The length of the branches differs among varieties.

Male (staminate) flower – five anthers on short filaments initially enclosed in a perianth. When the perianth splits into five sepals, the anthers can release pollen.

Panicle – the loose open inflorescence of the male plant. Individual male flowers are separated whereas the female flowers are bunched together in the burr.

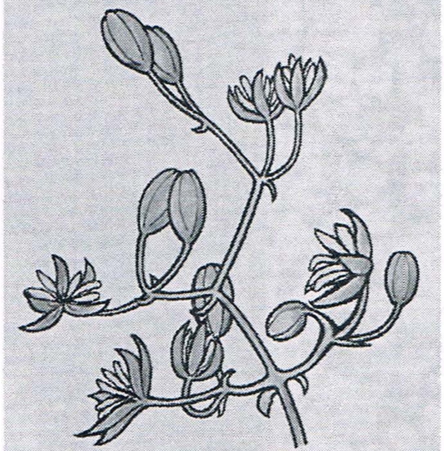
Rhizome – an underground stem with buds that initiates above-ground stems.

Rootstock or crown – the mass of rhizomes and roots that make up the underground portion of the hop plant.

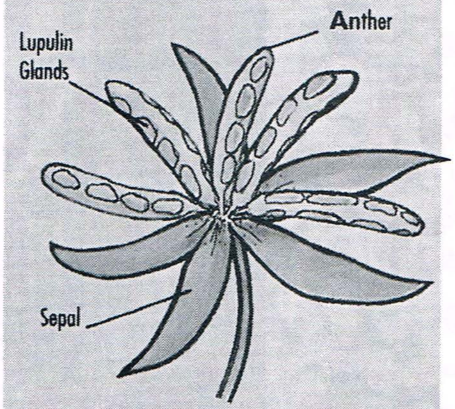
Shoots – the stems when they emerge from the soil.

Stephen Kenny, Ph.D., is in charge of hop genetics and breeding at Washington State University's Irrigated Agriculture Research and Extension Center in Prosser. His research includes characterizing hop varieties by essential oils, searching for DNA markers for important traits, and increasing hop resistance to pests. He is a member of the American Society of Brewing Chemists.

MALE INFLORESCENCE



MALE INDIVIDUAL FLOWER



SEEDS

Ray Daniels reveals the secrets of hop composition and the impact on bitterness, flavor and aroma.

Hop Physiology & Chemistry

By Ray Daniels

When you think of all the properties hops impart to beer, it is hard to believe that one little part of one plant could do so much. We all know hops give brewers – and beer drinkers – a wonderful array of flavors and aromas to savor. Mainly, they provide the bitterness needed to balance the sweetness of malt. Beyond that, hops play a role in head stabilization and kettle break formation. (Fix, 1989) They also help protect beer from being infected by certain types of bacteria.

All in all, hops provide an incredible range of benefits in beer. No wonder they are considered a defining element of the beverage we love. All of the effects provided by hops develop from the physical and chemical properties of the hops themselves.

In this article we will look at the composition of hops and trace individual elements to the benefits provided. Let's begin by looking at the major chemical categories that make up hops.

LUPULIN GLAND PHOTO COURTESY OF JOHN I. HAAS
HOP PHOTO COURTESY OF HOPUNION

Dried hops can be classified into a number of chemical categories as shown below.

The Composition of Hops

40%	Cellulose, lignin, etc. (vegetative material)
15 – 20%	Proteins (0.1% free amino acids)
8 – 12%	Water
5 – 9%	Ash
5%	Lipids, wax, pectin
2 – 5%	Tannins and polyphenols
2 – 3%	Monosaccharides
0.1 – 3%	Essential oils
5 – 24%	Total resins

The majority of the cellulose and protein compounds form structural components of hops and are unaffected by brewing. Some proteins are extracted into the wort where they might have some positive effect on head stability.

Although hops are dried after harvest, they still contain a small portion of water. While they could be dried more completely, the resulting cones would be extremely brittle and hard to handle. The exact water content will depend on the source and how the hops have been handled since harvest.

The ash, lipids and pectins are not believed to play any role in brewing.

Hop tannins and polyphenols are located almost entirely in the strigs or hop cores, and bracts, the flat leaflike parts of the hop. (Kunze, 1996) When extracted into wort, they constitute about 20 percent of the total tannin content, with the remainder coming from the malt. These compounds can react to produce red-brown color compounds during the boil and may contribute to finished beer color. (To see this effect, boil a couple ounces of hops in a gallon of water for 90 minutes.) On the positive side, these tannins also combine with complex proteins during the boil to aid break formation in the kettle.

Hops contain a very small portion of fermentable sugar (monosaccharides). These are insignificant as a source of fermentable sugar in beer regardless of when they are added. A beer with 1.048 original gravity contains about one pound of extract (sugar) per gallon of wort. If you added three ounces of hops to a five-gallon batch, you would only add about 0.005 additional pounds of sugar per gallon — a nearly undetectable one one-thousandth (0.1 percent) of the total.

Hop Resins

The resin component of the hop lupulin glands provide the substances that produce bitterness in beer. The total resin category can be further characterized as follows:

I. Soft Resins
- A. Alpha Acids (3 to 15% of total weight)
  - 1. Humulone
  - 2. Cohumulone
  - 3. Adhumulone
- B. Beta Acids: lupulone, colupulone, adlupulone
- C. Uncharacterized Soft Resins

II. Hard Resins

The alpha acids that appear in the soft resin portion of the hop are of the greatest interest to brewers because they provide the bulk of the bittering properties. The alpha acids make up approximately 7 percent of the hop by weight and include three specific compounds: humulone, cohumulone and adhumulone. (Broderick, 1993) The proportion of each of these alpha acids differs by hop variety. During the boil, all three of the alpha acids isomerize into highly bitter configurations that do most of the work of bittering beer.

FIGURE 1: AN OVERVIEW OF HOP OIL CONSTITUENTS

I. Hydrocarbons
- A. Oxygen-free terpenes
  - 1. Monoterpenes (contains 2 isoprene units)
    - a. Aliphatic
      - i. Myrcene
      - ii. Isobutene
      - iii. Ocimene
    - b. Cyclic
      - i. Alpha- (and beta-) pinene
  - 2. Sesquiterpenes (3 isoprene units)
    - a. Aliphatic
      - i. Farnesene
    - b. Cyclic
      - i. Humulene
      - ii. Caryophyllene
  - 3. Diterpenes
    - a. Aliphatic
      - i. Dimyrcene
- B. Other oxygen-free compounds: isoprene

II. Oxygenated Substances (Polar)
- A. Oxygenated Terpenes (Terpenoids, sesquiterpenoids)
  - 1. Epoxides
    - a. Myrcene epoxide
    - b. Farnesene epoxide
    - c. Humulene epoxide
    - d. Pinene epoxide
    - e. Caryophyllene epoxide
  - 2. Alcohols
    - a. Linalool
    - b. Myrcenol
    - c. Pinenol
    - d. Farnesenol
    - e. Caryophyllenol
    - f. Humulenol
    - g. Nerol (from Myrcene)
  - 3. Aldehydes
    - a. Geraniol
  - 4. Ketones
    - a. Humuladienone
  - 5. Acids
    - a. Myrcenic acid
  - 6. Esters
    - a. Geranyl acetate
- B. Other oxygenated products
  - a. Alcohols
  - b. Aldehydes
  - c. Ketones
  - d. Acids
  - e. Esters
  - f. Lactones
- C. Terpenes containing oxygen and sulfur
  - a. Epoxides: 8,9-epithiohumulene
- D. Other compounds containing oxygen and sulfur
  - a. Esters: S-methyl hexanothioate

III. Oxygen-free sulfur compounds: dimethyl trisulphide

(Compounds named are examples only and do not constitute a complete list of hop oil constituents.)

There are some qualitative – and perhaps quantitative – differences between the bitterness provided by the three individual alpha acids. Some brewers believe cohumulone delivers greater bitterness than the other two alpha acids. Others find the bitterness produced by hop varieties high in cohumulone to be harsh and unpleasant. As a result of these views, some brewers prefer hops with a higher or lower cohumulone proportion.

The isomerized alpha acids that provide bitterness also play other roles in beer. Because of their chemical properties, they help in the formation of foam bubbles and therefore contribute to the stability of beer head. Also, they have a certain bacteriostatic effect, especially at high concentrations.

Hop Flavor and Aroma Chemistry

We already have seen that the bittering properties of hops come from the soft resins, which generally account for less than 15 percent of the hop mass. For flavor and aroma, we will focus on an even smaller component, the essential oils. These can account for as little as 0.5 percent of the hop mass, up to as much as 3 percent in some varieties.

More than 250 chemical compounds appearing in beer have been traced to hop essential oil. Only a few dozen are believed to play a major role in hop flavor and aroma, but many more may contribute to the overall effect. The major classes of essential oils consist of oxygen-free hydrocarbons, oxygenated products and sulfur-containing compounds.

Hydrocarbons: This group accounts for up to 80 percent of hop oil in fresh hops. The key members of this group are terpenes and susquiterpenes including myrcene, humulene, caryophyllene and farnesene.

These compounds are highly volatile and rarely survive in their native form when boiled, but they are believed to contribute to the fresh hop flavor associated with dry hopping. More important, they react with oxygen during storage and boiling to create the second class of oils called oxygenated hydrocarbons.

Oxygenated hydrocarbons: This class accounts for many of the potent flavor compounds associated with late hop additions. They are largely the oxidation products of the hydrocarbons that occur in hop oil. Important examples include humulene epoxide I, II and III; humulenol; caryophyllene epoxide; linalool and geranyl acetate.

Sulphur-containing hydrocarbons: This small class of compounds includes products created by the combination of the hydrocarbons with sulphur. The chemical classifications include episulfides, thioesters and polysulfides. The polysulfides in particular are associated with unpleasant aromas and flavors described as cooked vegetables, onionlike, skunky, rubbery and sulfury. Some of the compounds have flavor thresholds as low as 0.3 parts per billion.

Flavors of Hop Compounds

Hop researchers believe no one compound is responsible for the aroma and flavor effects of hops. Instead, these sensations are created by a group of flavor-active components that may act individually as well as synergistically.

The compounds we will focus on have appeared repeatedly in the brewing literature as key components of hop flavor or aroma. Most data available to brewers on the specific flavor and aroma compounds present in hops relate to the four key hydrocarbons of myrcene, humulene, caryophyllene and farnesene. This section looks at the contributions made by these compounds, their oxidation products and selected other hydrocarbons.

Myrcene: In many varieties of hops myrcene comprises the largest component of hop oil. This compound is described as having a greater flavor intensity than humulene and is frequently characterized as "pungent." (Fix, 1989; Broderick, 1993)

The portion of total oil accounted for by myrcene can range from 20 to 65 percent depending on the variety of hop. Myrcene levels tend to be low in the "noble-type" hops (Saaz and Tettnanger, for example) and other hops prized for their aroma characteristics (such as East Kent Golding and Fuggle) and are often higher in hops used primarily for bittering (Brewers Gold, Nugget and Galena are a few).

Myrcene itself rarely survives in finished beer unless the hops are added at the very end of the boil or used for dry hopping. However, a number of other important flavor compounds are closely related to myrcene and are believed to occur in finished beer as oxidation or degradation products of myrcene. Included are linalool, geraniol, geranyl acetate and geranyl isobutyrate. (Haley and Peppard, 1983, Foster and Nickerson, 1985) These compounds contribute aromas or flavors usually described as floral or flowery. (Peacock and Deinzer 1981, 1988; Foster and Nickerson, 1985) Linalool, in particular, has been found to have a logarithmic relationship with floral flavor in beer. The linalool oxides 1 and 2 have been highly correlated with European hop flavor. (Peppard, Ramus, Witt, Siebert, 1988) Other myrcene degradation products include nerol and citral, which are believed to contribute to citrus or piny impressions. (Peppard, Ramus, Witt, Siebert, 1988)

More than 250 chemical compounds appearing in beer have been traced to hop essential oil.

Humulene: Brewers associate humulene with a delicate and refined flavor that often is described as elegant. (Fix, 1989) Humulene content varies inversely with that of myrcene. (Broderick, 1993) That is to say humulene is in general more abundant in aroma hops, whereas it is found in much smaller quantities in bittering hops. The oil of Saaz hops, for instance, typically consists of 40 to 45 percent humulene and only 20 to 25 percent myrcene. In typical bittering hop varieties such as Cluster, Bullion and Galena, humulene accounts for 15 percent or less of the total oil.

Like myrcene, humulene is unlikely to appear in finished beer unless the hops are added at the very end of the boil or used as a dry-hop addition. (Haley and Peppard, 1983) However its oxidation products survive in finished beer and play important roles in beer flavor and aroma. (Peacock and Deinzer, 1981; Haley and Peppard, 1983; Nickerson and Van Engel, 1992) These products include humulene epoxides (I, II and III); humulene diepoxides (A, B and C); humulenol II; humulol and humuladienone.

These degradation products form naturally over time in stored hops and at an accelerated rate when heated. (Foster and Nickerson, 1985; Peacock and Deinzer, 1981) They contribute a character that is generally described as herbal or spicy. (Lam, Foster, Deinzer, 1986) In particular, humulene mono- and diepoxides have been strongly associated with the spicy characteristic. (Peppard, Ramus, Witt, Siebert, 1988) Humulol has also been correlated with European hop character. (Peppard, Ramus, Witt, Siebert, 1988)

Caryophyllene and farnesene: The last two hop oil hydrocarbons commonly analyzed in fresh hops are caryophyllene and farnesene. These two account for a minor portion of the total oil. The flavors associated with farnesene are not well-characterized; some caryophyllene oxidation products are associated with herbal or spicy character and European hop character. (Lam, Foster, Deinzer, 1986; Peppard, Ramus, Witt, Siebert, 1988)

Other hydrocarbons: Several additional hydrocarbons occur in native hops and appear to play a role in beer flavoring. These include delta- and gamma-cadinene, alpha-muurolene and beta-selinene. These compounds play roles in the citrus-piny aromas and flavors derived from hops. (Nickerson and Van Engel, 1992)

Selection of Flavor and Aroma Hops

The character and degree of hop flavor and aroma produced in beer can be controlled by the brewer. The control points are selection of the hop variety and determination of how the hop will be processed during brewing. Generally character hops are selected from among the low-alpha aroma or "noble-type" hop varieties. Processing options generally call for a short period of boiling in the wort, or alternately, steeping the hops in the wort or beer.

Typical flavor or aroma hops include varieties such as Hallertauer, Tettnanger, Spalt, Saaz, Golding, Fuggle, Cascade, Willamette, Liberty, Crystal and Mount Hood. These represent a broad range of hop types from classic German lager hops to new American hybrids.

Generally, the safest way to choose an appropriate hop for a beer is to evaluate the traditions of the style you are brewing. Some styles have very specific traditions such as Saaz in Bohemian Pilseners and East Kent Golding in English pale ales. In such cases, the use of another hop variety may result in a beer that, while pleasing, would not be identifiable as an example of the classic style.

Other styles have less rigorous requirements with regard to hop character. In these cases, almost any aroma hop from the country where the style originates can be used. For example, German lagers generally may be brewed with Hallertauer, Hersbrucker, Tettnanger or Spalt finishing hops.

On occasions when the specific hop variety you desire is not available, select a suitable substitute by comparing hop oil profiles. The proportions of the oil components in the replacement hop you select should match those of the original hop as closely as possible.

Uses of Aroma Hops

Once you have selected an aroma hop for your beer, you still need to decide how the hop will be added and how much to add. Basically brewers have three options for the addition of aroma/flavor hops to a beer including:

- Boiling, generally for a short period – from as little as two minutes to about 30 minutes.
- Steeping, by addition to the kettle after the boil is completed or through the use of a hop back or grant where hot wort is passed through a bed of hops.
- Dry hopping, where the hops are added to the beer during fermentation or aging.

Each of these techniques provides a different flavor and aroma impact on the finished beer. Furthermore, the length of time you choose to boil (or to dry hop) also will affect the flavor.

The effects of hop additions across these techniques can be detected in either the flavor or the aroma of the finished beer. To produce a pronounced hop aroma generally requires dry hopping, or the use of larger amounts of steeped hops. Hops that are boiled generally have a greater impact on flavor and produce little aroma, especially as the boil time increases. In addition, while 30 minutes is a traditional cutoff point for flavor hops, many varieties will contribute detectable flavor characteristics (other than bitterness) even when boiled for 60 minutes or longer.

The reasons for these differences relate back to the chemistry of hop oil and brewing. Many hop oil components are highly volatile, meaning they vaporize at low temperatures and will be driven off during boiling. (Nickerson, Van Engel, 1992; Westwood, Daoud, 1985) Except when dry hopping is used, most native hop oil compounds are not found in finished beer. (Peppard, Ramus, Witt, Siebert, 1988) Thus very short boil times, steeping and dry hopping serve to increase the amount of fresh hop oil constituents that appear in the wort and, subsequently, in the beer. (Nickerson, Van Engel, 1992)

While fresh oils may be lost during the boil, other flavor active compounds not found in fresh hops are formed during the boil. They result when oil components undergo oxidation and other changes during boiling to create new flavor compounds. (Nickerson, Van Engel, 1992; Haley, Peppard, 1983)

Unfortunately, the results from late hop additions can be somewhat inconsistent. The composition of the essential oil changes over time with many hops and the amount of oil varies from year to year even in the same hop variety. In addition, hop compounds can be scrubbed away by the steam of the boil and the CO_2 evolved during fermentation. As a result, any change in evaporation rate or fermentation temperature can impact hop character in the finished beer. (Westwood, Daoud, 1985)

FIGURE 2: HOP FLAVORS AND RESPONSIBLE COMPOUNDS

FLAVOR	COMPOUNDS	SOURCE
Spicy	Humulene epoxides Humulene diepoxides	Humulene oxidation products
Herbal or European	Humulol Linalool oxides	Humulene oxidation product from linalool
Floral or Flowery	Linalool Geraniol Geranyl acetate Geranyl isobutyrate	Myrcene oxidation products
Citrus and Piny	Citral Nerol Limonene Cadinenes β-Selinene α-Muurolene	From Myrcene Hydrocarbons native to hops

Quantitative Considerations

Realistically speaking, small brewers have little means to predict the quantity of hop aroma or flavor in a finished beer. Neither alpha acids nor hop oil as a percent of hop weight have proven to provide effective control. A number of more sophisticated systems have been proposed, but most are based on costly chromatography techniques that will not soon be within the reach of the common brewer. (Nickerson, Van Engel, 1992; Forster and Schmidt, 1994; Westwood and Daoud, 1985; Foster and Nickerson, 1985)

Until a better system is devised, thankfully there will continue to be some art to the science of brewing. The brewer's taste buds and past experience play a greater role than any set of numerical printouts. Great brewers still will be distinguished not only by their ability to brew a great beer, but also by their ability to do so again and again, even as the character of their raw materials changes from year to year.

References

Broderick, H.M., ed., *The Practical Brewer*, 2nd edition, Edward Brothers Inc., 1993.

Fix, George. *Principles of Brewing Science*, Brewers Publications, 1989.

Forster, A. and Schmidt, R. "Characterization and Classification of Hop Varieties." *Brauwelt International*, 1994/II, pp 108-124.

Foster, R.T., and Nickerson, G.B. "Changes in Hop Oil Content and Hoppiness Potential (Sigma) During Hop Aging," *ASBC Journal*, Vol. 43, No. 3, 1985, pp 127-135.

Haley, J. and Peppard, T.L. "Differences in Utilization of the Essential Oil of Hops During the Production of Dry-hopped and Late-hopped Beers." *J. Inst. Brew.*, 1983, Vol. 89, p 87.

Kunze, Wolfgang. *Technology Brewing and Malting*, International Edition. VLB Berlin, 1996, p 47.

Lam, K.C.; Foster, R.T.; Deinzer, M.L., "Aging of Hops and Their Contribution to Beer Flavor," *Journal of Agricultural Food Chemistry* 34 (1986), pp 763-770.

Nickerson, G.B. and Van Engel, E.L. "Hop Aroma Component Profile and the Aroma Unit." *ASBC Journal*, Vol. 50, No. 3, 1992, pp 77-88.

Peacock, V.E. and Deinzer, M.L., "Chemistry of Hop Aroma in Beer," *ASBC Journal* 39, No. 4, 1981.

Peacock, V.E., and Deinzer, M.L. "Fate of Hop Oil Components in Beer," ASBC Journal 46, No. 4, 1988.

Peppard, T.L.; Ramus, S.A.; Witt, C.A.; Siebert, K.J.; "Correlation of Sensory and Instrumental Data in Elucidating the Effect of Varietal Differences in Hop Flavor in Beer," *ASBC Journal* 47, No. 1, 1989.

Ray Daniels is an internationally known expert on craft brewing. His book, *Designing Great Beers* (Brewers Publications, 1996) provides further details on hop chemistry as well as a wealth of information on the brewing of classic beer styles. For more information, see his Web page at http://www.mcs.com/~rdan/DGBindex.html.

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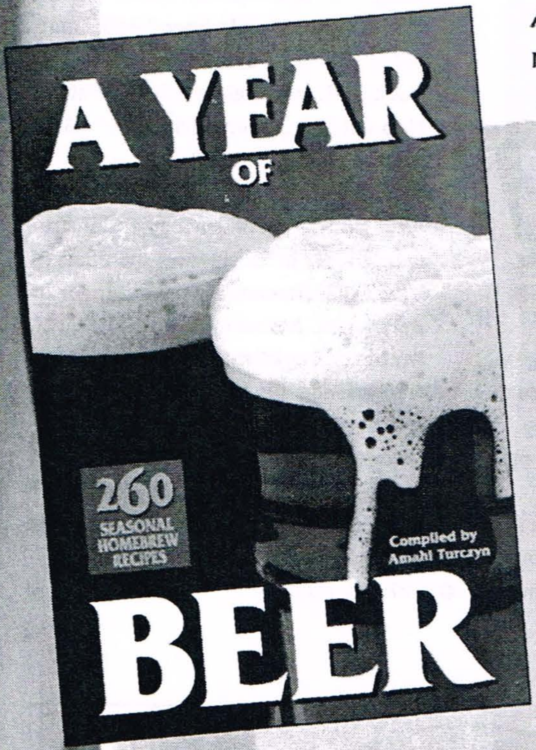

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YYRP

If I Were a Hop ...

In *Zymurgy* Summer 1997 (Vol. 20, No. 2) we asked AHA members to tell us, in 25 words or less, which hop they'd be and why. We sorted through the weird and zany entries to pick the best to share with you. Winners receive a grab bag of hop prizes.

First Place

I've ne'er found a nobler cause,
Than spicing my Pilsener with Saaz,
The gentle assault,
Of a handful of Spalt,
Guarantees your beer rounds of applause.

Amberly Scheppach
Boulder, Colo.

Second Place

I'd be a time-traveling hop to experience brewing history. Youthful, I'd bitter the first beer. Mature, I'd swim in stout. Old, I'd die in Chimay.

Ed Busch
Somerville, N.J.

Third Place

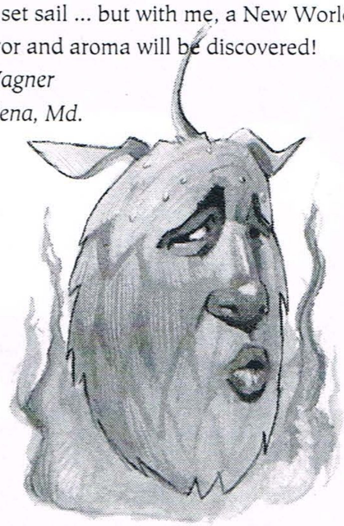
My favorite hop is Cascade,
It's been in every ale I've made.
My only wish,
Is that it were British,
So I could make a true IPA!

Charlie Vigorita
Newton, N.J.

Honorable Mention

If I were a hop I would be a Columbus, because without me, a homebrew could never set sail ... but with me, a New World of flavor and aroma will be discovered!

Jim Wagner
Pasadena, Md.



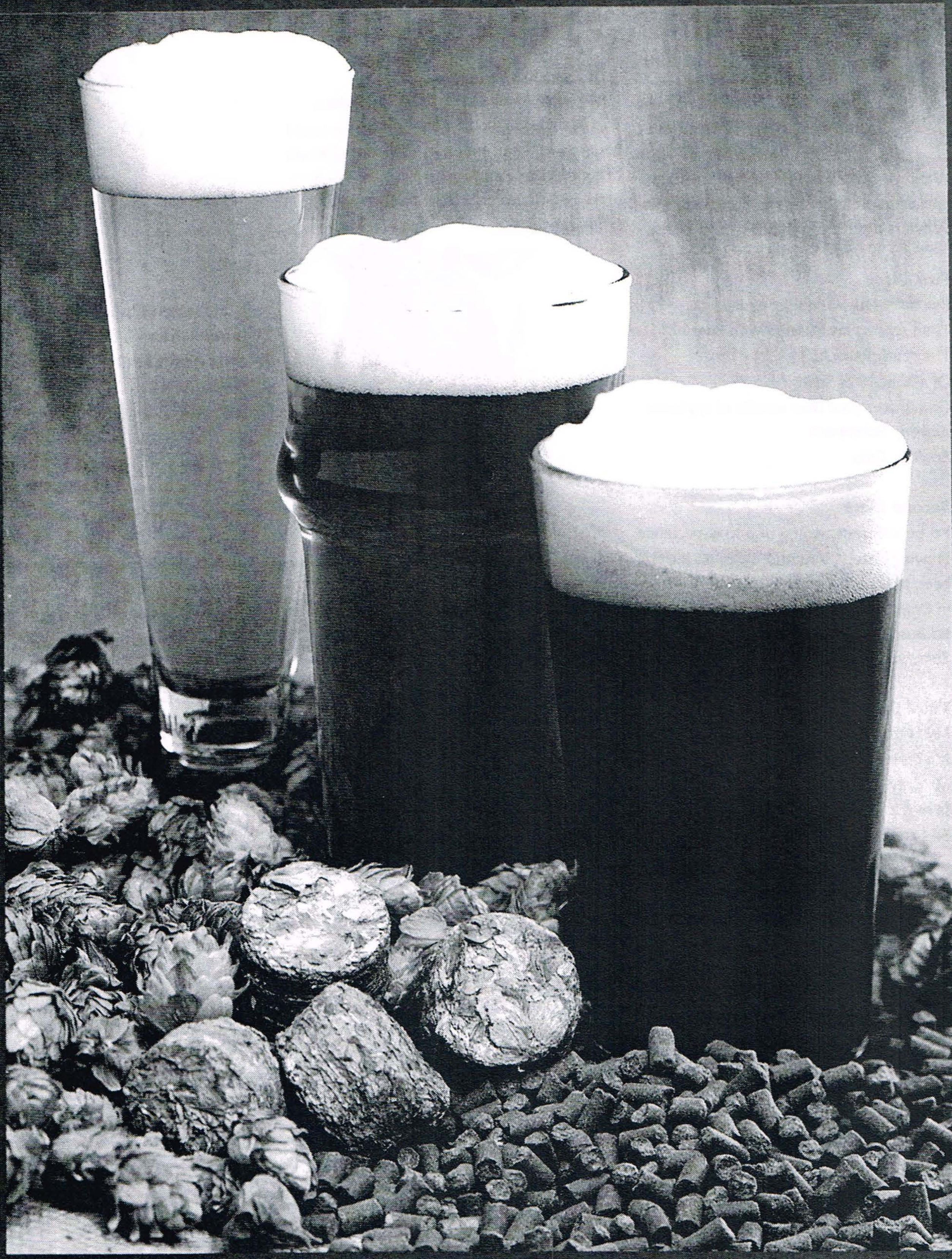
Honorable Mention

If I were a hop, I'd be Tettnanger, capable of both complex bitterness and expressing the noble refreshment that separates beer from other beverages.

John Stika
Dickinson, N.D.

Watch the pages of ***Zymurgy*** for the next Contest Corner!

ILLUSTRATIONS BY MARK NELSON



Bitterness Basics

Improve your recipe formulation skills by understanding the role of alpha acids in beer bitterness.

By Darwin E. Davidson, Ph.D.

On a practical basis hops impart to beer both bitterness and a hoppy nonbitter flavor. The majority of bitterness is derived from iso-alpha acids formed as the alpha acids in hops are isomerized during the kettle boil.

Three main types of alpha acids are found in hops: humulone, cohumulone and adhumulone. During the kettle boil the alpha acids, which are only slightly soluble in beer, undergo a chemical isomerization to produce isohumulone, isocohumulone and iso-adhumulone. These are the isomers of humulone, cohumulone and adhumulone, respectively. Each of these compounds also has two different forms, the trans and cis, for a total of six forms.

An isomer is a compound that possesses exactly the same elements, and exactly the same number of atoms of those elements, as another compound, but whose atoms are arranged in a different order from the first compound. What happens to the alpha acids during kettle boil is simply a structural change, not a change in their molecular formula. It is a simple thing, but without it hops would not produce bitterness because alpha acids are only slightly soluble in beer while iso-alpha acids are quite soluble in beer.

From a practical standpoint, the wort must be boiling to drive the isomerizaton of alpha to iso-alpha acids. Time is important because the isomerizaton process is very slow. Studies have shown that even after a four-hour boil the reaction is not complete, but the rate of the reaction is much higher during the first hour of kettle boil.

From a bittering standpoint, the longer the hops are boiled the more iso-alpha acid will be found in the wort. Alpha acid in wort usually is expressed as utilization percent, or simply utilization. This is the amount of iso-alpha acids found in wort divided by the total amount of alpha acid originally added to the kettle. Generally for cone hops, CO_2 extract or regular pellets, in a 1 1/2 hour boil, expect about 30 to 35 percent utilization. For a two-hour boil 35 to 45 percent and for a one-hour boil about 25 to 30 percent utilization can be expected. Of this amount, an additional 30 percent or so will be lost during fermentation, caused primarily by absorption by yeast cells. Consequently very little of the alpha acids added to the kettle actually end up as iso-alpha acids in beer. But those that do are what make beer bitter.

Secondary factors that affect the rate of alpha acid isomerization are wort gravity, wort pH, vigor of the boil, amount of hops added and type of hop product used. As the pH of the wort is increased so is the isomerization of alpha acids. However, it is not practical to attempt to increase the wort pH, because it is so highly buffered. There also are other serious consequences to a basic

PHOTO BY ROBERT GOLDMAN
HOP PELLETS AND PLUGS COURTESY OF WHAT'S BREWIN', BOULDER, COLO.

wort pH. As the gravity of wort is increased, utilization decreases. If the wort gravity is increased from 1.032 to 1.048 (8 to 12 °P), you may have to increase your hopping rate by about 10 percent to achieve the same final beer IBU. The exact reason for this is unclear, but is surely related to the absorption of alpha acids by the additional wort material.

It is well-documented that as the amount of alpha acid dosed to the kettle increases the utilization decreases. Therefore, the more bitter the beer the lower the utilization. You should expect to increase hop amounts by 10 percent or more than the utilization calculation calls for when increasing the final beer IBU from 15 to 20 or from 30 to 35. The ultimate factor is, of course, the solubility limit of iso-alpha acids in hot wort and later, cold wort. In practice, the solubility limit for iso-alpha acids in cold beer is about 100 ppm (IBU).

Nonalpha-Acid-Derived Hop Bitterness

During the natural oxidation of cone and pellet hops many known and unknown reactions take place that have an impact on beer flavor. One of many is the oxidation of some beta acids, which are otherwise nonbittering compounds. During hop aging, compounds called hulupones are formed from beta acids. These compounds are bitter and do end up in beer. Naturally, the higher the beta-acid content of hops (Galena is about 8 percent) and the older the hops (even cold stored) the more hulupone will be part of the final bitterness profile of the beer. Hulupones are similar in bitterness intensity to isohumulones.

Hop Products

Nonisomerized Hop Products

Regular hop pellets, concentrated hop pellets, cone hops and CO_2 extract are all common hop forms used for bittering via kettle hopping. Each of these products contains the full complement of the various hop oils, polyphenols and other variety-specific compounds. As a result, the perceived bitterness from iso-alpha acids is impacted by the nonbitter hoppiness (oil composition) derived from each variety.

Pre-isomerized Hop Products

Isomerized hop pellets, iso-extract, reduced iso-extract, hexa-iso-extract, and tetra-iso-extract are commonly used pre-isomerized hop forms. How these products are produced is discussed elsewhere in this issue, but it should be noted that isomerized hop pellets do contain hop oils and should be used in the kettle like regular pellets. Brewers can expect at least a two-fold increase in alpha utilization, with the normal beer hoppy aroma. The other pre-isomerized extracts do not contain hop oils, therefore the nonbitter hoppy note will not be present in beer. The iso-extract is a kettle or postfermentation extract that provides bitterness in the form of iso-alpha acids. The reduced (rho), hexa, and tetra extracts all provide bitterness and protection against the sunstruck reaction that produces a skunky note in beer. Additionally, hexa and tetra improve foam stability.

Considering sensory bitterness, the isomerized pellets and iso-extracts have the normal iso-alpha acid as the bittering agent. Therefore, the sensory bitterness from these compounds is normal. The reduced, hexa and tetra extracts are the reduced forms (by hydrogen addition to the iso-alpha acids) and the sensory bitterness of these compounds differs. Tetra-iso-extract has a prolonged sensory bitterness, a lingering bitterness compared to the normal iso-alpha acids. Hexa-iso-extract is less lingering and prolonged and is more similar to iso-alpha acids. The reduced iso-extract also is similar to iso-alpha acids, in that it tends to be a quick, clean bitterness.

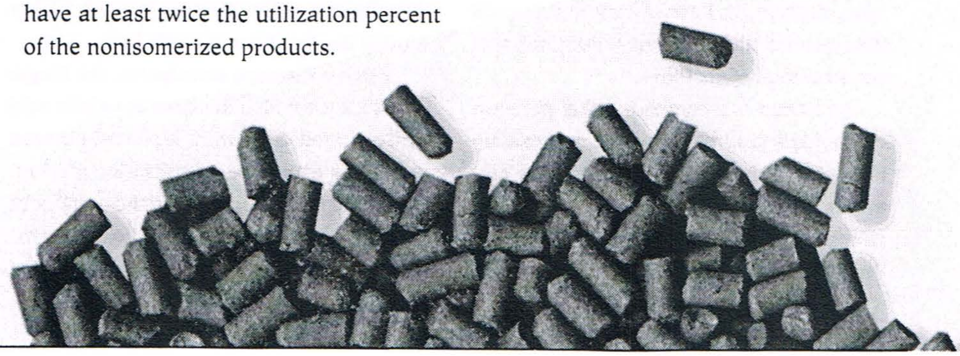
All of the preisomerized hop products have at least twice the utilization percent of the nonisomerized products.

Sensory Aspects of Bitterness

Interestingly, the perceived bitterness in beer reaches its maximum about 20 seconds after swallowing. The optimum time for sensory evaluation of beer is about 30 seconds after swallowing. Bitterness at that point is not predictable from the bitterness of beer during swallowing or in the mouth.

Others have studied the bittering nature of the various iso-alpha acids. Collin et. al. (1995) found isohumulone (with traces of iso-adhumulone) was preferred to isocohumulone. Verzele et. al. (1970) found the cis and trans iso-alpha acids exhibit similar bitter tastes. More recently, Hughes and Simpson (1996) studied the sensory bitterness intensity of the major hop bittering acids. They found that the cis-isohumulone was the most bitter hop acid and the trans-isocohumulone was the least bitter. In beer, this difference was slightly masked by other flavors, but still evident.

In a very interesting study, Grant (1995) reported on the perceived bitterness of hops compared to the IBU analytical determination in different beer types. At similar IBUs or bitterness levels (as iso-alpha acids) beers of different types (ales compared to lagers) can have much different perceived sensory bitterness. This demonstrates that malt types and residual extract of beers can have an important impact on the sensory bitterness derived from hops. Logically it seems that as the flavor intensity of nonhop products increases in beer, the perceived bitterness and hoppy flavor decrease, or is masked by the intensity of the other beer notes. For a balanced bitterness and hoppiness in beer, the stronger the beer flavor the more hops will be required. Consequently, a light lager will require fewer IBUs than an imperial stout to reach the same perceived bitterness level.



Hop Varieties and Bitterness

Generally the higher alpha-acid varieties (Chinook, Galena and Eroica, for example) have a higher percentage of cohumulone and a lower percentage of humulone than the lower alpha aroma varieties. Therefore, in a technical sense the intensity of bitterness derived from the iso forms will differ, as previously explained. However, in the practical world of brewing, the bitterness of hops cannot be separated from the hop oil hoppiness contributed by each variety. When using cone hops, pellets, CO_2 extract or iso pellets, with one comes the other. It is the combination and sensory synergistic effect of the whole-hop constituents that give each variety a certain perceived bitterness effect.

Some brewers find certain hop varieties produce a harsh bitterness and some give a more mellow bitterness. This depends on the brewing process, the variety of hops, the amount of hops used in the brew and when the hops were added. For example, Grant (1995) rated the quality of bitterness from Oregon Mount Hood as the highest among eight varieties evaluated. Yakima Tettnanger was rated the lowest in bitterness quality followed closely by Oregon Fuggle and Yakima Galena. The beers' IBUs were similar.

In general, low-alpha-acid hops are thought to give a more mellow bitterness to beer than high-alpha hops. I think of this as a balance issue. With lower alpha hops the bitterness contribution is balanced with a higher oil content per resultant beer IBU, compared to the higher alpha hops. More hops are required per final beer IBU than with lower alpha hops, so more hop oil is added. This is not always the case, however, because when the hops are added to the kettle determines how much bitterness results in the beer. A shorter boiling time results in a higher hop oil hoppiness in beer compared to the beer IBUs. This does affect the perceived hoppiness and perceived bitterness of the beer. The notion of beer bitterness is dependent on so many factors it is difficult to draw any absolute lines. The magic of perceived bitterness in hops lies with the brewer, the hops and the drinker.

References

Aitken, R.A.; Bruce, A.; Harris, J.O. and Seaton, J.C., *J. Inst., Brew.* Vol. 76, pp. 29-36, 1970.

Cepicka, J.; Strejcek, F. and Pokorny, J. *Monnattsschrift fur Braunwissenschaft*, Vol. 45, pp. 329-331, 1992.

Collin, S.; Dufour, J-P. and Derdelincky, G., ASBC Meeting Poster, 1995.

Grant, H.L., *Ferment*. Vol. 8, pp. 196-197, 1995.

Hughes, P.S. and Simpson, W.J. *Jour. of ASBC*. Vol. 54, pp. 234-237, 1996.

Verzele, M.; Jansen, H.E. and Ferdinandus, A. *J. Inst. Brew*. Vol. 76, pp. 25-28, 1970.

Darwin E. Davidson worked in Coors Brewing Co.'s research and development department for 19 years. He joined S.S. Steiner as technical director in 1994. He is founding member and past president of the Hop Research Council and president of the American Hop Museum in Toppinish, Wash.

What's Your

IBU?

By Michael L. Hall, Ph.D.

Finding the solution to balanced beer bitterness is all in the numbers.

One of the most important contributions of hops to beer is bitterness. Bitterness provides a counterpart to the sweetness of the malt to create a balanced beer. If you've ever made an IPA that turned out more like a bock, you know that making an accurate estimate of the amount of bitterness imparted by the hops is paramount to success in brewing. This article will compare several methods used to estimate hop bitterness.

The bitterness of hops is derived from the bitter resins in the yellow lupulin glands. These resins, or crystalline weak acids, originally were categorized into alpha-, beta- and gamma-fractions (De Clerck, 1957). The alpha- and beta-fractions are collectively known as the soft resins because they are soluble in hexane. The gamma resin fraction is now referred to as the hard resin fraction because it is insoluble in hexane.

The alpha-fraction is composed of a group of related chemicals called the alpha acids. Alpha acid, often referred to in literature simply as humulone, is comprised of the chemicals humulone, cohumulone, adhumulone, prehumulone and posthumulone (Fix, 1989). Each variety differs only by what is present on a side chain of the humulone molecule. The alpha acids will dissolve in hot wort, up to 250 mg/L at a pH of 5 and a temperature of 212 degrees F (100 degrees C). They are not very soluble in beer, with its lower pH and temperature, and will precipitate out if their concentration is higher than 5 mg/L at a pH of 4 and temperature of 32 degrees F (0 degrees C) (Hough et al., 1982). During the kettle boil, the alpha acids undergo a molecular rearrangement called isomerization. The resultant chemicals are called iso-alpha acids, and there is a corresponding version for each humulone (isohumulone, isocohumulone, etc.). The iso-alpha acids are much more soluble in wort and beer, and they are the primary source of bitterness in beer.

The beta-fraction of the hop resins is composed of the beta acids and many other chemicals, including the oxidation products of the alpha and beta acids that result from aging (De Clerck, 1957). The beta acids are known as lupulones and occur in varieties similar to the humulones. The same side chains of the humulone molecule applied to the lupulone molecule give rise to lupulone, colupulone, adlupulone, prelupulone and postlupulone (Fix, 1989). The beta acids are less soluble than the alpha acids (0.7 mg/L at a pH of 4 and a temperature of 32 degrees F or 0 degrees C) (Hough et al., 1982), but they do contribute some bitterness to beer through their oxidation products. The bitterness from oxidized beta acids, in beer made from aged hops, has been described as an unpleasant bitterness that is not as refined as the bitterness derived from iso-alpha acids (Fix, 1989; Garetz, 1994b).

The hard resins do not contribute to the bitterness of the finished beer.

Quantifying Hop Bitterness

The simplest way to quantify hop bitterness in beer is by specifying the weight of hops added to the wort. Many excellent homebrews have been made with recipes specifying simply "three ounces of hops," but repeating such a success can be difficult. The main problem with this technique is it doesn't take into account the alpha-acid

ILLUSTRATION BY AMY SMYTH

content of the hops. Alpha acids make up anywhere from 2 to 15 percent of the total weight of the hops, depending on variety. The alpha-acid content can therefore account for a factor of 7 difference in the bitterness level.

Adding alpha-acid content to the calculation allows the brewer to exercise greater control over the bitterness level. The Alpha Acid Unit (AAU) was developed by Dave Line (1985) and adopted by Charlie Papazian (1991) as the Homebrew Bittering Unit (HBU). Both are equal to the weight of the hops in ounces (W_{oz}) multiplied by the alpha-acid content as a percent (A%):

$$AAU = HBU = W_{oz}\ A\%.$$

A recipe calling for 15 AAUs or HBUs needs five ounces of 3 percent alpha-acid hops or two ounces of 7.5 percent alpha-acid hops. Using AAUs/HBUs is better than using only the weight of the hops, but it still allows for wide variations in the bitterness level. There are two main things missing from the formula: the volume of the wort and the boil time. You will achieve a much different bitterness from 15 AAUs in five gallons than 15 AAUs in 10 gallons. Similarly, 15 AAUs of hops boiled for 60 minutes will impart more bitterness than those boiled for 20 minutes. Many recipes sidestep this problem by specifying the volume and boil time explicitly.

There are, however, still some lurking difficulties with the AAU/HBU method, even if the volume and boil time are given. What does a brewer do if she accidentally boils for 30 minutes instead of 15? What if he can't afford the time to boil for 90 minutes and only boils for 60? What if the total volume of wort cannot be boiled? What if the brewer lives at an elevation of 7,300 feet (like me) where the boiling temperature is lower? In general, how does a brewer estimate bitterness levels under the changing conditions of a homebrewing setup so favorite batches may be duplicated?

The most precise way to define bitterness levels is the International Bitterness Unit, IBU (sometimes referred to as BU). The IBU is defined in terms of the amount of iso-alpha acid actually present in the beer, regardless of how it got there. The definition is:

$$IBU = 1 \text{ ppm of iso-}\alpha\text{-acid},$$
$$= 1 \text{ mg of iso-}\alpha\text{-acid/liter of beer}.$$

Assuming the unrealistic circumstance that all of the alpha acids in the hops are converted into iso-alpha acids in the final beer, we can easily calculate the ideal IBU number for a beer as:

$$IBU_{ideal} = \frac{W_{oz}\ A\%}{V_{gal}} \times \frac{7489}{100}.$$

The factor of 7489 converts from oz/gal to mg/L, and the factor of 1/100 converts the alpha-acid percent into an alpha-acid fraction. V_{gal} is the volume of the final beer in gallons.

Reality, however, is much more complicated than this simple equation. We will add one more factor to the ideal equation to account for all of the physical processes that make the amount of iso-alpha acids in the finished beer less than the amount of alpha acids added to the kettle. This lumped factor is known as the hop utilization, and will be denoted as a percentage by the symbol "U%." Here is the final equation, incorporating another factor of 1/100 for the utilization percent:

$$IBU = \frac{0.7489\ W_{oz}\ A\%\ U\%}{V_{gal}}.$$

This is the basic equation all IBU estimation methods use. Everything in this equation is readily available, with the exception of the alpha-acid utilization percent, U%. The only difference between the various IBU estimation methods, which are discussed later, is in the estimation of the utilization percent.

Alpha Acid and Iso-alpha Acid Loss Mechanisms

There are many ways for the alpha acids to go astray on their circuitous path from the lupulin glands of the hops to the iso-alpha acids dissolved in your beer. Each of the loss mechanisms chips away at the utilization percentage until it reaches a value that optimistically peaks at 35 percent. I will discuss the various loss mechanisms in chronological order through the cycle of beer production.

Storage deterioration: The first loss of bitterness potential occurs during hop storage. Before hops even hit the wort, alpha and beta acids are subject to oxidation, but it affects their bitterness in different ways. Oxidation decreases the bitterness of alpha acids and increases the bitterness of beta acids. Some researchers have suggested that the gains and losses in bitterness offset one another, but other studies have shown an overall decrease in perceived bitterness caused by hop deterioration (Rehberger and Bradee, 1975). The amount of alpha-acid deterioration is dependent on age of the hops, storage temperature, hop variety, amount of air present and hop form (pellets or whole cones).

Chemistry: Once the hops make it to the boil, the conversion of alpha acid to iso-alpha acid is imperfect. Instead of isomerization, the alpha acids can be oxidized to make humulinic acids, isohexanoic acid and isobutyraldehyde. There also is a competing form of isomerization, referred to as "reversed" isomerization resulting in anti-isohumulones. The anti-isohumulones, which account for about 10 percent of the isomerization products, are reported to be twice as bitter as isohumulones (Hough et al., 1982; Fix, 1989).

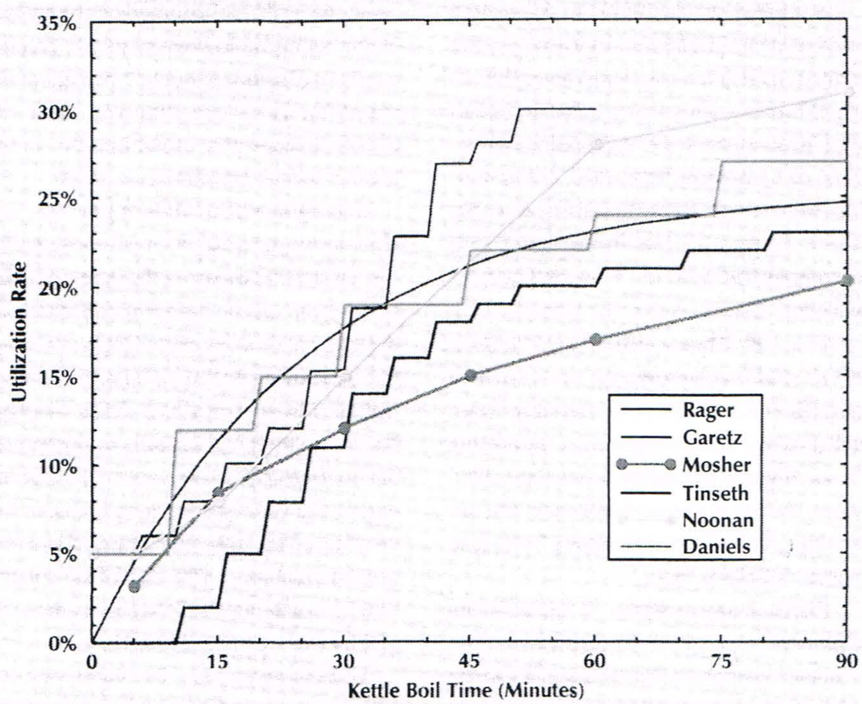
In addition to the problems associated with undesired chemical pathways, the main isomerization reaction is reversible. In experiments starting with isohumulone in wort, heating resulted in a quasi-equilibrium of 10 to 15 percent humulone, before prolonged heating resulted in turning all of the alpha acids and iso-alpha acids into decomposition products. As a further complication, it appears that the isomerization process can be catalyzed by hop cones, break material or even an inert surface (Hough et al., 1982). A catalyzed reaction will proceed at a different rate, translating into a different utilization percentage. Similarly, the pH of the wort will affect the utilization, with higher pH values leading to higher utilization rates.

Physical separations: At this point the alpha acids have been isomerized and the resultant iso-alpha acids are dissolved in the wort. In the hot wort at the end of the boil the utilization rate is about 50 percent. Physical separation processes now take over to further limit the amount of bitterness that makes it to your glass. Some of the iso-alpha acids are adsorbed on the surface of the hot and cold breaks and are precipitated out of solution. About 7 percent of the iso-alpha acids are removed with the breaks, irrespective of the amount of the break material. (Hough et al., 1982)

During the fermentation process, iso-alpha acids are scrubbed by the rising CO_2 and collect in the foam of the kraeusen. This sticky foam can be blown off, skimmed off or stuck on the sides of the fermenter, effectively removing the iso-alpha acids from the finished beer. Iso-alpha acids also are bound up by the yeast cells and removed when the yeast flocculates out. The amount of time the yeast spends in suspension has an effect on the utilization rate of about plus or minus 5 percent. Filtration of the finished beer also will physically remove some iso-alpha acids. (Garetz, 1994b)

Staling reactions: Even when the iso-alpha acids are safely ensconced in the finished beer in your bottle or keg, there can be losses. There are oxidation reactions that

FIGURE 1. Utilization Rate as a Function of Boil Time



Utilization rate as a function of boil time for wort of SG 1.050, boiled at sea level, using low hopping rates, using fresh leaf hops without a hop bag, with an average yeast flocculation rate, and with no filtration.

can reduce the bitterness of beer over extended storage periods and create "cheesy" aromas in its place.

Problems with Estimating IBUs

There are many difficulties associated with bitterness level estimation. First, all of the processes previously mentioned occur to different degrees and at different rates under the varying conditions of the brewhouse. Quantifying their effect on hop utilization can be a challenging task.

With whole leaf hops, variation of alpha-acid content from the measured sample can be a problem. Analyses can vary by as much as 11 percent from bale to bale, and the sampling rate can be as low as one out of every 10 bales. (Hardwick, 1995; Ramsey, 1990) This is less of a problem with pelletized hops because several bales are blended to achieve consistency.

The characteristics of the boil can have a great effect on the rate of hop utilization. The isomerization and solution rate depend directly on the temperature of the boil, which varies with the altitude of the brewery. How fast and to what extent the iso-alpha acids go into solution depends on the quality of the contact between undissolved iso-alpha acids and unsaturated wort. This is in turn affected by the boil vigor, the boil gravity (via the viscosity) and the hopping rate.

The physical form of the hops also can change the alpha-acid utilization. Pellet hops have been observed to give a greater utilization than loose leaf hops. Several reasons have been postulated: pellet hops disperse more easily in the wort; pellets retain their alpha-acid content during storage better than leaf hops and the pelletization process ruptures the lupulin glands and spreads the resins over the hop particles, giving a larger surface area for isomerization and solution. (Hardwick, 1995; Lewis, 1994)

Even if the level of iso-alpha acids in a beer could be determined exactly, the perception of bitterness can vary greatly. The ionic composition of the brewing water can accentuate hop bitterness; magnesium, carbonate, chloride and sulfate ions all increase the perception of bitterness (Noonan, 1996; Papazian 1994). Other compounds can cause bitter tastes in addition to iso-alpha acids. These compounds include the oxidation products of beta acids, compounds present in roasted grains and tannins extracted from the grain husks.

Methods of Estimating IBUs

If you ever tell a commercial brewer that you calculated the IBU level in your beer he or she will think you're crazy. The big breweries are very different from homebreweries: they make the same beer over and over again, allowing for modification of the recipe; they can blend different batches to achieve a consistent bitterness level; and they can afford to have the bitterness level of their beers measured often. As a homebrewer, you're probably making lots of different beers, and even when you repeat a beer it's usually a little different from the last time you made it. You can't spend a lot of money analyzing the last batch, and you need to be able to predict the bitterness of tomorrow's batch. Calculation, rather than measurement, is imperative.

But how is bitterness measured? The American Society of Brewing Chemists has adopted a standard method of measurement that involves a centrifuge and a spectrophotometer (1992). Unfortunately, these pieces of equipment are beyond the range of the average homebrewer. You can, however, have your beer measured for bitterness at various laboratories, for example the Siebel Institute of Technology in Chicago, for a fee of about $40. (Siebel, 1997) Mark Garetz also describes a taste-titration method for estimating IBUs at home using dilutions of iso-alpha extract and your own palate (Garetz, 1994b).

Before we get to the utilization factor estimation techniques, a couple of caveats. First, realize that estimating hop bitterness is a rough science, and it doesn't need to be more exact. The human threshold for detecting bitterness is about 4 IBUs (Kuroiwa et al., 1973), so controlling bitterness levels tighter than that tolerance probably won't be noticed. Also, the processes involved in getting alpha acids from the hops into your

TABLE 1: Utilization Rates (%) as a Function of Boil Time (min.)

Boil Time	RAGER	GARETZ	MOSHER	TINSETH	NOONAN	DANIELS
0.0	5.0	0.0	0.0	0.000	5.0	5.0
2.5	5.0	0.0	1.8	2.414	5.0	5.0
5.0	5.0	0.0	3.5	4.598	5.0	5.0
7.5	6.0	0.0	4.8	6.575	5.8	5.0
10.0	6.0	0.0	6.1	8.363	6.5	12.0
12.5	8.0	2.0	7.4	9.981	7.2	12.0
15.0	8.0	2.0	8.7	11.446	8.0	12.0
17.5	10.1	5.0	9.3	12.770	9.2	12.0
20.0	10.1	5.0	9.9	13.969	10.3	15.0
22.5	12.1	8.0	10.6	15.054	11.5	15.0
25.0	12.1	8.0	11.2	16.035	12.7	15.0
27.5	15.3	11.0	11.8	16.924	13.8	15.0
30.0	15.3	11.0	12.4	17.727	15.0	19.0
32.5	18.8	14.0	12.9	18.454	16.1	19.0
35.0	18.8	14.0	13.4	19.112	17.2	19.0
37.5	22.8	16.0	13.9	19.707	18.2	19.0
40.0	22.8	16.0	14.3	20.246	19.3	19.0
42.5	26.9	18.0	14.8	20.733	20.4	19.0
45.0	26.9	18.0	15.3	21.174	21.5	22.0
47.5	28.1	19.0	15.6	21.574	22.6	22.0
50.0	28.1	19.0	15.9	21.935	23.7	22.0
52.5	30.0	20.0	16.2	22.261	24.8	22.0
55.0	30.0	20.0	16.6	22.557	25.8	22.0
57.5	30.0	20.0	16.9	22.824	26.9	22.0
60.0	30.0	20.0	17.2	23.066	28.0	24.0
62.5	30.0	21.0	17.5	23.285	28.2	24.0
65.0	30.0	21.0	17.8	23.484	28.5	24.0
67.5	30.0	21.0	18.1	23.663	28.8	24.0
70.0	30.0	21.0	18.4	23.825	29.0	24.0
72.5	30.0	22.0	18.7	23.972	29.2	24.0
75.0	30.0	22.0	19.0	24.105	29.5	27.0
77.5	30.0	22.0	19.3	24.225	29.8	27.0
80.0	30.0	22.0	19.6	24.334	30.0	27.0
82.5	30.0	23.0	19.9	24.432	30.2	27.0
85.0	30.0	23.0	20.2	24.521	30.5	27.0
87.5	30.0	23.0	20.5	24.602	30.8	27.0
90.0	30.0	23.0	20.8	24.675	31.0	27.0

beer involve many steps that are not well known or are hard to quantify. You should evaluate your need for precise bitterness level knowledge and only do as many calculations as you need to satisfy it.

The second caveat is that the following descriptions constitute my versions of the various authors' methods. I have corrected obvious errors in some cases and elucidated confusing areas in others. Sometimes I have even added equations that should have been included by the author. I have tried to remain true to the original works, but you should consult the references if you have any questions.

Simple method: I'll start off with a bare-bones estimation of the IBU level in a beer. For the kettle or bittering hops, which are boiled for an hour or longer, use a utilization of 25 percent. For the flavoring hops, which are boiled for around 10 to 30 minutes, use a utilization of 10 percent. For the aroma or finishing hops (or dry hops), use a utilization of 0 percent. Using the Simple method, the IBU equation becomes:

$$IBU_{kettle} = \frac{18.7\ W_{oz}\ A\%}{V_{gal}},$$

$$IBU_{flavor} = \frac{7.5\ W_{oz}\ A\%}{V_{gal}},$$

$$IBU_{aroma} = 0.$$

Therefore, one ounce of a 1 percent alpha-acid hop in five gallons gives 3.75 IBUs if used for bittering and 1.5 IBUs if used for flavor. This means that, for a five-gallon batch, the Simple method can be used to convert AAUs/HBUs into IBUs:

IBU_{kettle} = 3.75 (HBUs or AAUs),
IBU_{flavor} = 1.5 (HBUs or AAUs).

Boil-time-dependent methods: The rest of the methods discussed in this article give a utilization rate that is a function of the amount of time the hops are boiled. All of the methods apply one or more correction factors to this rate to account for various perturbations to the hop utilization rate. Figure 1 and Table 1 give the utilization percentages for all of the methods, with no correction factors used. These values should be assumed to correspond to a wort of specific gravity of 1.050, boiled at sea level, using low hopping rates, using fresh leaf hops without a hop bag, with an average yeast flocculation rate and with no filtration. The correction factors to account for situations different from these will be discussed in the next major section.

Rager method: Jackie Rager's ***Zymurgy's*** article (1990) was the first article in the homebrew literature that attempted to estimate hop utilization rates. It still is widely used because of its accuracy and simplicity. His method gives utilization values for different boiling times as well as a correction factor for boil gravity. No other correction factors are given. The plot has a stair-step form because single values of utilization for ranges of temperatures were given in the original article. (Papazian gives a method for estimating utilization [Papazian, 1991], but his method is an abbreviated version of Rager's method, including the gravity correction, and will not be discussed further here.)

Garetz method: Mark Garetz published a relatively complex method to estimate hop utilization rates in his book, *Using Hops.* (1994b) The Garetz method includes a table of utilization values for different boil times, like the earlier Rager method, but the new values are significantly lower than the Rager values. The correction for boil gravity given in the Rager article is used, and new formulas for correction factors for boil temperature and hopping rate are developed. Rough ranges for correction factors for yeast flocculation rate, hop form, hop bags and filtration are given. Also, a formula to predict alpha-acid loss during storage is given (Garetz, 1994a, b).

Mosher method: Randy Mosher published a method for estimating hop utilization that was based on graphical lookups (Mosher, 1994). Unfortunately, this makes it difficult to precisely determine the utilization percentages, so the values quoted in this article should be assumed to have an error of at least plus or minus 0.1 percent. The Mosher method gives utilization values that are even lower than the Garetz method values for long boil times. The graphs in the Mosher method give an effective correction factor for boil gravity and hop form.

Tinseth method: As far as I know, Glenn Tinseth has only published his method on the World Wide Web to date (Tinseth, 1997; Pyle, 1997). The Tinseth method is the first to use a formula instead of a graph or table for the relationship between hop utilization and boil time. The Tinseth formula is set up so the boil gravity correction factor is unity at a specific gravity of 1.0557. Modifying it slightly so it is on an equal footing with the other methods (boil gravity correction factor of unity at 1.050), gives this relationship for the utilization rate:

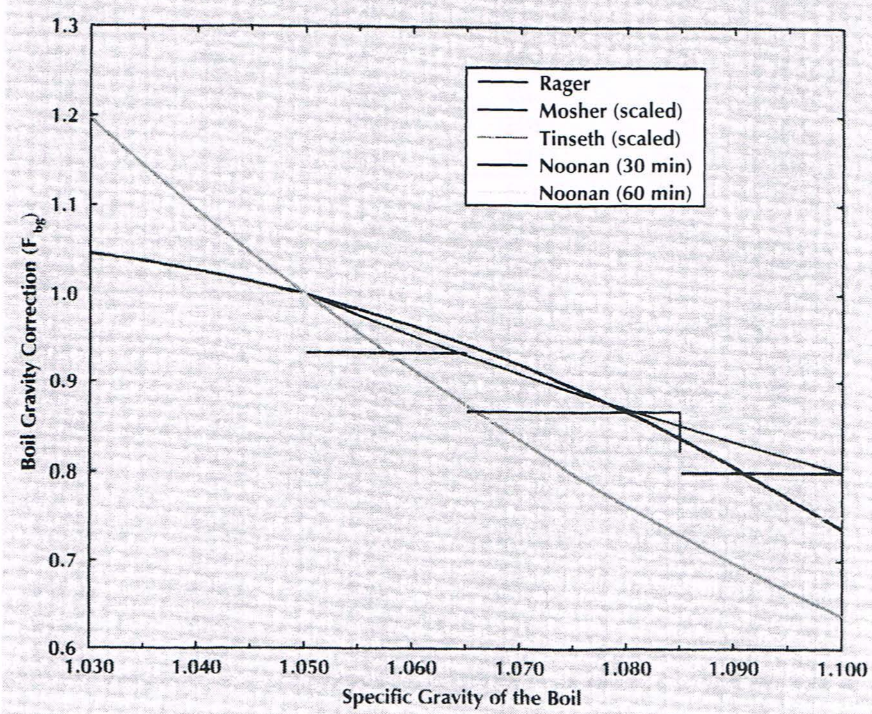
$$U\%_{bt} = 25.367715\ (1 - e^{-0.04\ t_{boil}})$$

where t_{boil} is the boil time in minutes and $U\%_{bt}$ is the utilization rate that is only dependent on the boil time, the uncorrected rate. Tinseth notes that this curve corresponds to the solution of a chemical first-order reaction. The Tinseth method does not include any correction factors except the boil gravity correction factor. However, the 25.367715 factor in front of the equation represents the maximum value of utilization that can be achieved with extended boiling (at this boil gravity), so a homebrewer easily can modify the equation to fit his or her own circumstances. For long boils, the Tinseth method gives utilization values between the Rager and Garetz methods.

Noonan method: The first mention I've seen of IBUs in the homebrewing literature was in the original edition of Gregory Noonan's *Brewing Lager Beer* (1986). In his recent work Noonan provides a method for calculating hop utilization using tabular values (Noonan, 1996). There are implicit corrections for boil gravity and hop form, in addition to the standard boil time factor. The Noonan method gives utilization values on the high side for long wort boils.

Daniels method: Another recent method was published by Ray Daniels (1996). The Daniels method gives tabular values for utilization rate versus boil time. The boil gravity correction by Rager is included in the method, as is the correction for hopping rate from Garetz. Daniels also provides some tables which can be used to scale the utilization rate dependent on the results from laboratory testing.

FIGURE 2. Boil Gravity Correction Factor



Modifications to the Utilization Factor

The overall utilization rate is the product of the boil time utilization rate (or uncorrected utilization rate) and all of the correction factors:

$$U\% = U\%_{bt} F_{bg} F_{hf} F_{hr} F_{bp} F_{st} F_{hb} F_{yf} F_{fil} ,$$

where the Fs stand for correction factors for boil gravity, hop form, hopping rate, boiling-point temperature, storage losses, hop bags, yeast flocculation rate and filtration, respectively. All of the F variables are nominally equal to unity, so you may omit any that don't seem necessary to you. Also, because of the way I have structured the formulas, any of the correction factors may be used with any of the other correction factors, and with any of the boil time utilizations given

TABLE 2: Boil Gravity Correction Factors

SG_{boil}	RAGER	MOSHER (scaled)	TINSETH (scaled)	NOONAN 30-min.	NOONAN 60-min.
1.030	1.0000	1.0463	1.1969	1.0000	1.0000
1.035	1.0000	1.0379	1.1443	1.0000	1.0000
1.040	1.0000	1.0273	1.0940	1.0000	1.0000
1.045	1.0000	1.0147	1.0460	1.0000	1.0000
1.050	1.0000	1.0000	1.0000	1.0000	1.0000
1.050	1.0000	1.0000	1.0000	0.9333	0.9286
1.055	0.9756	0.9831	0.9561	0.9333	0.9286
1.060	0.9524	0.9642	0.9140	0.9333	0.9286
1.065	0.9302	0.9431	0.8739	0.9333	0.9286
1.065	0.9302	0.9431	0.8739	0.8667	0.8571
1.070	0.9091	0.9200	0.8355	0.8667	0.8571
1.075	0.8889	0.8947	0.7988	0.8667	0.8571
1.075	0.8889	0.8947	0.7988	0.8667	0.8214
1.080	0.8696	0.8673	0.7637	0.8667	0.8214
1.085	0.8511	0.8379	0.7301	0.8667	0.8214
1.085	0.8511	0.8379	0.7301	0.8000	0.7500
1.090	0.8333	0.8063	0.6980	0.8000	0.7500
1.095	0.8163	0.7726	0.6674	0.8000	0.7500
1.100	0.8000	0.7368	0.6380	0.8000	0.7500

in the previous section. First, choose one of the methods to determine the basic boil time utilization (this may be a table lookup). Then, pick and choose which of the following correction factors to apply.

Boil gravity factor: All of the methods employ a boil gravity factor. Figure 2 and Table 2 show the behavior of several boil gravity factor formulas. The most common formula for this correction was given by Rager:

$$F_{bg} = \frac{1}{1 + 5\,(SG_{boil} - 1.050)},$$

where SG_{boil} is the specific gravity of the boil (which may differ from the original specific gravity of the wort). This equation is only used if SG_{boil} is greater than 1.050; otherwise, F_{bg} is equal to unity. This form for the boil gravity correction factor is used in the Rager, Papazian, Garetz and Daniels methods. The Mosher boil gravity correction factor seems to be based on the Rager method, except it has been fit to a curve to smooth out the rough transition at SG_{boil} = 1.050. Mosher only gives his correction factor graphically, but after a little work the form I developed for it is:

$$F_{bg} = 1.0526\,[SG_{boil} - 40\,(SG_{boil} - 1)^2].$$

The Tinseth method gives another formula for the boil gravity correction:

$$F_{bg} = 1.5673\,[(0.000125^{(SG_{boil} - 1)})].$$

I've adjusted both the Mosher and Tinseth formulas so they are equal to unity at SG_{boil} = 1.050, which makes them interchangeable with all the other boil gravity factors. Lastly, Noonan only gives his boil gravity factor implicitly in table form, and it varies based on boil time and hop form. I've given a couple of representative curves from his method (30 and 60 minutes for leaf hops) in Figure 2 and Table 2, but if you want to use his method it would be better to consult his tables directly.

From the graph you can see there is a certain amount of agreement. In general, hop utilization rates decrease with increasing boil gravity above 1.050. Below 1.050, Rager and Noonan set the boil gravity factor to unity, while Mosher and Tinseth allow higher values.

Hop form: Correcting the utilization to account for the hop form also is common. Leaf hops or hop plugs do not need a correction, but hops in the pellet form are reported to have an increased utilization. The Garetz method sets F_{hf} equal to 1.1 for pellets boiled from 10 to 30 minutes, and unity otherwise. The Mosher method sets F_{hf} equal to 1.33 for pellets in general, independent of gravity and boil time. Noonan again uses a table, which gives F_{hf} between 1.0 and 1.5 for pellets, with maximum values centering around 15 minutes of boil time and low boil gravities. Daniels does not give a value for F_{hf}, although he recommends using something between 1 and 1.25 for pellets. The other methods do not give a correction factor for hop form, but any of the above methods may be used with them.

Hopping rate: As more hops are added to the boil, the utilization factor decreases. The Garetz method includes a factor, or rather an equation, to account for this:

$$F_{hr} = \frac{1}{1 + (V_{final} / V_{wort})(IBU/260)},$$

where V_{final} is the final volume of the beer (the same as V_{gal} above), V_{wort} is the volume of wort in which the hops are boiled, and IBU is the number of IBUs extracted from the hops. Garetz suggests that an iterative procedure should be used because this factor includes the IBU value that is unknown at the start of the calculation. However, placing this factor into the original formula,

$$IBU = \left[\frac{0.7489\, W_{oz}\, A\%\, U\%^*}{V_{gal}}\right]\left[\frac{1}{(V_{gal}/V_{wort})\, IBU/260 + 1}\right],$$

where U%* is U% with all the factors except F_{hr} (i.e. U%* = U% / F_{hr}), we can see this is a quadratic equation in IBU. Quadratic equations can be solved easily to obtain:

$$IBU = \frac{130\, V_{wort}}{V_{gal}} \times \left[-1 + \sqrt{1 + 0.0115215\, W_{oz}\, A\%\, U\%^*/V_{wort}}\right].$$

Note that the hopping rate factor calculation must be the last calculation, after all the other factors have been determined. The Daniels method is the only other method that includes a hopping rate factor, and he quotes the Garetz method, using the iterative solution procedure instead of the quadratic procedure given here. The hopping rate factor is a function of the boil time utilization rate and all of the other correction factors, so it will change when they are modified. The hopping rate factor could be applied to any of the methods.

Boiling-point temperature: The isomerization reaction rate depends on temperature, so the boiling-point temperature at your elevation can make a big difference. At my elevation, 7,365 feet, water boils at 198 degrees F (92 degrees C) instead of 212 degrees F (100 degrees C). Garetz gives a correction factor for this effect:

$$F_{bp} = \frac{1}{1 + E_{ft} / 27500},$$

where E_{ft} is the elevation in feet. None of the other methods correct for boiling-point temperature.

Storage losses: The alpha acids in hops deteriorate over time, reducing the bittering power of the hops. It is unclear whether or not the gain in bitterness from the oxidation of the beta acids offsets this effect to the extent that no correction is necessary. The best solution for the homebrewer is to buy only fresh hops in vacuum-sealed bags and store them in a freezer for less than three months before use. If you do want to calculate the storage losses, Garetz (1994a, b) provides a formula for the correction factor:

$$F_{st} = e^{-k\, M_t\, M_{st}\, t_{st}},$$

where k is the base rate constant, M_t is a modification factor for the storage temperature, M_{st} is a modification factor for the type of storage and t_{st} is the storage time in months. M_t is given by

$$M_t = 2^{(T - 20)/15},$$

where T is the storage temperature in Celsius. M_{st} is unity for hops exposed to air (either unsealed or in polybags), 0.75 for hops stored in airtight but oxygen-permeable containers, and 0.5 for vacuum-packed hops or hops stored under nitrogen or carbon dioxide. The base rate constant, k, is dependent on the hop variety and can be calculated from either the Hop Storage Index (HSI) or the "% Loss" value for the hop variety, which you can get from your hop supplier or from Garetz (Garetz, 1994a, b). If you start with the HSI, first calculate

%Loss = 110 log (HSI/0.25),

which is actually the fraction (not the percent) of alpha acids lost during storage at 68 degrees F (20 degrees C) for six months. Now that you know the "%Loss," the base rate constant is given by

$$k = -\ln(1 - \%Loss)/6.$$

This corrects an error in the original work and is somewhat simpler.

Other factors: There are many other factors that affect the iso-alpha-acid utilization in beer, but most of them are very hard to quantify. The only method that even attempts to quantify any other effects is the Garetz method.

Garetz recommends F_{hb} = 1.0 for hops loose in the boil, F_{hb} = 0.9 for hops in a hop bag, and F_{hb} = 0.8 for hops in a hop bag stuffed full. A yeast flocculation rate factor (F_{yf}) of 0.95 is recommended for slow flocculation, 1.0 for average flocculation and 1.05 for fast flocculation. The filtration factor (F_{fil}) varies from 1.0 for no filtration to 0.975 for aggressive filtration.

A Sample Calculation

For this article I brewed a batch of my standard hoppy pale ale (Jemez Pale Ale 5, a.k.a. More Hops, Daddy!) and had the bitterness level measured by the Siebel Institute. This beer was brewed with the following characteristics:

Batch size: 11.5 gal (full boil)
Boil gravity: 1.057
Hop schedule: (all English Goldings at 5.1% alpha acid)

- **5 oz (60 min.)**
- **2 oz (20 min.)**
- **2 oz (five min.)**
- **4 oz (dryhopped for five days)**

%Loss: 0.45
Storage: Hops were used in the springtime, right after receiving them via mail order, so assume hops were stored at 32 degrees F (0 degrees C) for four months in airtight bags at the supplier.
Hop form: plugs
Hop bags: no
Filtration: no
Elevation: 7,365 ft.
Yeast: Wyeast No. 1968 Special London Ale
Flocculation: high

Table 3 shows the calculated utilization correction factors for this beer for all of the methods. With the exception of the Simple method, all of the methods include a boil gravity correction. Most of the methods include a correction for hop form, but this beer only used plug hops, so no correction was necessary. The Garetz and Daniels methods include a hopping rate calculation, and the rest of the corrections are the sole province of the Garetz method. Note that the product of correction factors is much lower for the Garetz method.

Combining the correction factors with the boil time utilization factors from Table 1 and using the IBU equation gives the estimates for the IBUs of the sample beer shown in Table 4, which range from 24 to 57. The actual bitterness, as measured by Siebel, was 45.5 IBUs.

So what does this mean? Are some methods better at predicting bitterness than others? Keep in mind this is only a single data point, and there are many intangibles in the brewing process that can affect the bitterness level. Some methods may be better for certain brewers. Justifications aside, three of the methods came very close to the mark: Tinseth, Daniels and, surprisingly, the Simple method. The Simple method worked well because the beer was close to an average brew; the correction factor product was close to unity. The Tinseth and Daniels methods have similar boil time utilization factors (see Figure 1) and correction factors

TABLE 3: Sample Beer Utilization Correction Factors

METHOD	F_{bg}	F_{hf}	F_{hr}	F_{bp}	F_{st}	F_{hb}	F_{yf}	F_{fil}	Product
SIMPLE	1	1	1	1	1	1	1	1	1
RAGER	0.9662	1	1	1	1	1	1	1	0.9662
GARETZ	0.9662	1	0.9227[1]	0.7888	0.8881	1	1.05	1	0.6558
MOSHER	0.9758	1	1	1	1	1	1	1	0.9758
TINSETH	0.9390	1	1	1	1	1	1	1	0.9390
NOONAN	0.9286[2]	1	1	1	1	1	1	1	0.9286
DANIELS	0.9662	1	0.8842[3]	1	1	1	1	1	0.8543

[1] 20 min. = 0.9911.
[2] 30 min. = 0.9333, 15 min. = 1.0, 5 min. = 1.0.
[3] 20 min. = 0.9655, 5 min. = 0.9880.

TABLE 4: Sample Beer IBUs

METHOD	60 min.	20 min.	5 min.	5 day	TOTAL
SIMPLE	41.52	6.64	0	0	48.16
RAGER	48.13	6.48	3.21	6.42[1]	57.82
GARETZ	21.78	2.34	0	0	24.12
MOSHER	27.55	6.03	2.07	0	35.65
TINSETH	35.97	8.71	2.86	0	47.54
NOONAN	43.18	6.71	3.32	6.64[1]	53.21
DANIELS	34.05	9.29	3.17	0	46.51

[1] Even though Rager and Noonan specify a utilization rate of 5 percent for hops that are not boiled, I don't think they meant to include dry hops, so these values are left out of the totals. Daniels specifically states a utilization of 0 percent for dry hops.

that pull them closer to each other – and to the measured value.

The Garetz method, which didn't fare as well, started out with lower boil time utilization values than most of the other methods and was pulled down even further by the low correction factor for boil temperature because I brew at a high altitude. The Mosher method, which has the lowest boil time utilization numbers, was somewhat higher than the Garetz estimate because it had a high correction factor product. The Rager and Noonan methods both came in on the high side, which could have been predicted because their boil time utilization curves are the highest.

So which method should a homebrewer use? I recommend brewing a batch as close to your normal procedure as possible, and taking good notes. Then, send a beer off to be analyzed. Calculate the bitterness using all of the methods to determine which one fits your brewing style best. If you want to, mix and match the formulas (in this article only) to use your favorite boil time utilization curve with your favorite correction factors.

Designing a Recipe

How does one go about determining the hop bill for a new recipe? First, decide on the hop varieties you will use for bittering, flavor, aroma and dry hops according to style or personal preference. Then check with your hop supplier to see what the alpha-acid percentages are for your chosen varieties. Once again, use personal preference or the requirements of the style to set the amount of flavor, aroma and dry hops. Calculate the bitterness contributed by the flavor and aroma hops and subtract this from the overall desired bitterness level. Finally, work backwards to determine the weight of bittering hops to add to your brew.

A Glimpse Ahead

In this first article I have given a survey of the methods available in the homebrewing literature for estimating the hop bitterness level in beer. In a future article I will develop a new method for bitterness estimation based on research I am doing in the professional brewing literature. I hope you will be able to enhance your brewing process with the formulas contained in this article.

Nomenclature

AAU Alpha Acid Unit, = W_{oz} A%

A% alpha acid content as a percentage

E_{ft} elevation or altitude in feet

F_{bg} hop utilization rate correction factor for boil gravity

F_{bp} hop utilization rate correction factor for boil point temperature

F_{fil} hop utilization rate correction factor for filtration

F_{hb} hop utilization rate correction factor for hop bags

F_{hf} hop utilization rate correction factor for hop form

F_{hr} hop utilization rate correction factor for hopping rate

F_{st} hop utilization rate correction factor for storage losses

F_{yf} hop utilization rate correction factor for yeast flocculation rate

HBU Homebrew Bittering Unit, = W_{oz} A%

HSI Hop Storage Index

IBU International Bitterness Unit, = 1 ppm of iso-alpha acid = 1 mg of iso-alpha acid / liter of beer

IBU_{aroma} IBU number contributed by the aroma hops

IBU_{flavor} IBU number contributed by the flavoring hops

IBU_{ideal} IBU number for a beer assuming 100% utilization (not realistic)

IBU_{kettle} IBU number contributed by the kettle or bittering hops

k base rate constant for bitterness loss during storage

%Loss fraction (not percent) of alpha acids lost during storage at 68 degrees F (20 degrees C) for six months

M_{st} a modification factor to the storage loss rate for the storage type

M_t a modification factor to the storage loss rate for the storage temperature

SG_{boil} specific gravity of the boil, which may differ from the original specific gravity of the wort

t_{st} hop storage time in months

U% hop utilization rate as a percentage

$U\%_{bt}$ hop utilization rate (as a percentage) that is only dependent on the boil time; the uncorrected rate

*U%** hop utilization factor, U%, with all the factors except F_{hr}; i.e. $U\%^* = U\% / F_{hr}$

V_{final} final volume of beer in gallons, = V_{gal}

V_{gal} final volume of beer in gallons, = V_{final}

V_{wort} volume of wort that the hops are boiled in, in gallons

W_{oz} weight of the hops in ounces

T hop storage temperature in Celsius
t_{boil} boil time in minutes

References

American Society of Brewing Chemists, *Methods of Analysis* (8th Edition), 1992.

Daniels, Ray. *Designing Great Beers – The Ultimate Guide to Brewing Classic Beer Styles*, Brewers Publications, 1996.

De Clerck, Jean. *A Textbook of Brewing*, Chapman and Hall Ltd., 1957.

Fix, George. *Principles of Brewing Science*, Brewers Publications, 1989.

Garetz, Mark. "Hop Storage: How to Get – And Keep – Your Hops' Optimum Value," *BrewingTechniques*, pp. 26-32, 2:1, Jan/Feb 1994a.

Garetz, Mark. *Using Hops – The Complete Guide to Hops for the Craft Brewer*, HopTech, 1994b.

Hardwick, William A., ed., *Handbook of Brewing*, Marcel Dekker Inc., 1995.

Hough, J.S.; D.E. Briggs; R. Stevens and T.W. Young. *Malting and Brewing Science*, Chapman and Hall, 1982.

Kuroiwa, Y.; E. Kokubo and N. Hashimoto. "Advanced Hop Chemistry in Connection with Beer Flavor," *MBAA Technical Quarterly*, 10:4, pp. 215-219, 1973.

Lewis, Gregory K. "Kiss of the Hops," *The New Brewer*, pp. 10-19, 11:4, July/Aug. 1994.

Line, Dave. *The Big Book of Brewing*, Argus Books Ltd., 1985.

Mosher, Randy. *The Brewer's Companion*, Alephenalia Press, 1994.

Noonan, Gregory J. *Brewing Lager Beer*, Brewers Publications, 1986.

Noonan, Gregory J. *New Brewing Lager Beer*, Brewers Publications, 1996.

Papazian, Charlie. *The New Complete Joy of Home Brewing*, Avon Books, 1991.

Papazian, Charlie. *The Home Brewer's Companion*, Avon Books, 1994.

Pyle, Norm. Hops FAQ, http://realbeer.com/hops/FAQ.html, as of June 1997.

Rager, Jackie. "Calculating Hop Bitterness in Beer," **Zymurgy** Special Issue 1990 (Vol. 13, No. 4), pp. 53-54.

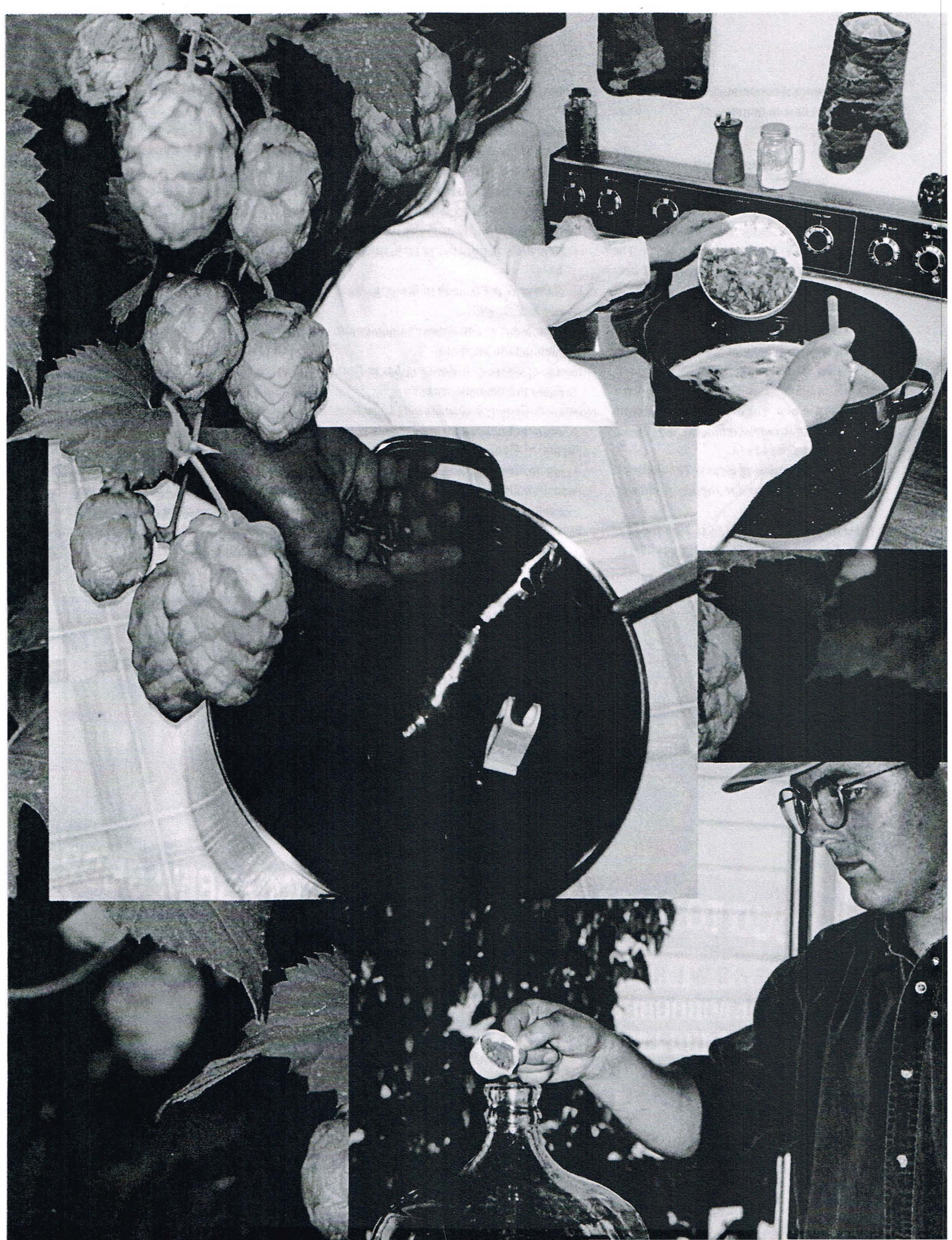
Ramsey, Michael. "Factors Influencing Hop Utilization or Where Does It All Go?" **Zymurgy** Special Issue 1990 (Vol. 13, No. 4), pp. 46-52.

Rehberger, A.J. and L.H. Bradee. "Hop Oxidative Transformations and Control of Beer Bitterness," *MBAA Technical Quarterly*, 12:1, pp. 1-8, 1975.

Siebel Institute of Technology home page, http://www.breworld.com/welcome/, as of June 1997.

Tinseth, Glenn. The Hop Page, http://realbeer.com/hops/, as of June 1997.

Michael L. Hall, Ph.D., is a computational physicist at Los Alamos National Laboratory in New Mexico. He has been brewing for eight years, is a BJCP Certified judge and was one of the founding members of the Los Alamos Atom Mashers. Michael is a member of the AHA Board of Advisers and can be reached at hall@lanl.gov via E-mail.



The Spice of Life

By Timothy O'Rourke

Master your use of hops for optimal flavor and aroma.

Although hops are used extensively in brewing to provide bitterness and aroma, they contribute to other important characteristics such as foam stability, colloidal stability and as a preservative. The major contributions are:

- Provide the bitter taste in beer (with alpha acid the principal precursor).
- Provide aroma.
- Modify yeast performance during fermentation.
- Contribute to beer texture (mouthfeel).
- Their bacteriostatic properties protect beer against some biological spoilage organisms.
- Reduce overfoaming during wort boiling.
- Aid in protein coagulation during the boil.
- Act as a natural filter medium when a hop back is used.
- Contain compounds that are foam active agents in beer.
- Contribute tannins that may increase the reducing power of beer, and hence its resistance to oxidative staling. Tannins also may contribute to a tendency to produce chill haze.

The Bittering Principals

The hop cone contains lupulin glands consisting of a mixture of hard and soft resin and hop essential oils, otherwise the bulk of the hop cone is made up of vegetative matter containing cellulose, proteins and tannins. The soft resins (soluble in hexane) are most important in brewing. These consist of alpha acids, beta acids and uncharacterized soft resins.

The alpha acids and beta acids provide the bittering principals and exist as a mixture of different compounds. These acids are largely insoluble in cold water and, while they are more soluble in boiling water, any material dissolved while hot will precipitate on cooling. During wort boiling, however, the alpha acids are isomerized into iso-alpha acids that are much more soluble. The less soluble beta acids are largely unchanged during wort boiling, and contribute little to the final bitterness of the beer unless they are oxidized to hupulones, in which case they also will contribute bitterness.

Hops contain a wide range of polyphenolic compounds of low molecular weight, which generally survive wort boiling and pass into the final beer where, particularly in the presence of oxygen, they convert slowly into products that contribute to chill haze and chemical and flavor instability. However, the tannins contributed by hops generally are considered to be less problematical than the tannins contributed by malt. From 2 and 5 percent of the hop material consists of higher molecular weight tannins/polyphenols which, together with a larger (by weight) contribution from the malt tannins, precipitate with proteins during wort boiling and help improve the kettle break. The bittering principal forms only a small proportion of the total hop cone.

The majority of bittering from hops comes when the alpha acids are isomerized during wort boiling. With bitterness playing

PHOTOS BY DENA NISHEK

such a vital role in beer flavor, it is important to achieve a consistent level of bitterness in the final beer. Table 1 shows the main factors that influence hop utilization.

Not all beers have the same degree of bitterness. The bitterness levels vary substantially according to the style being brewed and the quality of bitterness required in different geographical areas.

The bitterness level is determined primarily by the amount of alpha acid added to the wort (which is the weight of hops times the percent alpha acid content of the hops) and the percentage utilization of the hops in the finished beer, between 20 and 35 percent of the original hop charge.

The Aromatic Principals

As well as bitterness, hops supply unique floral and spicy aromas. The essential oils in hops and the volatile degradation products of the resins are the source of aroma compounds. These oils are volatile and will be almost entirely vaporized from the kettle if they are present at the start of a 60- to 90-minute boil, although some will be converted by heat or chemical reaction. To compensate, brewers who want beer with a hoppy character add selected aroma varieties to the kettle from five to 20 minutes before the end of the boil, giving sufficient time to extract the aroma but making sure the oil is not lost in the vapor.

Late hop character often is described as floral or citrus, but can be unpleasant if present in too high a concentration. The variety of hops used, the timing of the addition, the kettle shape and the material of construction all have a major influence on the subtlety of the final beer aroma.

Hops also can be added after fermentation – to the maturation vessel or the cask – to give a dry-hop flavor often described as resinous, spicy and citrus. Because alpha acids are not soluble in cold beer, there is no increase in bitterness with dry hopping.

Hops contain up to 5 percent of essential oils during the later stages of ripening after the bulk of the resin synthesis is complete. The composition of the oil reflects not only the variety but also the degree of ripeness. More than 300 hop oil compounds have been isolated. They usually are separated and identified using gas chromatography with mass spectroscopy (GCMS). The essential oils can be divided into three classes.

Hydrocarbons (comprising 50 to 80 percent of the total) The principal hydrocarbons are the monoterpene (C10) myrcene, and the sesquiterpenes (C15) caryophyllene and humulene. Farnesene and seliene occur in some varieties but not all, and can be used as markers for hop varietal identification.

Many hydrocarbons are volatile at raised temperatures (especially myrcene) and few, if any, survive the full wort boiling process to end up in the beer, and they also seem to be lost from late hopping. Traces of these compounds will dissolve in dilute alcohol, with both myrcene and humulene being detected in beers that have been dry hopped.

Oxygenated Compounds (comprising 20 to 50 percent of the total) Some of the oxygenated compounds are produced by the esters of the corresponding hydrocarbons, which produce a more polar and chemically complicated group of compounds. These are better able to survive wort boiling, particularly from a late kettle hop addition, and

TABLE 1. Factors Affecting Hop Utilization in Brewing

	Factor	Influence	Utilization
1	Wort pH	Increase pH	Increased
2	Length of boil	Longer boil	Increased then decreased
3	Hop addition rate	Higher addition	Decreased
4	Wort original gravity	Higher gravity	Decreased
5	Foaming in kettle	More	Decreased
6	Foam in fermenter	More	Decreased
7	Age of hops	Older	Decreased
8	Alpha acid content (%)	Higher	Decreased
9	Trub volume	Higher	Decreased
10	Cold break volume	Higher	Decreased
11	Yeast strain	?	Yeast dependent
12	Pressure boiling (higher temp.)	More	Quicker

find their way into beer. However, it is not known precisely which, if any, of these compounds are responsible for the desirable hop aroma because many of the compounds will be volatilized during the last minutes of boiling, and those that survive in the wort may be lost with CO_2 purging or be chemically modified during fermentation.

Sulfur Compounds (comprising less than 1 percent of the total) Although the sulfur compounds are present only in very low concentrations in hop oil, they have potent aromas. Few sulfur compounds survive wort boiling, but late addition of hops can introduce trace amounts of sulfur compounds as can the addition of hop oils. Some of the sulfur compounds give cooked vegetable, onionlike, rubbery sulfur aromas with very low perception thresholds.

Although many of the pure hop oil compounds have been isolated and identified, their exact contribution to the aroma of the finished beer is far from completely understood. Opinions differ as to the relevance of the ratios of humulene to farnesene and caryophyllene to myrcene, often quoted by hop merchants and believed by some to give a clear definition of aroma quality, and by others as a useful indication of trueness to varietal type. I tend to share the latter view.

It appears that hop flavors in the finished beer are a result of a synergistic mixture of compounds. These may be modified by:

- Variety, type of hop.
- Length and nature of boil.
- Oxidation and degradation products during the brewing process.
- Yeast metabolism.
- Time and nature of hop storage.

Column chromatography of an oil-rich carbon dioxide extract of hops gave five

TABLE 2. Example of Bitterness Levels in Different Beer Styles

Type of Beer	Area in World	Average Bitterness (BU)
Lagers	North America	12 - 20
	Germany	26 - 28
Pale Ales	North America	14 - 18
	United Kingdom	24 - 28
Stouts	Ireland	36 - 42
Sweet Stouts	United Kingdom	20 - 30
Mild	United Kingdom	18 - 24

Note: 1 BU (Bitterness Unit) is equivalent to 1 milligram of iso-alpha acid in 1 liter of water or beer.

TABLE 3. Separation of Hop Oils by Column Chromatography

Fraction	Components	Character
I	Mainly hydrocarbons	dry hop character
II	Mainly esters	no characteristic hop flavor
III	Mainly esters & ketones	dry hop character
IV	Mainly esters & ketones	late hop character
V	Mainly sulfur compounds	late hop character

fractions that were then added to beer. A summary of each components' character appears in Table 3.

Giving a hop aroma character to beer not only requires selecting an appropriate hop variety to provide the essential oils, but also requires adding the hops at an appropriate stage in the process.

Kettle Hops When hops are added at the beginning of the kettle boil few, if any, aromatic oils persist in the finished beer. There will be some chemical modification or combination of flavor compounds.

Late Hop Addition Hops may be added at any stage from 20 to five minutes before the end of the boil, or fresh hops may be added to a hop back to allow sufficient time for the extraction of some of the oils without them all being lost by vaporization. Not only will some of the more volatile hop oils be lost in the last few minutes of boiling or while waiting for wort cooling, but the remaining oils may be modified or lost during fermentation. Usually the heavier esters and ketones are retained to give the fruit/citrus characters found in many late-hopped lagers. The extent to which these characters persist depends on the kettle design as well as the hop variety.

Dry Hop Appropriate hop varieties can be added during maturation or to the cask to impart an aroma and taste, particularly to traditional ales. A wider range of hop oils is extracted than during late hopping, which imparts a floral fragrant note often with spicy characters that can be astringent if overdone. When whole hops are added to a cask the extraction and chemical reaction of the oils will continue throughout the drinking life of the cask, which produces a constantly evolving change in palate over time.

Battling the Skunk

By Scott Bickham

The positive contributions of hops to beer flavor and stability have been discussed elsewhere in this issue. The bitterness provided by hop iso-alpha acids is particularly important because it balances the malty sweetness. Unfortunately, these same compounds play a key role in the development of objectionable skunky flavors when beer is exposed to light.

When hops are added to the kettle the alpha acids are isomerized into compounds that are partially soluble in wort. The amount of these iso-alpha acids in beer is given in International Bitterness Units (IBUs), simply the concentration in parts per million. Most individuals can perceive the bitterness imparted by these compounds at a level of about 5 IBUs. In comparison, the compound associated with the skunky flavor, 3-methyl-2-butene-1-thiol (MBT), has a flavor and aroma threshold on the order of 10 parts per *billion*.

Obviously only a small fraction of the iso-alpha acids needs to react with light to adversely affect the beer flavor. The time for this reaction ranges from a few seconds in bright sunlight to several days under incandescent light, so it is important to protect our beer during both storage and consumption.

The light-struck reaction falls into the science of photochemistry, which describes chemical reactions that result from the interaction of light and matter. The exact mechanism of MBT formation is not known, but is thought to begin with the absorption of ultraviolet radiation by photosensitive compounds that occur naturally in beer. Some of the absorbed energy is then transferred from these photosensitizers to iso-alpha acid molecules and sulfur-containing proteins such as cysteine. This energy excites the iso-alpha acid molecule, rupturing a chemical bond and producing a ketyl-acyl radical pair. The acyl radical undergoes further transformation into a 3-methyl-2-butyl radical, which then recombines with a thiol radical to produce MBT. For a detailed description of this process see Peter Ensminger's article, "Light and Beer," in ***Zymurgy*** Fall 1996 (Vol. 19, No. 3).

The most obvious way to protect your beer from this fate is to store it in a cool, dark environment. This is not always possible, especially for retailers, but the color and thickness of the bottles can be chosen by the brewer to better protect the contents. The most damaging radiation has a wavelength in the range of 350 to 500 nanometers, which coincidentally is a region of high intensity for both sunlight and fluorescent lights. Clear glass is almost completely transparent to these wavelengths, while most green bottles transmit more than half the incident radiation. On the other hand, brown longneck bottles, are nearly opaque and offer the best protection.

While these variables are within the control of homebrewers, some commercial breweries prefer clear or green bottles to make their product more appealing to consumers. To overcome this obstacle, brewing scientists have developed a method of chemically modifying the hop isoalpha acids into similar molecules lacking the double bonds that cleave during the light-struck reaction. These modified acids are not photochemically active, but still provide the necessary bitterness.

Of course, not all breweries use this technology, but it may not be necessary because the light-struck character displayed by many popular imports cannot be entirely unacceptable to the consumer.

Scott Bickham is a technical editor for *Zymurgy*, the exam coordinator for the BJCP and a homebrewer of seven years.

The Mystery of First-Wort Hopping

By Amahl Turczyn

First-wort hopping, a practice in which low-alpha "noble-type" hops are added to the first runnings of wort into the kettle, was common in turn-of-the-century German breweries. Its main purpose was to achieve better utilization from hops because of the longer boiling time. Recently, however, it has been "rediscovered" as a means of producing a cleaner, finer hop aroma primarily, but also of producing a more rounded, uniform bitterness profile. Though it would seem counterintuitive by current standards that adding aroma hops before the boil actually would add to finished beer aroma, studies carried out in German breweries on first-wort hopping bring to light a more detailed explanation of why it really may work.

Of the many substances present in hops, some are clearly desirable in finished beer, and some are not. First-wort hopping may work because it reduces undesirable hop components caused by the longer exposure to heat. De Clerk mentions a process in *A Textbook of Brewing* (Chapman and Hall, 1957) in which hops are immersed in 122-degree-F (50-degree-C) water before they are added to the kettle, a process not unlike first-wort hopping. His reasoning was to remove unpleasant substances and smells.

Two German breweries ran tests with analytical equipment to specify exactly what benefits modern commercial use of this practice could bring about. Pilsener was chosen as the test brew because of the high influence of hops on its flavor profile. Four batches were run, each with all other procedures and additions constant except as related to hopping: pitching rates, malt, boiling time and water composition were as close to identical as possible. Of the two batches brewed in the first brewery, one was kept as a reference batch, the other first-wort hopped with 34 percent of the total hop addition of Saaz and Tettnanger. The two batches brewed in the second brewery also included one reference batch and one first-wort hopped, this time with 52 percent of the total hop addition of Tettnanger. In both first-wort batches late aroma additions were omitted.

In blind tastings, 12 trained tasters sampled the first brewery's batches and 13 tasters sampled the second brewery's tests. Eleven of the 12 from the first site were able to correctly identify the first-wort hopped batch. Three favored the conventionally hopped reference batch, the other eight preferred the first-wort hopped Pils. From the second brewery, 12 of the 13 made the correct identification and 11 preferred the first-wort hopped samples. Reasons given for the majority preferences included: "a fine, unobtrusive hop aroma," "a more harmonic beer" and "a more uniform bitterness."

In subsequent analysis of the beers, the first-wort hopped batches, as expected, contained a much higher percentage of isomerized alpha acids, particularly the larger first-wort-dose batch. To have the tasters prefer this hop profile, calling it "unobtrusive," leads one to believe some harsh bittering compounds might have been removed, where they would remain in the conventionally hopped batch. Gas chromatographic analysis showed that three possibly undesirable substances, linalool, terpineol, and humulene epoxide, had much higher concentrations in the reference batches than in the first-wort hopped ones. It was obvious from the test results that, across the board, normally hopped beers always contain more, and a greater variety of, hop aroma substances.

When trying this technique with your own brewing it is tempting to believe that wonderful aroma of first runnings and fresh hops somehow will be mysteriously preserved to the finished beer. These studies, however, prove this is misleading, and many of those fresh, volatile aromas actually could transform into undesirably harsh substances during the rest of the brewing process. More likely, first-wort hopping works because, at least in regard to aroma hop substances, less is better.

For this method to work you should use only "noble-type" aroma hops for first-wort and subsequent hop additions and you should add at least 30 percent of your total hop addition to the first runnings. Later, more conventional aroma additions can be added depending on the beer style, but you may be adding back substances that are best left out. Finally, the technique seems to work much better in beer styles that do not have heavy malt aromas. More extensive tests certainly will be carried out with first-wort hopping, but from my own results with test batches, I plan to use this "rediscovery" quite a bit.

References

Brauwelt International, 4/95 Vol. 13, 308-315.

Peter Garofalo, personal communication, August 1997.

Amahl Turczyn is the AHA's project coordinator.

Hop Oils and Hop Essence

The essential oils can be separated from hops by steam distillation or by CO_2 extraction. The oils are ideal for postfermentation addition, where they give dry-hop aroma and retain much of the aroma character of the original hop variety. Hop oils usually are added in the form of an emulsion (with a food-grade emulsifier), marketed in concentrations from 1,000 to 10,000 ppm of pure oil, or by redissolving in liquid CO_2 and added directly to the beer.

Other techniques for adding hop oil continue to evolve, including the adsorption of oils onto the surface of finely divided silica and the retention of oils inside the ring structure of cyclodextrin molecules. Both of these methods trap the oil in a solid (powder) form, which readily releases the oils to beer on contact with water.

By column chromatography it is possible to fractionate the whole hop oil into late hop essence, which may itself be divided into spicy and floral fractions:

Spicy late hop essence – contains terpene and sesquiterpene oxides that produce spicy flavor, improve mouthfeel and enhance perceived bitterness.

TABLE 4. Using Hop Oils and Essences

Advantages	Disadvantages
Easy to handle and store	Oils require emulsifying before use
Standardized consistent product	Essences are very costly
Available for different hop varieties	Some drinkers can detect the difference in a hop character
Provides a means of precisely controlling late hop character	Hop oils are occasionally reported to make drinkers belch.
No change in late hop character over time	They are very concentrated, requiring exact dosage rates.

Floral late hop essence – contains ketone fraction, which imparts light floral notes improving the fragrance rather than the taste.

Using Hops to Flavor Beer

Hops contribute many of the positive flavor notes in beer and, using the excellent flavor profile wheel developed by Dr. Morton Meilgaard, it is possible to attribute some of these qualities to the specific flavor characters mentioned in the wheel.

The isomerized alpha acid contributes to the bitterness of beer, as do the hop oils. This flavor may be confused with astringency and is one of the major faults with craft-brewed beers. Although the craft brews may have a low bitterness (in the range 18 to 26 BUs as measured by the amount of isomerized alpha acid) they have a large, and usually unquantified, bitterness contribution from the hop oils and resins. This gives the beer a much higher perceived bitterness, reduces its drinkability and destroys the balance of an otherwise excellent product.

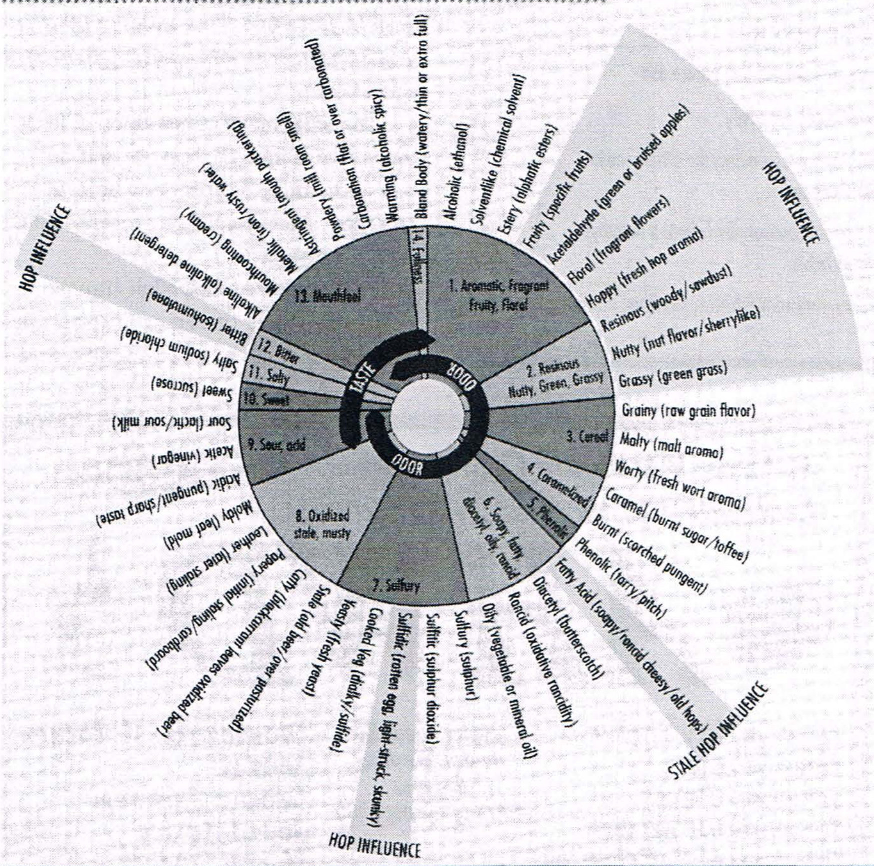
The Influence of Hops on Beer Flavors

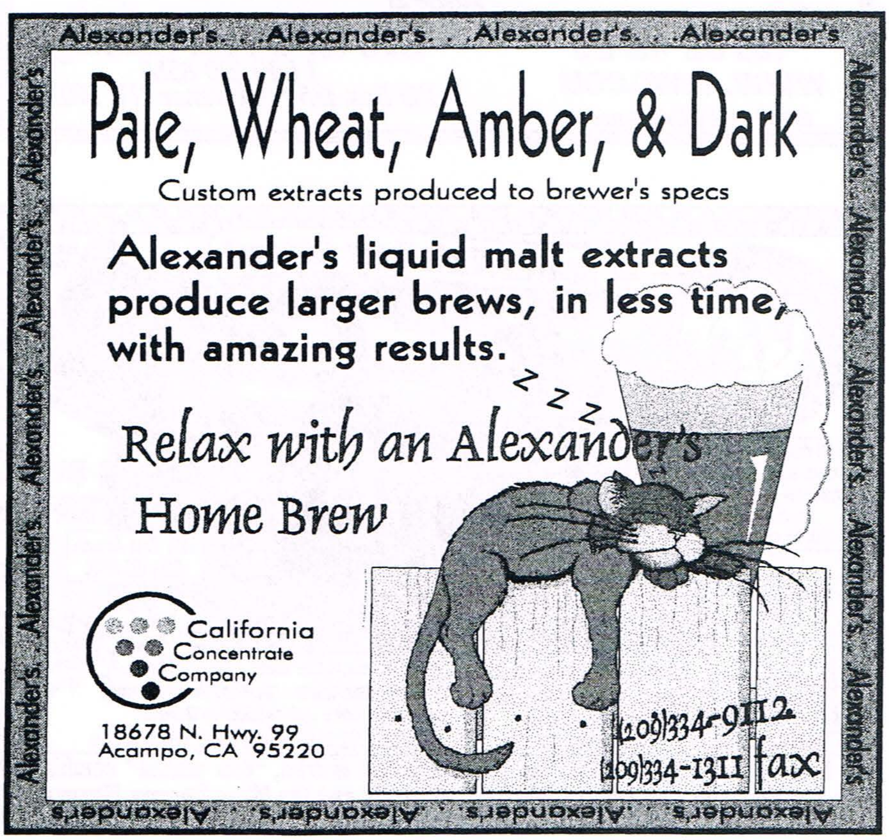
Alpha acid is prone to oxidation that produces a sulfidic compound with a light-struck or skunky off-flavor. This is a problem particularly with beers packaged in clear or green glass. To avoid the problem brewers use a specially modified hop compound that is not sensitive to ultraviolet radiation. Brewers can avoid the light-struck phenomenon by packaging beer in brown glass or solid containers that are not transparent to the wavelength of ultraviolet light.

The other major contribution of fresh hops comes from the hop oils and can vary according to variety and point of addition. The typical flavor contributions are described as:

- Fruity (specific fruits, often citrus).
- Acetaldehyde (green or bruised apple skins, usually at low intensity. Strong

FIGURE 1. Influence of Hops on Beer Flavors





aldehydes also can occur as a result of a sluggish fermentation).

- Floral (fragrant flowers).
- Hoppy (fresh hop aroma).
- Resinous (woody/sawdust/pine – in low concentrations this can be pleasant, but can be overdone).
- Nutty (nut flavor or sherry type).
- Grassy (green grass).

To find the ideal character for your beer it is necessary to experiment with different fresh hop varieties. Hops rapidly oxidize and lose their oils, so they should be bought fresh and vacuum packed, and be stored in a refrigerator or freezer once they are open.

To give an example of the contributions of different hop varieties used in different ways consider the following. Dry hopping with English Fuggle will give a grassy, resinous, floral hoppy aroma with a slightly warming spicy mouthfeel. Late hopping with Hallertauer Hersbrucker gives a fruity citrus (often described as grapefruit) aroma and flavor.

Lucky for brewers, experimenting with the multitude of hop varieties and applications amounts to tasty fun. Understanding how hops work will only help you optimize the flavor and aroma profiles you are yearning for.

References

Hough, J.S.; Briggs, D.E.; Stephens, R. and Young, T.W. *Malting and Brewing Science*, Vol. 2 Hopped Wort and Beer, Chapman and Hall, 1982.

Moir, M. "Development in Hop Usage," *Ferment*, Vol. 1, No 3, 1988.

Morris Hanbury Jackson LeMay Ltd. technical literature.

Neve, R.A. *Hops*, Chapman and Hall, 1991.

The New Brewer, July/Aug., 1994.

Pollock, J.R.A., ed. *Brewing Science* Vol. 1, Academic Press, 1979.

An Introduction to Brewing Science and Technology Series II (Revised Version) Hops, Institute of Brewing.

Timothy O'Rourke lectures and writes on brewing technology for large and small brewing applications.

Helpful Hop How-Tos

By Norm Pyle

Hops bring a plentiful bounty to a glass of beer, but they also present a unique set of challenges for the brewer, namely getting them in and out of wort easily. In most cases, as it is throughout the brewing process, there are a variety of solutions for any particular situation. Not all possible solutions will be, or even could be, discussed here, but you should glean some new ways to approach various hop use challenges, and maybe even engineer some better solutions.

What Goes in Must (Eventually) Come Out

As any homebrewer knows, hops are used to add bitterness and flavor to beer. Bitterness is added by boiling hops, usually from 30 to 90 minutes. Boiling is necessary to isomerize the hops, or make their oils soluble in wort. Flavor and aroma are acquired from hop additions later in the boil, and later in the process, up to and including additions in the beer glass. The brewer's problems begin as soon as the hops are added, and the question that immediately arises is, "How do I get them back out?" Usually, getting hops into the wort or beer isn't a problem, but some forethought is required if they are to be removed without anguish.

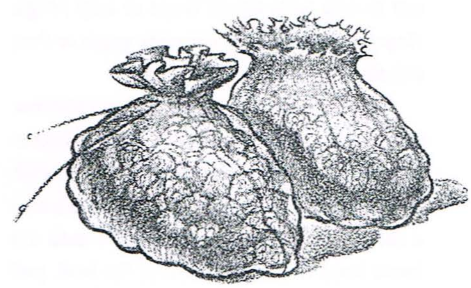
Though much of this article pertains to the removal of hops from wort prior to fermentation, homebrewers can make great beer without this step. The small particle size of pelletized hops makes them difficult to remove. Some brewers simply leave them in until after fermentation. Once in the primary fermenter they settle and are left behind when the beer is siphoned to the secondary fermenter, bottle or keg. Professional brewers remove hops before fermentation for practical reasons like preventing plumbing problems and to avoid the inevitable chemical reactions that occur when spent hops remain in contact with wort.

In general, whole hop cones are easier to remove because of their size, and it is their large size that makes it imperative to remove them in most breweries to prevent downstream plumbing problems. This is true with many amateur and virtually all professional brewery setups. There is merit in removing the hops prior to fermentation, if for no other reason than because it eventually must be done.

Gadgets for Handling Hops

Getting hops into the kettle is easy, but to retrieve them homebrewers have been known to pour hot, hop-laden wort through funnels with mesh strainers. This process, though it achieves the purpose, exposes hot wort to oxygen, causing staling effects in the finished beer. A better practice is to chill the wort prior to filtering it into the fermenter. Chilling then pouring wort through a strainer removes the hops and aerates the wort, which results in better yeast metabolism. Even though prechilling solves the oxidation problem, it doesn't solve an important safety issue. Holding several gallons of wort in a large kettle, hot or cold, and leaning over to pour it into the funnel is a fine recipe for a visit to the chiropractor. Recalling the old adage, "a pint's a pound the world around," plus the weight of the kettle and the fact that this is high-gravity wort (one gallon of wort weighs more than one gallon of water), a five-gallon batch easily can weigh 45 to 50 pounds. With that in mind, let's explore some safer alternatives.

One solution is to sanitize a small pot and use it to transfer the wort, one pot at a time, into the fermenter. This is easiest when you use a fine mesh strainer inside a large funnel to strain hops from the boiled (and preferably chilled) wort into the fermenter.



Another simple solution is a hop bag, which is a nylon mesh bag with a drawstring closure. To use, place the premeasured hops in bags (you'll need at least one bag per hop addition) and drop them into the boiling wort. Removal involves hooking the drawstring to pull the bag out. Even the best hop bags tend to wear out over time, prompting some homebrewers to opt for less expensive disposable cotton bags.

One drawback to the hop-bag method is reduced utilization because the hops don't get the same agitation in the boil as loose hops would. Bitterness calculations are complicated because alpha-acid utilization is reduced by an unknown quantity. Adjustments can be made, but the density of the hops in each bag affects the calculation (a firmly packed bag will not achieve the same utilization as one lightly packed). Homebrewers can approach consistent bittering with hop bags by being consistent about the amount of hops in a certain size bag, and

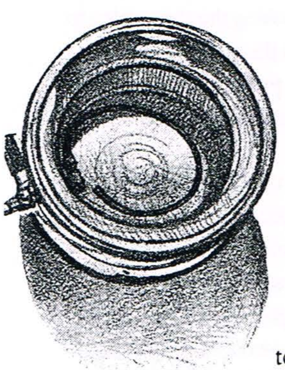
ILLUSTRATIONS BY MATT BROWNSON

using a constant adjustment factor. Utilization estimates may not be perfectly accurate, but they will be fairly repeatable.

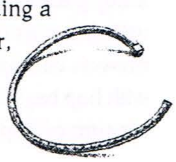
Hop bags, in one form or another, are useful tools for homebrewers to get hops into and out of the kettle, but they are easiest to use with whole hops or hop plugs. Hop pellets require a very fine mesh or they will float right through the bag.

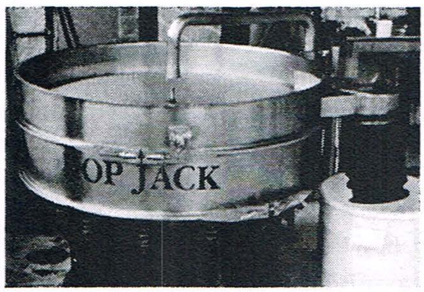
More expensive but permanent alternatives for hop removal are the various homebrewed gadgets including spigots with strainers mounted to the kettle. There's also a tool resembling a fryer basket – add the loose hops then at the end of the boil, pull out the basket. Look for stainless-steel screening and wire when assembling your hop strainer/basket.

Chilling Possibilities



Anyone who has built any kind of brewery realizes that the design and the brewing process are intricately linked, and the design options are almost endless. The method used to chill wort after boiling often dictates the method used to remove hops. For example, if the kettle is fitted with an outlet feeding a counterflow wort chiller, then a false bottom or pipe manifold can be fitted into the kettle in a





The hop jack at Rockies Brewing Co. in Boulder, Colo., was retired in favor of a whirlpool.

manner similar to that used to separate wort from grain in a lauter tun. On the other hand, if the wort is to be siphoned out of the kettle, a hop bag or other filter over the end of the racking cane may be the best choice.

Many professional brewers use a vessel referred to as a hop back or hop jack. Some incarnations of hop backs are built much like the homebrewer's funnel with a screen. The screen within the hop back captures the spent kettle hops prior to fermentation. Wort is pumped through and the whole device is vibrated to move the hops toward the center. If not well-designed, this system can oxidize hot wort, shortening the shelf life of the beer. For this reason, Rockies Brewing Co. in Boulder, Colo., stopped using their hop back and now uses a whirlpool vessel for hop separation. Some hop-back designs incorporate seals so the vessel fills with water vapor rather than oxygen-rich air, thus preventing wort oxidation.

One advantage to a hop back is fresh whole hop cones can be placed in it to contact the hot wort just prior to chilling. The wort carries the fresh hop aroma into the fermenter. Immediate chilling greatly reduces the irreversible chemical reactions with the volatile hop oils so the beer retains a hop aroma.

Hop backs are only useful for those brewers who use a counterflow chiller rather than an immersion chiller because hot wort extracts essential aromatic hop constituents within minutes, but it takes days for the same to happen with cool wort.

One popular hop-back design was presented by Kinney Baughman in *Zymurgy* Special Issue 1992, "Gadgets and Equipment" (Vol. 15, No. 4). The design is still used today because it is simple to build and use and, most important, it works. The container in the Baughman design is a canning jar fitted with an airtight lid. The lid of the jar can be drilled and fitted with grommets, as Baughman presented, but a large two-hole stopper is easier to use and works at least as well. Inlet tubing runs from the kettle to the bottom of the jar to avoid splashing. Outlet tubing runs to the inline chiller and is fitted with a copper pad or other filtering device. The larger the jar the better, because the beguiling aroma of fresh hops tends to make a brewer want to add more and more.

Hop backs can be constructed with a variety of materials, but they must be able to withstand temperatures up to 212 degrees F (100 degrees C), they must seal to prevent leaking and oxidation of hot wort and they must disassemble for cleaning.

Tea Time

The idea of doctoring under hopped beers should not be dismissed, but kegged homebrew is typically the easiest to remedy. Hop aroma can be added by dry hopping in the keg, or you can use hop aroma teas. These are simple to make and have some advantages over dry hopping.

Hop aroma teas are a good option for those who dislike or worry about the sanitation implications of dry hopping, and teas offer

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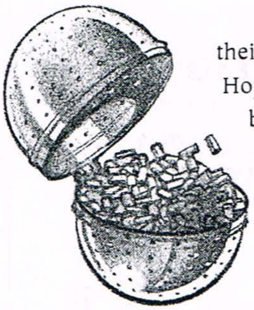


their own advantages. Hop aroma tea is made by preboiling water to sanitize and drive off chlorine and oxygen. Fine aroma hops are placed in the near-boiling water and allowed to steep for one to 10 minutes before being chilled and added to the beer. The hot water helps sanitize the hops, but don't steep for too long or the hop aroma will be lost. For this reason it is best to chill the tea as quickly as possible after a short steep.

The aroma extracted from hops in this manner is different from that extracted from raw hops by dry hopping because the volatile oils react very quickly when heated. It is a matter of preference, but the difference between teas and dry hops should not be considered a flaw. Hop tea aroma more closely resembles finishing hops than it does dry hops, and the aroma from finishing hops is fine indeed. Many beer enthusiasts prefer the flavor/aroma of finishing hops to dry hops because they tend to be less grassy and more refined.

If a finished beer comes out lacking in bitterness, a hop bittering tea can remedy the situation. Some brewers in such a situation will brew an over bittered beer and blend the two for a pleasing balance. This works, but it is easier to add bitterness with hop tea. A hop bittering tea is similar to a hop aroma tea, but in this case the hops and water are boiled for 30 to 60 minutes to isomerize the alpha acids, creating bitter iso-alpha acids.

This tea can be added to taste, starting with a measured amount (a medicine dropper or syringe works well) in a measured amount of beer, and then scaling up to the whole batch. More complicated methods and calculations can be performed in an attempt to quantify the bitterness added, but this may amount to little more than a fair guess, because alpha-acid utilization numbers usually are not quoted for water. Iso-alpha acid extract can be purchased as well, and will solve the issue of quantifying the amounts, but most brewers already have a stock of hops, so why not use them?

Dry Hopping and Beyond

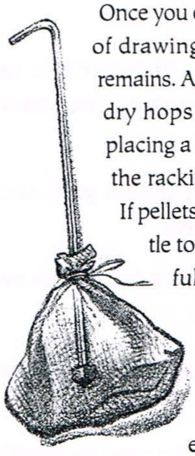
Brewers often make the mistake of thinking that once the wort is in the fermenter the brewing process in general, and hopping in particular, is finished. Nothing could be further from the truth. Dry hopping, the practice of adding fresh finishing hops to the fermenting beer, is one way to add incredible fresh hop aroma. Add dry hops late in the fermentation process, after high kraeusen in the primary or in the secondary, to prevent the aroma from being scrubbed out and carried away by the escaping CO_2. That wonderful smell during active fermentation is aroma being lost from the finished beer.

Hop pellets are easy to pour directly into the small opening of a carboy for dry hopping, but hop plugs must be broken or cut in order to stuff them in. Whole hops can be even more difficult. Usually a funnel and a plunger of some sort will get the job done. This process isn't too difficult, but the funnel and plunger must be sanitized, which amounts to a minor hassle.

Once the hops are in the fermenter there is little to do but wait for them to work their aromatic magic. A typical dry-hopping cycle is seven to 14 days. Less than this is an inefficient use of hops; much more and the beer is simply growing old. Whole cones and plugs (after they hydrate and swell) will float in the beer, while pellets will sink to the bottom. Some brewers dutifully place their whole hops or plugs in a hop bag weighted with marbles (all items sanitized, of course). This pulls the hops below the surface and may better utilize the fine aroma hops. A lazy brewer's solution is to simply leave them in the fermenter for another couple of days.

The issue of sinking pellets, though, is something for the conscientious brewer to be aware of. The pellets break up into tiny particles and, depending on the timing of their addition, can become covered with settling yeast, making them nearly worth-

less. A simple solution is to gently rouse the yeast from time to time, making sure the green layer of pellets is not lost below a beige strata of dormant yeast. Alternatively, allow the yeast to settle before pellet addition and avoid the problem.



Once you dry hop a batch, the task of drawing the beer off the hops remains. As with kettle hops, whole dry hops can be left behind by placing a hop bag over the end of the racking cane before transfer. If pellets were used, let them settle to the bottom before carefully racking the beer off the sediment. You may find it necessary to use a hop bag over the cane to avoid taking up excess pellet residue.

One variation of dry hopping is adding commercially extracted hop oils. These are concentrated liquid extract of the essential hop oils. Not only is adding oil to the fermenter simple, it obviates the hop removal process altogether. Processed hop oils cannot deliver the same aromatic qualities as fresh whole hops, but the same argument could be made for other forms of hops such as plugs and pellets. One popular Colorado microbrewer reports less grassiness with hop oils than in beers dry hopped with whole hops, in addition to a great savings in beer (from 10 to 15 percent) that otherwise would be soaked up by the hops. Yeast harvesting after dry hopping can be a nightmare without the proper equipment. In most cases you'll need a cylindroconical fermenter so you can remove yeast from below the hop sediment. By comparison, hop oils are a dream. Using hop oils can be slightly less expensive as well, but the real selling point is the simplicity of adding the oil and not having anything to remove.

Hops can be added at any time until the glass of beer is pressed to the lips. Hop oil can be added to the glass. In fact, some beer fanatics have been known to carry a small bottle of hop oil to bars in case of emergency. I enjoy placing a single hop cone in a stainless-steel tea ball directly into a glass of beer. The aroma is unmatched and, better yet, it increases as the beer is consumed!

Admittedly, hops can be problematic for the brewer but without them, most classic beer styles would not exist, at least not as we know them. Even those beers that do not accentuate the bitterness and flavor of the hops require them to balance the sweetness of the grains. The bottom line is hops are not an option, they are simply a required and much-desired ingredient. Hops should not be thought of as a problem. Rather, they should be enjoyed for all the wonderful properties they bring to a fine glass of beer. Cheers!

References

Baughman, Kinney, "Hopping Up Homebrew with a Hop Back," ***Zymurgy*** Special Issue 1992 (Vol. 15, No. 4).

Rahn, Phil, "Boiling Wort Using the Slotted T Drain," ***Zymurgy*** Special Issue 1992 (Vol. 15 No. 4).

Further Reading

Fix, George, *Principles of Brewing Science*, Brewers Publications, 1989.

Garetz, Mark, *Using Hops*, HopTech, 1994.

Neve, R.A., *Hops*, Chapman and Hall, 1991.

Pyle, Norm, Editor, "Hops FAQ (Frequently Asked Questions)," available on-line at: http://realbeer.com/hops/FAQ.html.

Tinseth, Glenn, "The Essential Oil of Hops: Aroma and Flavor in Hops and Beer," *BrewingTechniques 2* (1), Jan./Feb. 1994.

Norm Pyle, a homebrewer since 1990, has been a hop head and gadget freak from the beginning. He is a frequent contributor to *BrewingTechniques* magazine, and can be reached at norm_pyle@bigfoot.com via e-mail.

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Cheers,

Dena Nishek

Dena Nishek
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1997 HOMEBREWER OF THE YEAR

Award sponsored by Munton & Fison of England and the Great American Beer Festival®

Charlie Gottenkieny

By Jim Dorsch

Traveling half the year on business, AHA Homebrewer of the Year Charlie Gottenkieny of Dallas has to be creative to squeeze homebrewing into his schedule. Lambic-style beers fit well. "Once you get it made and in the fermenter, there's no particular window in which to get it bottled," he says. "In fact, with lambic, the longer the better."

When told he was the AHA's Homebrewer of the Year, Gottenkieny, who was unable to attend the National Homebrewers Conference, said, "You could have knocked me over with a feather. I really didn't expect it. I was on cloud 10!"

Gottenkieny started brewing after visiting his brother in North Carolina in 1990. "He served me a homebrew that tasted just like a Belgian beer," he recalls. "I decided then and there I was going to learn how to brew beer."

His first was an English ale made from a kit with plenty of sugar added. His brewing career almost ended with his second batch, when a blowoff tube literally blew off, leaving several gallons of stout on the ceiling and floor.

Gottenkieny's beers improved steadily after he picked up a copy of Charlie Papazian's *The New Complete Joy of Home Brewing* (Avon, 1991). He credits his 1993 switch to all-grain brewing, which he practices almost exclusively, for significant improvement in his beers.

Gottenkieny brews with a 10-gallon stainless-steel mash/lauter tun for his step mashes. He boils wort in a 15-gallon brewpot over a propane burner and occasionally performs single-stage infusions in a picnic cooler mash/lauter tun. Gottenkieny chills his wort with a counterflow unit and ferments in glass carboys. Lagers go in a temperature-controlled refrigerator; ales do well in a 55-degree-F (13-degree-C) wine closet.

English ales are the staple in Gottenkieny's homebrewery, but he also brews Belgian ales, American pale ales, the occasional German-style lager and, of course, lambic. Gottenkieny often splits a 10-gallon (37.8-L) batch of lambic, bottling some straight, blending a portion to make gueuze and adding cherries or raspberries to part of the batch.

During his travels Gottenkieny often is able to visit breweries. He had the opportunity to tour the Cantillon lambic brewery while in Brussels. Despite the language barrier, he managed to walk away with some tips from brewer Jean-Pierre Van Roy.

Gottenkieny brewed his winning lambic more than two years ago and bottled it about 16 months before the July Conference in Cleveland. The beer also took best-of-show at the Texas Blue Bonnet Brew-Off in March. "I really liked it," he says. "Unfortunately, I drank most of it. The last bottles went to the AHA Nationals."

While he's not averse to experimentation, Gottenkieny makes sure tradition is an integral part of a traditional beer style. "I don't put German malts into English bitters or use American hops in a German altbier." That's why Gottenkieny poured dregs from Cantillon bottles into the fermenting lambic and added oak chips to the secondary – "I couldn't put it in their barrels," he says.

The Homebrewer of the Year enjoys bicycling, cooking and wine tasting and collecting. "There are a lot of similarities between cooking and brewing," he says. Gottenkieny believes wine tasting has helped his beer judging, which in turn has enhanced his brewing skills. "Judging has refined my ability to brew to style," he says.

Gottenkieny started entering competitions and learning beer judging through his local club, the North Texas Homebrewers Association. Now a BJCP Certified judge, he says, "While I am not a competition maniac, I always enter beers in our local competition and the Blue Bonnet Brew-Off, and have participated in a number of regional competitions in addition to the AHA Nationals."

"I enter largely because I get feedback," he says. "I think it has improved my beers." While he doesn't brew specifically for competitions, "I try to get a number of them ready that could go in a competition, but I brew beer to drink. I do it because I enjoy it."

Opportunities to try foreign beers on their home turf have convinced Gottenkieny of the value of homebrewing: "I have the opportunity to taste a lot of beers in their local habitats. Unfortunately, I have come to discover that many of them do not travel well. The only beers that can really compare to fresh, unpasteurized European beers are homebrewed beers."

Jim Dorsch writes about beer for *The Washington Post, Chicago Tribune, The New Brewer, Zymurgy* and *Beer Connoisseur.*

For Gottenkieny's award-winning Belgian-style lambic recipe, "Lambic 415," see page 94.

PHOTO COURTESY OF CHARLIE GOTTENKIENY

1997 NINKASI AWARD

Award sponsored by Boston Beer Co., Boston Mass.

George Fix

By Jim Dorsch

Until now, the Ninkasi Award was one of the few brewing awards that George Fix of Arlington, Texas, hadn't won. He did it this year with a first-place Kölsch and a second-place American Pilsener.

Fix is a longtime brewing consultant, member of the Knights of the Brown Bottle homebrew club and a Great American Beer Festival® judge. He is author of two books published by Brewers Publications, *Principles of Brewing Science* (1989) and *Vienna, Märzen, Oktoberfest* (with Laurie Fix, 1991). A third book, *An Analysis of Brewing Techniques* (with Laurie Fix) will be released this year by Brewers Publications.

Fix almost went to school at the University of California at Davis, where the fermentation science program is well-known. But a scholarship to study applied math at Harvard changed his plans. No matter. He uses his math chops to improve his brewing. Without a doubt, George Fix lives and breathes beer.

He won his first AHA National award in 1984 for a wheat beer. He has won National Homebrew Competition ribbons for seven beers since 1984. In 1981 he received the Dave Line Trophy, topping the field at the International Homebrew Competition in Phoenix. He already was a veteran brewer at the time. "I've been brewing ever since I was a kid," he says.

In addition to receiving the Ninkasi Award in Cleveland this year, Fix received the AHA Recognition Award in 1991. "I'm very proud. I don't think I deserved either one. I'm more proud of how many people won the first round with American Pilsener," he says, reeling off the brewers' names.

Fix has been banging the drum for American-style adjunct beers for more than 20 years. He started his brewing career washing bottles for his grandfather, who had brewed commercially until Prohibition and at home after that. He based his corn-adjunct recipes on those of his grandfather.

He believes entering competitions can help anyone make better beer. "You get a lot of feedback," he says. But the Fixes think the judges themselves need more evaluation. In their new book they propose testing judges with ringer beers and triangle tests. "A lot of judges suffer from a carry-over effect because of flavors from the previous beer," Fix maintains. He's definitely excited about the new book. "It's about the way we evaluate brewing materials and procedures. It's a personal statement. *Principles of Brewing Science* was objective. This one is the exact opposite."

Fix brews on a half-barrel system in his garage and ferments in kegs. He uses a Zahm and Nagel system to filter coarsely – "to keep the armadillos from coming through" – and carbonate the beer.

Asked for advice to homebrewers, Fix says, "No. 1 and No. 2 are 'yeast and yeast.' Keep clean and take care of your yeast and you're going to win awards." For cleaning, he recommends taking a good look at the range of cleaners and sanitizers now available to homebrewers. "There are some nice, environmentally friendly, but strong and effective cleaners." And, he stresses, "You can't sanitize something if it's not clean."

How does he find time for homebrewing in his busy schedule? "You find time," he says. "It keeps my sanity. I love the weekends when I brew. I'm going to find the time." His first priority – about half his output – consists of lagers. "I like Dortmunders, classic Pils, helles, Maibock. We haven't brewed Vienna lately. When you write a book about something you can get tired of it," he says with a laugh.

He also makes British and German ales. Every New Year's Eve he and Laurie brew five gallons of barley wine for special occasions in the coming year. "I try to hit all the major styles," he says. "I haven't gotten to the Belgians yet; I have to find a yeast I can live with."

Fix has made his share of mistakes, but he learns from them. "The best way to learn is by making mistakes," he says. It's the same in math. You see new dimensions in the problem. The things I've learned best have come from screwing up."

With the Ninkasi Award comes the opportunity to take a two-week course at the Siebel Institute in Chicago. Homebrewer of the Year Charlie Gottenkieny, who lives in nearby Dallas, suggests Fix could set a precedent by teaching the class he attends. But Fix has another idea. "I just want to spend the two weeks in their library."

Figures. As long as there's more to learn about brewing, George Fix will be trying to learn it.

Jim Dorsch writes about beer for *The Washington Post, Chicago Tribune, The New Brewer, Zymurgy* and *Beer Connoisseur.*

For George's award-winning Kölsch recipe, "Bonn-Bonn," see page 99.

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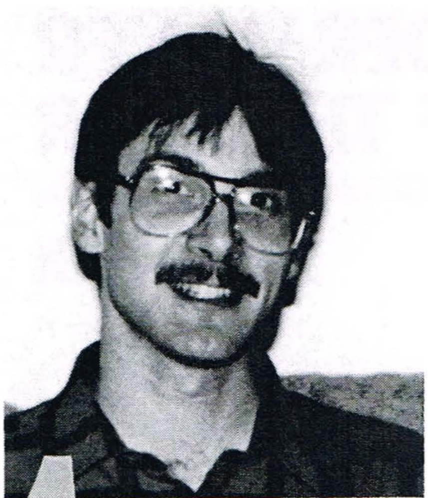


1997 MEADMAKER OF THE YEAR

Award sponsored by Madhava's Mountain Gold Honey of Lyons, Colo.

Ron Badley

By Jim Dorsch

Meadmaker of the Year Ron Badley made wine in the late '70s and early '80s, then "got into the beer thing." But the Reno, Nev., resident hasn't made much beer lately, saying, "Mead is a little bit quicker [to make]."

Badley kept bees when he lived in Washington state around 1979-80. "That's probably when I got initiated. It was a natural progression," he says.

The winning chipotle mead was made from crimson clover honey. Badley also made sparkling and still meads from the same batch. He has a honey supplier who sends samples. "Really light honeys, like fireweed, are best for playing around," he says. "I have some pumpkin honey I'm going to work with. It's dark and aggressive." Badley used some honeycomb in his prize winner because he says, "The comb lends a bit of interesting character."

"There are so many variables," Badley muses. "Honeys, waters, fermentation, yeast." Badley learned to ferment at warmer temperatures, around 80 degrees F (27 degrees C), from two-time Meadmaker of the Year Byron Burch of Santa Rosa, Calif. "The best combination is to agitate – use oxygen and add plenty of yeast nutrient," he says. "If you do it right, you can have a high-gravity mead that has a beautiful honey character without being cloying."

Badley is a member of the Washoe Zephyr Zymurgists. With seven national judges in the club, "Per capita, I believe we have the most National BJCP judges in the United States." The members are becoming attracted to meadmaking as well. "We've had more and more [mead brewed] since I've been involved with the club," Badley says.

This isn't the first award Badley has won. "I won best of show at the Nevada State Fair with another mead, and a few ribbons from the Home Wine and Beer Trade Association competition," he says. Badley has entered the AHA National Homebrew Competition off and on, sometimes making the second round but never winning a ribbon. "It was starting to tick me off," he jokes. This year was the first time he entered mead in the Nationals, and he won it all.

Badley is an inveterate tinkerer. "I'd love to have a full-time job playing around with this stuff," he says. He makes cider for summer sipping and intends to experiment with cyser, which is cider fortified with honey.

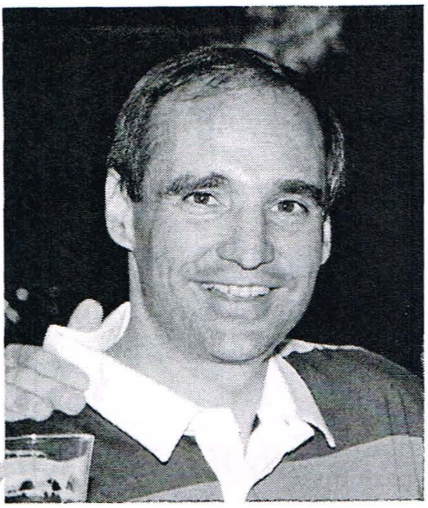
For flavored meads, Badley recommends making a tea from the flavoring agent and adding it to taste to a fermented mead. "It's better to make a base mead and add flavors," he says. Meadmakers can test flavors by adding them to a cup of mead. Use a light hand. "You're better off keeping it subtle," Badley maintains. "If you can get three flavors to come out distinctly, you're doing great."

Badley intends to enter the AHA Nationals next year. "I guess I'll have to defend my title," he says. His parting advice to competitors: Spicing is secondary. "The base mead always has to be good."

Jim Dorsch writes about beer for *The Washington Post, Chicago Tribune, The New Brewer, Zymurgy* and *Beer Connoisseur*.

For Badley's award-winning herb and spice mead recipe, "Cinco de Meado," see page 102.

PHOTO COURTESY OF RON BADLEY



1997 CIDERMAKER OF THE YEAR

Award sponsored by Lyon's Brewery of Dublin, Dublin, Calif.

Frank Salt

By Jim Dorsch

Cidermaker of the Year Frank Salt, a detective who has been with the New York City Police Department for 28 years, has always considered himself a beer brewer. "I got into cider because my wife, Patricia, doesn't like beer," says the Staten Island resident.

In 1993 Salt's homebrew club, the Homebrewers of Staten Island, discovered they could purchase a custom apple pressing in a minimum 300-gallon quantity and made a buy. Salt went in on the purchase. "I was doing a run of ales at the time," he recalls. "I was using Wyeast No. 1056 American ale yeast." Salt used the yeast to ferment his first cider after pitching a few Campden tablets into the juice, to which he had added some brown sugar. "I put it away and never thought much about it," he says. The cider fermented at room temperature for about a year, after which Salt stored it between 33 and 48 degrees F (1 and 9 degrees C).

The cider won best of show in the New York City Spring Regionals in March, and was runner-up best of show a few weeks later in the New York City Homebrewers Guild annual contest. According to the lead judge in the first contest, John Naegele of Flushing, N.Y., one best-of-show judge claimed to hate cider. "I said, 'Go ahead. Knock out the cider,'" recalls Naegele, "and he said, 'Not just yet.'" Naegele says the cider scored 98 out of a possible 100 points in the second contest.

That same cider, the first one Salt ever made, was inadvertently shipped to Lancaster, Pa., a first-round beer and mead site for the 1997 National Homebrew Competition. "By the grace of God," he says, "it made it to Massachusetts," the cider-judging site.

Salt had been a winemaker before switching to homebrewing in 1988 because he couldn't get the quality wine grapes he wanted. "California doesn't send us their best grapes," he says. Salt learned cidermaking from *Sweet & Hard Cider* by Annie Proulx and Lew Nichols (Garden Way, 1980).

Having been the target of some ribbing by homebrewing friends, Salt is doubly pleased to be Cidermaker of the Year. "Beer people have been teasing me," he says. "I think they're just envious." Salt's winning ways have motivated some members of the Homebrewers of Staten Island to give cider another try. "It woke up members of my club and renewed their interest," he says. The club had ceased making its annual sweet cider buy, but this year orders easily exceeded the 300-gallon minimum.

Salt has won many brewing prizes, but had never placed in the AHA Nationals. "I've won a lot of awards with beer, but cider got me to the Nationals," he says.

Successful cidermaking has a lot in common with good brewing, says Salt. "Stay very clean, pitch a good viable yeast and you're way ahead of the game."

Salt's victory has resolved questions about his identity. "I'm a confirmed cidermaker now," he says. "Come fall, I'm going to put the hops and malt aside and make cider."

Jim Dorsch writes about beer for *The Washington Post, Chicago Tribune, The New Brewer, Zymurgy* and *Beer Connoisseur.*

For Salt's award-winning cider recipe, "Farmer Grey's Crazy Rabbit Sparkling Cider," see page 102.

PHOTO COURTESY OF FRANK SALT

WINNERS CIRCLE

Amahl Turczyn

The American Homebrewers Association announced its National Homebrew Competition winners during a cruise on Lake Erie. About 350 homebrewers cheered their peers during what many considered the highlight of the Cleveland Conference.

Once again, we bring you the gold-medal-winning recipes from the top 28 homebrewers of the AHA 1997 National Homebrew Competition. This year's Competition was by far the largest we've ever had, with 3,980 entries from around the world. The AHA sponsored eight judging sites in the United States and Canada, from which 580 entries advanced to the second round in Cleveland. More than 100 judges deliberated for eight hours before choosing gold, silver and bronze medalists from each of the style categories. Following are the complete recipes for the 28 first-place homebrews.

The Homebrewer of the Year award, sponsored by Muntons p.l.c., went to Charlie Gottenkieny of Dallas for his "Lambic 415." Best-of-show judges had quite a difficult task deciding this year's winner from a pool of exceptional gold-medal beers, but Gottenkieny's was a truly great representation of homebrewing's best.

A wonderful surprise for all of us who appreciate George Fix's numerous contributions to homebrewing and brewing science in general was his claim to the coveted Ninkasi Award. This award is given to the brewer who accumulates the most points during the second round of the Nationals. Sponsorship for the Ninkasi Award is generously provided by the Boston Beer Co.

The "traveling trophy," given to the Club of the Year, was handed over personally at the awards ceremony. In a spirited display of good sportsmanship, the Chicago Beer Society passed the trophy to the Derby Homebrew Club of Wichita, Kan. Sponsored by Coopers Brewery of Adelaide, Australia, this award goes to the homebrew club whose members accumulate the most points in the first and second rounds of the National Homebrew Competition and in the six annual Club-Only Competitions.

PHOTOS BY RICHARD J. LUBRANT

Randy Mosher (r) and his team of judges deliberate over a flight of brown ale.

Claus Holten and David Houseman inspect a bottle of smoked beer.

Ron Badley of Reno, Nev., won the Meadmaker of the Year award for his "Cinco de Meado" smoked chipotle chili sweet mead. I had the opportunity to taste this mead, which was, quite frankly, incredible. This award, sponsored by Madhava's Mountain Gold Honey, was accompanied by a tremendous handblown mead chalice created by Chuck Lopez.

Cidermaker of the Year was Frank Salt of Staten Island, N.Y., taking top cider honors for his Farmer Grey's Crazy Rabbit Sparkling Cider, a blend of juice from six apple varieties. Salt received a handblown cider chalice also made by Chuck Lopez. This category was sponsored by Lyon's Brewery of Dublin, Calif.

There are some terrific recipes here. With this year's edition of "Winners Circle," you can brew the best homebrew in the world in your own homebrewery.

Amahl Turczyn of Boulder, Colo., has been a homebrewer since 1985, a professional brewer since 1995 and is now AHA project coordinator. *A Year of Beer* (Brewers Publications, 1997), a book of seasonal homebrew recipes he compiled, was released Aug. 15, 1997.

BARLEY WINE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by American Homebrewers Association, Boulder, Colo.

KURT ZYLA
LEBANON, N.J.
"MOUNTAINVILLE MADNESS"
AMERICAN-STYLE BARLEY WINE

Ingredients for 5 U.S. gal (19 L)

10 lb British pale malt (4.54 kg)
1 1/2 lb Munich malt (0.68 kg)
1 lb British crystal 60 °L (0.45 kg)
1/2 lb Victory malt (0.23 kg)
6 1/2 lb Muntons light malt extract (2.95 kg)
2 1/2 oz Eroica pellet hops, 11.2% alpha acid (71 g) (75 min.)
1/4 oz Eroica pellet hops, 11.2% alpha acid (7 g) (15 min.)
1 oz Cascade pellet hops, 4.4% alpha acid (28 g) (three min.)
1 oz Cascade pellet hops, 4.4% alpha acid (28 g) (dry)
Wyeast No. 1056 American ale yeast
Red Star Champagne yeast
3/4 cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.112
- Final specific gravity: 1.034
- Boiling time: 90 min.
- Primary fermentation: eight days at 68 degrees F (20 degrees C) in glass
- Secondary fermentation: 27 days at 68 degrees F (20 degrees C) in glass

Brewer's Specifics

Mash grains at 152 degrees F (67 degrees C) for 90 minutes.

Judges' Comments

"Yum! Great balance between malt, hops, alcohol and age."

"Initial malty-caramel character; good American hop flavor. Vinous alcohol flavors present and complex. Lingering hop flavor and bitterness nice."

Brewer's Comments

"I wanted this to be a big barley wine ale," Zyla said. "I made sure to put in plenty of bittering hops to balance the high starting gravity. Dry hopping with Cascade definitely improved the aroma. For the first six months, this beer tasted like sweet, strong tea. With time, however, it mellowed and turned into a local favorite."

Runners-up

Silver Medal: Chuck Boyce, Cincinnati, Ohio, "Boob's Barley Wine"
Bronze Medal: David Suda, Ottowa, Ontario, Canada, "Glebe Barley Wine"

BELGIAN ALE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Manneken-Brussel Imports Inc., S.A. Bières de Chimay, Austin, Texas

DAVID SUDA
OTTAWA, ONTARIO, CANADA
"BRUSSELS TRIPEL"
TRIPEL

Ingredients for 5 U.S. gal (19 L)

6 3/5 lb Weyerman Pilsener malt (3 kg)
6 lb DeWolf-Cosyns Pilsener malt (2.72 kg)
7/10 lb DeWolf-Cosyns CaraPils malt (0.32 kg)
1/5 lb white sugar (0.1 kg)
4/5 lb brown sugar (0.36 kg)
2 oz Saaz whole hops, 4.2% alpha acid (57 g) (60 min.)
1 2/5 oz Tettnanger whole hops, 3.3% alpha acid (39 g) (30 min.)
Wyeast No. 1762 Belgian Abbey II ale yeast
3/4 cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.083
- Final specific gravity: 1.021
- Boiling time: 120 min.
- Primary fermentation: 14 days at 65 degrees F (18 degrees C) in glass
- Secondary fermentation: 21 days at 65 degrees F (18 degrees C) in glass
- Age when judged: five months

Brewer's Specifics

Mash grains at 155 degrees F (68 degrees C) for 50 minutes. Boil the sugars for 120 minutes.

Judges' Comments

"Clean malt profile. Estery, hint of fusels. Low bitterness. Hop flavor – could use a little more of both, though this is optional for style."

"Nice tripel. No real faults to speak of but could use a little more intensity in aroma and flavor."

"Good balance. Complex flavor. Malt sweetness in finish. Alcohol evident but well-balanced."

"Very nice beer. Good example of style. The brothers at Westmalle should be jealous."

"Alcoholic. The malt is there. It finishes a bit sweet. I would like a touch more kettle hops for balance."

Brewer's Comments

Not available.

Runners-up

Silver Medal: Bruce Hammell, Trenton, New Jersey, "L'Hommage Par Hercule Poirot"
Bronze Medal: Kelly Robinson, Ceres, California, "Rhinocopter"

BELGIAN-STYLE LAMBIC

GOLD MEDAL

AHA 1997 Homebrewer of the Year

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by L.D. Carlson Co., Kent, Ohio.

CHARLIE GOTTENKIENY
DALLAS, TEXAS
"LAMBIC 415"
BELGIAN-STYLE LAMBIC

Ingredients for 8 U.S. gal (30.28 L)

14	lb Belgian pale ale malt (6.4 kg)
7	lb rolled wheat (unmalted) (3.18 kg)
1	lb 40 °L crystal malt (0.45 kg)
1 1/2	oz aged Fuggle whole hops, 4% alpha acid (43 g) (120 min.)
	Wyeast No. 1056 American ale yeast
	G.W. Kent *Pediococcus cerevisiae* (secondary)
	G.W. Kent *Brettanomyces lambicus*
3/4	cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.050
- Final specific gravity: 1.016
- Boiling time: 180 min.
- Primary fermentation: 19 days at 70 degrees F (21 degrees C) in glass
- Secondary fermentation: 48 days at 70 degrees F (21 degrees C) in glass
- Age when judged: 16 months

Brewer's Specifics

Mash grains at 155 degrees F (68 degrees C) for two hours.

Judges' Comments

"Oak, brett., some lactic honey and vanilla. Inviting."

"Pretty – deep gold. Great head retention."

"Great clean sourness. Sour brett. Dry aftertaste."

"Great work on a tough style. Clean beer."

"Complex, well-done!"

Brewers' Comments

Gottenkieny stresses that the main thing to remember when brewing a lambic is that it takes a long time – for the yeast and lambic cultures to develop the right flavor profile, aging is critical, as is the order in which they are added to the base beer. Although brewing lambics is a fairly straightforward process, they can be unpredictable. Gottenkieny says he knew when he sampled this batch in January that it was going to be good.

Runners-up

Silver Medal: Bert Zelten, Kewaunee, Wis., (untitled)
Bronze Medal: Ron Raike, Orlando, Fla., "Gueuzish"

MILD AND BROWN ALE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Premier Malt Products, Grosse Pointe, Mich.

STEVE VALLEY
SHELTON, WASH.
"STEVE'S BROWN ALE"
ENGLISH BROWN ALE

Ingredients for 16 1/2 U.S. gal (62.45 L)

19 1/2	lb Great Western two-row malt (8.84 kg)
2	lb Briess wheat malt (0.91 kg)
1/2	lb 50 °L English crystal malt (0.23 kg)
1/2	lb English chocolate malt (0.23 kg)
1	oz Bullion whole hops, 10.2% alpha acid (28 g) (60 min.)
3	oz Fuggle whole hops, 6.1% alpha acid (85 g) (10 min.)
6	oz Fuggle whole hops, 6.1% alpha acid (170 g) (finish)
	Wyeast No. 1028 London ale yeast
	force carbonate in keg

- Original specific gravity: 1.046
- Final specific gravity: 1.008
- Boiling time: 90 min.
- Primary fermentation: four days at 68 degrees F (20 degrees C) in plastic
- Secondary fermentation: three days at 36 degrees F (2 degrees C) in glass
- Age when judged: four months

Brewer's Specifics

Mash grains at 152 degrees F (67 degrees C) for 90 minutes.

Judges' Comments

"Drinkable but needs more body and conditioning."

"Very clean maltiness. Decent complexity. Nutty malt character comes through."

"Very nice brown ale. Not overhopped (a rarity)."

Brewer's Comments

This recipe is loosely based on Newcastle draught ale. Valley tries to emulate English brewing methods as closely as possible, preferring all-English hops, malts and yeast strains. He also open-ferments in plastic buckets and top-crops the flocculent London ale yeast for subsequent batches.

Runners-up

Silver Medal: David Hartwig, Lone Jack, Mo., "Dave's Bitter Brown"
Bronze Medal: Michael Seachrist, North Canton, Ohio, "She Said 'Yes!' Brown Ale"

ENGLISH-STYLE PALE ALE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Wynkoop Brewing Co., Denver, Colo.

DAVID ALLABEN
FISHERS, IND.
(UNTITLED)
CLASSIC ENGLISH PALE ALE

Ingredients for 20 U.S. gal (75.7 L)

29	lb two-row malt (13.6 kg)
2	lb flaked maize (0.91 kg)
1 1/2	lb CaraPils malt (0.68 kg)
1/5	lb German light crystal malt (0.23 kg)
4/5	oz Northern Brewer hops, 9% alpha acid (24 g) (90 min.)
3.37	oz Northern Brewer hops, 9% alpha acid (95 g) (45 min.)
2	oz Nugget hops, 13.7% alpha acid (57 g) (30 min.)
2	oz Kent Golding hops, 5% alpha acid (57 g) (30 min.)
2	oz Styrian Golding hops, 4.5 to 6% alpha acid (57 g) (10-min. steep)
1/2	oz Kent Golding hops, 4.5 to 6.5% alpha acid (14 g) (dry)
	Wyeast No. 1028 London ale yeast
	Polyclar and gelatin (to clarify)
10	qt gyle (9.46 L) (to prime)

- Original specific gravity: 1.058
- Final specific gravity: 1.012
- Boiling time: 90 min.
- Primary fermentation: nine hours at 68 degrees F (20 degrees C) in glass
- Secondary fermentation: seven days at 68 degrees F (20 degrees C) in glass
- Tertiary fermentation: 14 days at 32 degrees F (0 degrees C) in glass
- Age when judged: three months

Brewer's Specifics

Mash at 152 degrees F (67 degrees C) for 90 minutes.

Judges' Comments

"Hop flavor subdued, but still evident."

"Nice English hop character carries from aroma to finish. Could stand slightly more body."

"Lightly malty with good, smooth hop character."

Brewer's Comments

Allaben primes with wort and racks off the trub at high kraeusen. This prevents fusel alcohols, which he believes can affect lighter styles of beer.

Runners-up

Silver Medal: Joseph Styke and Tom Stawarz, Roseville, Mich., "IPA #3"
Bronze Medal: Kenneth Lefkowitz, Blacksburg, Va., "American Indian Pale Ale"

AMERICAN-STYLE ALE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Northwestern Extract Co., Brookfield, Wis.

GARY WESTMAN
SHOREWOOD, MINN.
"BOSTON MARATHON ALE"
AMERICAN-STYLE ALE

Ingredients for 5 U.S. gal (19 L)

9 1/2	lb Crisp Maris Otter malt (4.31 kg)
1/2	lb 40 °L crystal malt (0.23 kg)
1/2	lb 20 °L crystal malt (0.23 kg)
1/2	lb 10 °L crystal malt (0.23 kg)
1/2	lb Munich malt (0.23 kg)
1/2	lb wheat malt (0.23 kg)
1/4	oz Chinook hop pellets, 12.8% alpha acid (7 g) (60 min.)
1/4	oz Chinook hop pellets, 12.8% alpha acid (7 g) (30 min.)
1 1/2	oz Cascade hop pellets, 7% alpha acid (43 g) (30 min.)
1	oz Cascade hop pellets, 4.4% alpha acid (28 g) (two min.)
1 1/2	oz Cascade hop pellets, 4.4% alpha acid (43 g) (dry) (one week)
	Wyeast No. 1084 Irish ale yeast
3/4	cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.054
- Final specific gravity: 1.010
- Boiling time: 90 min.
- Primary fermentation: seven days at 65 degrees F (18 degrees C) in glass
- Secondary fermentation: seven days at 65 degrees F (18 degrees C) in glass
- Tertiary fermentation: seven days at 65 degrees F (18 degrees C) in glass
- Age when judged: three months

Brewer's Specifics

Mash at 154 degrees F (12 degrees C) for 90 minutes.

Judges' Comments

"Fairly high bitterness, some resiny hop character, light maltiness."

"Malty sweetness evident. Hop flavor and bitterness good and lingering."

Brewer's Comments

"I brewed this ale two weeks prior to running the Boston Marathon. Proper care was taken to adjust the pH of natural spring water, which I believe adds to the crispness and clarity of all the beers I brew."

Runners-up

Silver Medal: Mike Rivard, Chicago, Ill., "Alpha Amber Ale"

Bronze Medal: Doug Jeffs, Kaneohe, Hawaii, "Columbus Pale Ale"

ENGLISH BITTER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Alternative Beverage, Charlotte, N.C.

KEN BROWN
FREMONT, CALIF.
"ARDENWOOD EXTRA SPECIAL BITTER"
ENGLISH STRONG (EXTRA SPECIAL) BITTER

Ingredients for 5 U.S. gal (19 L)

9	lb Great Western two-row malt (4.08 kg)
3/4	lb British 17 °L crystal malt (0.34 kg)
1	lb Belgian aromatic malt (0.45 kg)
3	oz Belgian biscuit malt (85 g)
2	oz Belgian Special "B" malt (57g)
1	oz English Fuggle pellet hops, 4.3% alpha acid (28 g) (60 min.)
1 1/2	oz East Kent Golding pellet hops, 6% alpha acid (43 g) (10 min.)
1	oz East Kent Golding pellet hops, 6% alpha acid (28 g) (dry)
	White Labs British ale yeast
1/2	cup corn sugar (118 mL) (to prime)

- Original specific gravity: 1.060
- Final specific gravity: 1.019
- Boiling time: 70 min.
- Primary fermentation: seven days at 70 degrees F (21 degrees C) in glass
- Secondary fermentation: 13 days at 70 degrees F (21 degrees C) in glass
- Age when judged: three months

Brewer's Specifics

Mash grains at 156 degrees F (69 degrees C) for 90 minutes.

Judges' Comments

"Alcoholic warmth is evident."

"Nice beer. Relatively clean. Watch ferment temperatures. Nice malting in flavor, could use a little more hop flavor and bitterness."

"Nice round mouthfeel."

Brewers' Comments

"I was inspired to brew this style after visiting a small microbrewery in Thornton, Colo., [Colorado Brewing Co.] which only brews English-style ales," Brown says. "Using aromatic and biscuit malts along with fresh imported English hops made my homebrew seem almost as good as the ESB I had in Colorado."

Runners-up

Silver Medal: Jim Hilbing, Redondo Beach, Calif., "Jackstone Bitter"

Bronze Medal: Ted Johnston, Phoenixville, Pa., "Henley Bear Bitter"

SCOTTISH ALE

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Beercrafters Inc., Turnersville, N.J.

CHUCK AND NANCY STINER
BELLE PLAINE, KAN.
"C & N SCOTTISH"
SCOTTISH EXPORT ALE

Ingredients for 5 U.S. gal (19 L)

10	lb Briess two-row malt (4.54 kg)
2	lb aromatic malt (0.91 kg)
3/4	lb English 60 °L crystal malt (0.34 kg)
3	oz roasted barley (85 g)
1/2	oz Golding whole hops, 4.7% alpha acid (14 g) (90 min.)
1 1/2	oz Golding whole hops, 4.7% alpha acid (43 g) (60 min.)
	Wyeast No.1728 Scottish ale yeast
	force carbonate in keg

- Original specific gravity: 1.070
- Final specific gravity: 1.022
- Boiling time: 90 min.
- Primary fermentation: 21 days at 55 degrees F (13 degrees C) in glass
- Secondary fermentation: 14 weeks at 55 degrees F (13 degrees C) in glass
- Age when judged: nine months

Brewers' Specifics

Mash grains at 154 degrees F (68 degrees C) for 60 minutes.

Judges' Comments

"Very good malt, good fruit, well-balanced. Complex! Slightly smoky – just right for style – don't add any more."

"This beer is beautiful! I want the recipe."

"Malty as hell, good slight fruitiness. Not a single off-flavor. Good malty sweetness."

"Malt sweetness apparent. Balanced well with bitterness. Supports alcohol well – slighty dry finish."

Brewers' Comments

Stiner has two recommendations for brewing good Scottish styles: First, fermentation temperature is very important. He uses a small freezer, just big enough for a carboy, modified with a thermostat to keep constant temperatures. Second, a good pitching rate should be used for this particular strain of yeast – he suggests at least a half-gallon starter.

Runners-up

Silver Medal: Daniel Darnell, Penn Valley, Calif., "Leather and Lace"

Bronze Medal: Ray Jeno, Hardin, Mont., "Slainte"

PORTER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by The Cellar Homebrew, Seattle, Wash.

JAMES D. WEINER
LA JOLLA, CALIF.
"FAUX PORTER"
ROBUST PORTER

Ingredients for 5 U.S. gal (19 L)

- 9 lb pale malt (4.08 kg)
- 1 lb 10 °L Munich malt (.45 kg)
- 1/2 lb chocolate malt (0.23 kg)
- 1/2 lb black patent malt (0.23 kg)
- 1/2 lb 60 °L crystal malt (0.23 kg)
- 1/2 lb dextrin malt (0.23 kg)
- 1 1/2 oz Kent Golding pellet hops (43g) (60 min.)
- 1/2 oz Kent Golding pellet hops (14 g) (30 min.)
- 1/2 oz Kent Golding pellet hops (14 g) (finish)
- White Labs British ale yeast
- 1 1/4 cup light dry malt extract (296 mL) (to prime)

- Original specific gravity: 1.065
- Final specific gravity: 1.022
- Boiling time: 60 minutes
- Primary fermentation: three days in glass (temperature not available)
- Secondary fermentation: two weeks in glass (temperature not available)
- Age when judged: three months

Brewer's Specifics

Mash at 154 degrees F (68 degrees C) for one hour.

Judges' Comments

"Malty flavors with dark malt bitterness. Nice hop balance. Delicious finish, good balance."

"Very roasty flavor. Smooth finish, some malt sweetness. Appropriate bitterness."

"Good use of dark grain for rich flavor without burnt or astringent flavors. Clean finish."

Brewer's Comments

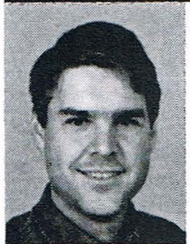
Weiner based this recipe on Charlie Papazian's "Silver Dollar Porter," and has brewed it seven or eight times. Each time he enters it in a competition, he follows the judges' suggestions and makes constant improvements to his recipe and brewing procedure.

Runners-up

Silver Medal: David Ham, Hill AFB, Utah, "Black Widow Porter"

Bronze Medal: Barry Browne, Atlanta, Ga., "Screamer"

ENGLISH AND SCOTTISH STRONG ALE



GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Wine and Hop Shop, Denver, Colo.

TODD WALLINGER
COLORADO SPRINGS, COLO.
"OLD FUZZHEAD"
ENGLISH OLD ALE

Ingredients for 5 U.S. gal (19 L)

- 12 lb William's English light malt extract syrup (5.44 kg)
- 1 oz East Kent Golding pellet hops, 4.65% alpha acid (28 g) (60 min.)
- Wyeast No. 1968 Special London ale yeast
- 1/2 cup corn sugar (118 mL) (to prime)

- Original specific gravity: 1.084
- Final specific gravity: 1.027
- Boiling time: 60 min.
- Primary fermentation: 28 days at 59 degrees F (15 degrees C) in plastic
- Secondary fermentation: 28 days at 64 degrees F (18 degrees C) in glass
- Age when judged: 14 months

Brewer's Specifics

Boil malt syrup with hops for one hour.

Judges' Comments

"Spicy, alcoholic flavors dominate. Malt character is discernible and enjoyable, but could be more forward. Nice malt-hop balance, nice finish."

"Nice beer. A bit solventy, but overall a nice beer for the style."

"Sweet up front then alcohol and hops in the finish."

"Very nice effort, all aspects well-balanced."

Brewer's Comments

"Old Fuzzhead uses a pale malt extract exclusively. The lack of specialty grains and low hop level allow the full, caramel richness of this malt to shine through, while the dryness of the alcohol is used to balance the sweetness of the malt."

Runners-up

Silver Medal: Daniel Darnell, Penn Valley, Calif., "Kilt Lifter"

Bronze Medal: Alan L. Folsom, Jr., Warrington, Pa., "Kirkpatrick's Kilt"

STOUT

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Alternative Garden Supply DBA Brew and Grow, Streamwood, Ill.

DAVID GRAY
WICHITA, KAN.
"NO DOUBT IMPERIAL STOUT"
IMPERIAL STOUT

Ingredients for 8 U.S. gal (30.28 L)

- 16 lb two-row pale malt (7.26 kg)
- 6 lb Munich malt (2.72 kg)
- 4 lb CaraPils malt (1.81 kg)
- 4 lb CaraMunich malt (1.81 kg)
- 3 lb black roast malt (1.36 kg)
- 1 lb chocolate malt (0.45 kg)
- 1 lb wheat malt (0.45 kg)
- 3/5 lb oats (0.27 kg)
- 1/2 lb black patent malt (0.23 kg)
- 1 1/2 oz Nugget whole hops, 11.8% alpha acid (29 g) (60 min.)
- 1/2 oz Chinook whole hops, 11.4% alpha acid (14 g) (60 min.)
- 2 oz Fuggle whole hops, 4.5% alpha acid (57 g) (10 min.)
- 6 1/2 oz Cascade whole hops, 4.9% alpha acid (184 g) (10 min.)
- 1/2 oz Hallertauer whole hops, 6.3% alpha acid (14 g) (finish)
- 1 1/4 oz Fuggle whole hops, 4.9% alpha acid (35 g) (finish)
- Wyeast No. 1084 Irish ale yeast
- force carbonate in keg

- Original specific gravity: 1.102
- Final specific gravity: 1.038
- Boiling time: 60 min.
- Primary fermentation: 10 days at 65 degrees F (18 degrees C) in glass
- Secondary fermentation: 60 days at 65 degrees F (18 degrees C) in glass
- Age when judged: 22 months

Brewer's Specifics

Mash grains at 122 degrees F (50 degrees C) for 30 minutes. Raise temperature to 158 degrees F (70 degrees C) for 90 minutes. Mash-out at 168 degrees F (76 degrees C) for 10 minutes.

Judges' Comments

"Wow! Lots of malt and malty sweetness up front – alcohol is definitely there! Roasted malt bitterness tends to dominate flavor – needs higher hopping to help balance."

"Nice imperial! I'd like it to have a subtle hop character to add complexity and take away the one-dimensional malt character."

"Nice roasty malt – not sweet but not harsh, hop

STOUT

flavor comes through, conditioning low but appropriate; complex aftertaste; sweet, roasty; alcohol well-balanced; rich, some fruit."

"Very nice and well-made. A dry version that I like a lot. No sticky sweetness, no dry astringency."

Brewer's Comments

Gray suggests brewers not sample their imperial stout for at least a year. For "No Doubt," Gray said he used every hop in the house. The first keg tasted fairly "rugged," he said. After a year, though, everything blended together – and he wishes he'd waited for it. Gray also suggests possibly using a different yeast strain, one with more character, like the London ale strain, to bring a bit more of the appropriate fruitiness into the beer's already complex profile.

Runners-up

Silver Medal: Kenny McDonald and Paul Gwin, Germantown, Tenn., "Flight Level Stout"
Bronze Medal: Charles Hessom, Redwood Valley, Calif., "Kitchen Sink Stout"

BOCK

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Washington Hop Commission, Yakima, Wash.

JOHN DENNY
CEDAR RAPIDS, IOWA
"DOPPELBOCK96"
DOPPELBOCK

Ingredients for 4.5 U.S. gal (17 L)

8	lb Munich malt (3.63 kg)
4 1/2	lb Belgian Pilsener malt (2.04 kg)
2 1/2	lb Belgian CaraMunich malt (1.13 kg)
1	lb CaraPils malt (0.45 kg)
1/2	lb dry light malt extract (0.23 kg)
1/4	lb 40 °L crystal malt (0.11 kg)
1 1/2	oz Northern Brewer plug hops, 5% alpha acid (43 g) (45 min.)
1/2	oz Hersbrucker plug hops, 2.6% alpha acid (14g) (10 min.)
	BrewTek East European lager yeast
3/4	cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.086
- Final specific gravity: 1.020
- Boiling time: 60 min.
- Primary fermentation: seven days at 40 degrees F (4 degrees C) in glass
- Secondary fermentation: six weeks at 36 degrees F (2 degrees C) in glass
- Age when judged: 10 months

Brewer's Specifics

Use a single decoction mash for a total of 180 minutes.

Judges' Comments

"Malt character is just right – balance is good. No off-flavors, only a bit high on caramel flavors."

"Great job! Wonderful malt complexity with good balance. Only fault is a bit of caramelized wort taste, or very dark caramel malt."

"Full, almost chewy mouthfeel."

"Very good, sippable beer. Cold night, warm fire, beer ..."

Brewer's Comments

Denny says this recipe was originally intended to be a double-decoction mash, but ended up a single. He plans to brew it the same way in the future. He says it took a long time to age, but the wait was worth it.

Runners-up

Silver Medal: Tom Estudillo, La Canada, Calif., "Accelerator"
Bronze Medal: Michael Iovine, Englewood, N.J., "Hard Bob"

GERMAN DARK LAGER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Homebrew Headquarters, Dallas, Texas

BRUCE STOTT
ROCKVILLE, CONN.
"CLEVELAND DUNKEL"
MUNICH DUNKEL

Ingredients for 5 U.S. gal (19 L)

6	lb pale two-row malt (2.72 kg)
2 1/4	lb Pilsener malt (0.91 kg)
3/4	lb aromatic malt (0.34 kg)
1/2	lb wheat malt (0.23 kg)
1/2	lb CaraVienne malt (0.23 kg)
6	oz CaraPils malt (170 g)
5	oz Belgian Special "B" malt (142 g)
3	oz black patent malt (85 g)
1	oz Hallertauer hops, 4.2% alpha acid (28 g) (60 min.)
1/4	oz Northern Brewer hops, 8.9% alpha acid (7 g) (60 min.)
1/2	oz Hallertauer hops, 4.2% alpha acid (43 g) (30 min.)
	Wyeast No. 2206 Bavarian lager yeast
	force carbonate in keg

- Original specific gravity: 1.055
- Final specific gravity: 1.015
- Boiling time: 60 min.
- Primary fermentation: 10 days at 52 degrees F (11 degrees C) in glass
- Secondary fermentation: seven weeks at 52 degrees F (11 degrees C) in glass
- Age when judged: four months

Brewer's Specifics

Use a single decoction mash.

Judges' Comments

"Malty but with obvious hop presence to balance, noticeable hop flavor in the aftertaste."

"Pleasant golden lager with obvious but not excessive hop presence."

"A fine example of the style except for the excessive conditioning. Nice job!"

Brewer's Comments

Stott has entered the AHA Nationals before and, although he's made to the second round, he's never won a medal. This year, he decided, was the year he'd get a medal, so he named the beer "Cleveland Dunkel." He was right!

Runners-up

Silver Medal: Brian Cole, Black Mountain, N.C., (untitled)
Bronze Medal: Thomas Plunkard, Warren, Mich., "Freundschaft"

GERMAN LIGHT LAGER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Briess Malting Co., Chilton, Wis.

JACK SYKES
OVERLAND PARK, KAN.
"JACKMEISTER'S JOY"
DORTMUNDER/EUROPEAN-STYLE EXPORT

Ingredients for 6 U.S. gal (22.71 L)

- 8 lb Breiss pale two-row malt (3.63 kg)
- 2 lb Belgian Munich malt (0.91 kg)
- 1 lb CaraPils malt (0.45 kg)
- 1 oz chocolate malt (28 g)
- 1 oz Tettnanger hop pellets, 4.4% alpha acid, (28 g) (60 min.)
- 1 oz Hallertauer hop pellets, 3.2% alpha acid, (28 g) (60 min.)
- 3/4 oz Tettnanger whole hops, 4.4% alpha acid (21 g) (30 min.)
- 1 oz Saaz hop pellets, 3.1% alpha acid (28 g) (finish)
- 1 pinch dry yeast energizer
- Wyeast No. 2206 Bavarian lager yeast
- Polyclar (seven days)
- 3/4 cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.052
- Final specific gravity: 1.018
- Boiling time: 75 minutes
- Primary fermentation: six hours at 42 degrees F (6 degrees C) in plastic
- Secondary fermentation: two weeks at 42 degrees F (6 degrees C) in glass
- Tertiary fermentation: two weeks at 38 degrees F (3 degrees C) in glass
- Age when judged: eight months

Brewer's Specifics

Not available.

Judges' Comments

"Malty but with obvious hop presence to balance, noticeable hop flavor in the aftertaste."

"Good malt but hops keep up. Not enough sulfur for a lager."

Brewer's Comments

Sykes believes in using whole hops for their greater overall flavor and aroma and as a filtering agent in the hop-back. His chocolate malt addition was inspired by Charlie Papazian's recommendation for rounding out the character of this style. It is his first Dortmunder.

Runners-up

Silver Medal: Harrison Gibbs, Los Angeles, Calif., "My Munich"
Bronze Medal: Scott Boeke, Aiken, Tenn., "Dort #1"

CLASSIC PILSENER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by American Homebrewers Association, Boulder, Colo.

JESPER SCHMIDT
LIDINGO, SWEDEN
"SCHMIDTBURGER"
GERMAN-STYLE PILSENER

Ingredients for 7.3 U.S. gal (28 L)

- 12 1/2 lb Pilsener malt (5.7 kg)
- 1/2 oz Saaz whole hops, 3% alpha acid (15 g) (first wort)
- 2 1/3 oz Perle hop pellets, 5.3% alpha acid (67 g) (60 min.)
- 1/2 oz Saaz whole hops, 3% alpha acid (15 g) (20 min.)
- 1 1/4 oz Saaz whole hops, 3% alpha acid (35 g) (two min.)
- Wyeast No. 2308 Munich lager yeast
- 1/8 cup corn sugar (3.5 g) (to prime)

- Original specific gravity: 1.047
- Final specific gravity: 1.013
- Boiling time: 75 min.
- Primary fermentation: 23 days at 45 to 48 degrees F (7 to 9 degrees C) in plastic
- Secondary fermentation: 24 hours at 68 degrees F (20 degrees C) in plastic
- Tertiary fermentation: 16 days at 36 degrees F (2 degrees C) in plastic
- Age when judged: four months

Brewer's Specifics

Single-decoction mash: 135 degrees F (57 degrees C) for 55 minutes, raise 1 1/4-gallon (4.5-L) decoction to 149 degrees F (65 degrees C) for 15 minutes, boil decoction and return to the main mash. Stabilize at 152 degrees F (67 degrees C) for 60 minutes, 167-degree-F (75-degree-C) mash out.

Judges' Comments

"Nice and clean. Not quite the whomp of hops I had anticipated from the nose. Dry. Well attenuated. Could use a touch more unfermentable sweetness."

"More malt and hop necessary to make it great. Watch priming sugar or bottling time."

Brewer's Comments

"Good brewing is a balance between art, handicraft and science – if you forget one of these elements or let one take over, you're likely to end up with either problematic or uninteresting beer," Schmidt says.

Runners-up

Silver Medal: George Fix, Arlington Texas, "Pre-Pro"
Bronze Medal: Dave Shaffer, Lafayette, Colo., "Lizard Head Lager"

AMERICAN LAGER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Pabst Brewing Co., Milwaukee, Wis.

GERALD M. POSS JR.
FISH CREEK, WIS.
"AN AMERICAN BEER HERO"
AMERICAN LAGER/ALE OR CREAM ALE

Ingredients for 5 U.S. gal (19 L)

- 6 lb American two-row malt (2.72 kg)
- 1 1/5 lb rice syrup (0.54 kg)
- 1/2 lb CaraPils malt (0.23 kg)
- 1/2 lb wheat malt (0.23 kg)
- 1/4 oz Cluster hop pellets, alpha acid 6.8% (7 g) (60 min.)
- 1/2 oz Tettnanger hop pellets, alpha acid 4.4% (14 g) (two min.)
- Wyeast No. 2035 American lager yeast
- 1 cup corn sugar (237 mL) (to prime)

- Original specific gravity: 1.044
- Final specific gravity: 1.006
- Boiling time: 60 min.
- Primary fermentation: seven days at 65 to 70 degrees F (18 to 21 degrees C) in glass
- Secondary fermentation: 12 days at 45 degrees F (7 degrees C) in glass
- Age when judged: three months

Brewer's Specifics

Mash grains for 30 minutes at 122 degrees F (68 degrees C). Raise temperature to 146 degrees F (63 degrees C) and hold for 60 minutes. Raise to 152 degrees F (67 degrees C) and hold 30 minutes. Raise to 158 degrees F (70 degrees C) and hold 15 minutes. Mash-out at 170 degrees F (77 degrees C).

Judges' Comments

"Nice hop balance. Great finish. Clean and crisp."

"Nice light thirst-quenching beer. Good example of the style."

Brewer's Comments

Not available.

Runners-up

Silver Medal: Pat Kennedy, Overland Park, Kan., "B42 – Untouchable Pilsener"
Bronze Medal: Terry Durant, Westminster, Colo., "Cruzin' Cream Ale"

VIENNA/MÄRZEN/ OKTOBERFEST

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by F.H. Steinbart, Portland, Ore.

PAUL SHICK
CLEVELAND HEIGHTS, OHIO
"VIENNA HEIGHTS"
VIENNA

Ingredients for 5 U.S. gal (19 L)

- 3 lb Hugh Baird Pilsener malt (1.36 kg)
- 3 lb Gambrinus Munich malt (1.36 kg)
- 3 lb Briess two-row malt (1.36 kg)
- 1 1/2 lbs Hugh Baird Vienna malt (0.68 kg)
- 1/2 lb Hugh Baird 50 °L crystal malt (0.23)
- 1/2 lb two-row malt, toasted 20 minutes (0.23 kg)
- 1/2 oz Hallertauer pellet hops, 4.1% alpha acid (14 g) (preboil)
- 3/4 oz Hallertauer pellet hops, 4.1% alpha acid (21 g) (60 min.)
- 3/4 oz Hallertauer pellet hops, 4.1% alpha acid (21 g) (15 min.) Wyeast No. 2206 Bavarian lager yeast
- 4 1/2 oz corn sugar (128 g) (to prime)

- Original specific gravity: 1.055
- Final specific gravity: 1.010
- Boiling time: 70 min.
- Primary fermentation: 22 days at 50 to 55 degrees F (10 to 13 degrees C) in plastic
- Secondary fermentation: 16 days at 45 to 50 degrees F (7 to 10 degrees C) in glass
- Age when judged: seven months

Brewer's Specifics

Step mash: 122 degrees F (50 degrees C) for 20 minutes, 140 degrees F (60 degrees C) for 20 minutes, 157 degrees F (69 degrees C) for 40 minutes. Mash-out at 168 degrees F (76 degrees C).

Judges' Comments

"I like the maltiness. It's a bit complex. Right in line on the balance – finishes a little dry – good beer."

"Bigger than style. I really love this, but the strength of maltiness and alcohol detract from style."

Brewer's Comments

Not available.

Runners-up

Silver Medal: Wayne Burgstahler, Napa, Calif., "Märzen"

Bronze Medal: John D. Watson, Ridgefield, Conn., "Marzfest"

GERMAN-STYLE ALE

GOLD MEDAL

1997 Ninkasi Award Winner

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by H.C. Berger, Fort Collins, Colo.

GEORGE FIX
ARLINGTON, TEXAS
"BONN-BONN"
KOLSCH

Ingredients for 13.5 U.S. gal (51 L)

- 17 lb Pilsener malt (7.71 kg)
- 3 lb wheat malt (1.36 kg)
- 1 lb crystal malt (0.45 kg)
- 1 1/2 oz German Tradition whole hops, 5% alpha acid (43 g) (45 min.)
- 1 1/2 oz German Select whole hops, 4% alpha acid (43 g) (45 min.)
- 1 1/2 oz German Tettnanger whole hops, 3% alpha acid (43 g) (30 min.) WLP 001 lager yeast force carbonate in keg

- Original specific gravity: 1.048
- Final specific gravity: 1.012
- Boiling time: 90 min.
- Primary fermentation: seven days at 68 degrees F (20 degrees C) in stainless steel
- Secondary fermentation: four weeks at 50 degrees F (10 degrees C) in stainless steel
- Age when judged: one month

Brewer's Specifics

Mash grains at 104 degrees F (40 degrees C) for 90 minutes. Raise temperature to 140 degrees F (60 degrees C) and hold for 90 minutes. Raise to 158 degrees F (70 degrees C) and hold for 60 minutes.

Judges' Comments

"Little sweetness. Hop bitterness in finish, dry aftertaste."

"Nice balance, good malt profile, hops maybe a bit aggressive for style."

"A very nice beer. Good depth, nice overall balance, well-made and cared for – good job."

Brewer's Comments

Fix's opinion on Kölsch is that "slightly bigger is better." From his travels to Cologne, where the style originated, Fix thinks true, commercial examples of Kölsch are hoppier and maltier than described in the AHA style guidelines. The wheat is also an important element for achieving an authentic Kölsch character.

Runners-up

Silver Medal: Marc Kullberg, Lisle, Ill., "Marc's Alt"

Bronze Medal: Bruce Stott, Rockville, Conn., "3rd Alt"

GERMAN-STYLE WHEAT BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Tabernash Brewing Co., Denver, Colo.

TOM BELL
PARKER, COLO.
WEIZEN

Ingredients for 10 U.S. gal (37.85 L)

- 10 lb Briess wheat malt (4.54 kg)
- 9 lb Briess pale two-row malt (4.08 kg)
- 1 lb six-row malt (0.45 kg)
- 1 1/4 oz Perle whole hops, 8.4% alpha acid (35 g) (75 min.) Wyeast No. 3068 Weihenstephan wheat ale yeast
- 3/4 cup corn sugar per 5 gal (177 mL per 19 L) (to prime)

- Original specific gravity: 1.052
- Final specific gravity: 1.011
- Boiling time: 75 min.
- Primary fermentation: seven days at 58 degrees F (14 degrees C) in glass
- Secondary fermentation: 12 days at 58 degrees F (14 degrees C) in glass
- Age when judged: four months

Brewer's Specifics

Mash grains at 122 degrees F (50 degrees C) for 30 minutes. Raise temperature to 154 degrees F (68 degrees C) and hold for 60 minutes. Mash-out at 170 degrees F (77 degrees C) for five minutes.

Judges' Comments

"Bubble-gum nose, banana, hint of clove."

"Nice phenol palate."

Brewer's Comments

Bell believes water quality to be particularly important in the brewing process – he uses carbon-filtered water. He uses authentic German strains of yeast for his hefe-weizens, and has recently invested in a wort recirculation pump to improve the quality of his beers.

Runners-up

Silver Medal: Mike Rivard, Chicago, Ill., "Amber Waves"

Bronze Medal: Chas Peterson and Tom Bergman, Laytonsville, Md., "Two Fools' Hefe Weizen"

SMOKED BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Jim's Homebrew Supply, Spokane, Wash.

JEFF GLADISH
TAMPA, FLA.
"#87"
OTHER SMOKED BEER

Ingredients for 5 U.S. gal (19 L)

- 6 lb British two-row beech-smoked malt (2.72 kg)
- 2 lb British two-row pale malt (0.91 kg)
- 1/2 lb 10 °L crystal malt (0.23 kg)
- 1/2 lb Belgian Special "B" malt (0.23 kg)
- 1/2 lb CaraMunich malt (0.23 kg)
- 4 oz chocolate malt (113 g)
- 3 oz black patent malt (85 g)
- 1 oz East Kent Golding hop pellets, 4.5% alpha acid (28 g) (60 min.)
- 3/4 oz Yakima Hallertauer pellets, 3.5% alpha acid (21 g) (45 min.)
- 1/2 oz Yakima Hallertauer pellets, 3.5% alpha acid (14 g) (30 min.)
- 1/2 oz East Kent Golding pellets, 4.5% alpha acid (14 g) (15 min.)
- 1/2 oz East Kent Golding pellets, 4.5% alpha acid (14 g) (five min.)
- Wyeast No. 1318 London Ale III yeast culture
- 3/4 cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.055
- Final specific gravity: 1.017
- Boiling time: 75 min.
- Primary fermentation: two weeks at 64 degrees F (18 degrees C) in glass
- Secondary fermentation: one week at 64 degrees F (18 degrees C) in glass
- Age when judged: nine months

Brewer's Specifics

Mash at 119 degrees F (48 degrees C) for 30 minutes, 153 degrees F (67 degrees C) for one hour.

Judges' Comments

"Roasted malts and smoke dominate. No hop flavor. Hop bitterness balances with malt smokiness."

"Leather aroma and some beechwood."

Brewer's Comments

"This beer was designed as a smoked porter, but luckily for me a local judge suggested 'smoked other.'" Gladish says.

Runners-up

Silver Medal: Brian Beckmann, Andover, N.J., "Smoker Porter"
Bronze Medal: Mike Bardallis, Allen Park, Mich., (untitled)

FRUIT AND VEGETABLE BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Purple Foot, Milwaukee, Wis.

GREGORY S. HERMAN AND HAI T. MAI
RICHLAND, WASH.
"GRACE'S ORCHARD"
CLASSIC-STYLE FRUIT BEER

Ingredients for 5 U.S. gal (19 L)

- 6 lb Liberty Malt Supply English light malt extract (2.72 kg)
- 1/2 lb English light crystal malt (0.23 kg)
- 2 oz Mount Hood pellet hops, alpha acid 5.3% (57 g) (60 min.)
- 1 oz Willamette pellet hops, 5.5% alpha acid (28 g) (30 min.)
- 1 oz Willamette pellet hops, alpha acid 5.5% (28 g) (two min.)
- Muntons brewing yeast
- 2 oz F.H. Steinbart peach flavoring (57 g) (at bottling)
- 3/4 cup corn sugar (177 mL) (to prime)

- Original specific gravity: 1.051
- Final specific gravity: 1.023
- Boiling time: 60 min.
- Primary fermentation: five days at 70 degrees F (21 degrees C) in glass
- Secondary fermentation: 17 days at 70 degrees F (21 degrees C) in glass
- Age when judged: four months

Brewer's Specifics

Steep crystal malt at 170 degrees F (77 degrees C) for 30 minutes. Boil malt extract with hops for 60 minutes. Bottle with peach flavoring and priming sugar.

Judges' Comments

Not available.

Brewer's Comments

Hermanprefers to use fruit extracts added at bottling to give his beers the freshest fruit flavor. He has used fresh fruit as well, but says adding puree before fermentation does not allow the more aromatic fruit qualities to stay in the beer.

Runners-up

Silver Medal: Dennis and Paul Waltman, Atlanta, Ga., "Old Grizzly Raspberry Ale"
Bronze Medal: Thomas J. O'Connor III, M.D., Rockport, Maine, "J. Duck's Peach American Wheat Ale"

HERB AND SPICE BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Marin Brewing Co., Larkspur, Calif.

PAUL SULLIVAN
BROOKLYN, N.Y.
"FEELING THE BINCH"
CLASSIC-STYLE HERB AND SPICE BEER

Ingredients for 6 1/2 U.S. gal (24.6 L)

- 17 lb DeWolf-Cosyns pale malt (7.71 kg)
- 4 lb DeWolf-Cosyns CaraMunich malt (1.81 kg)
- 8 oz DeWolf-Cosyns CaraVienne malt (227 g)
- 6 oz DeWolf-Cosyns aromatic malt (170 g)
- 1 1/2 oz Willamette whole hops, 4.9% alpha acid (43 g) (70 min.)
- 1/2 oz Kent Golding whole hops, 4.8% alpha acid (14 g) (30 min.)
- 3/4 lb candi sugar (0.34 kg) (30 min.)
- 1/2 oz sweet orange peel (14 g) (15 min.)
- 1 oz coriander (28 g) (15 min.)
- 1/2 oz Styrian Golding hops, 3.8% alpha acid (14 g) (five min.)
- 1/2 oz coriander (14 g) (five min.)
- La Chouffe ale yeast culture
- force carbonate in keg

- Original specific gravity: 1.092
- Final specific gravity: 1.022
- Boiling time: 60 min.
- Primary fermentation: seven days at 70 degrees F (21 degrees C) in glass
- Secondary fermentation: two weeks at 50 degrees F (10 degrees C) in glass
- Tertiary fermentation: five months 32 degrees F (0 degrees C) in keg
- Age when judged: two weeks

Brewer's Specifics

Mash at 154 degrees F (68 degrees C) for 90 minutes.

Judges' Comments

"Complex melange of malt, treacle, fruit, coriander and orange. Orange predominates at finish."

"Nice Belgian yeast character, big orange, coriander is surprisingly secondary."

Brewer's Comments

Not available.

Runners-up

Silver Medal: Ron Kline, Cupertino, Calif., "Picante Pilsener"
Bronze Medal: Mark J. Messmer, Wichita, Iowa, "Jamocha Holiday Brew"

SPECIALTY AND EXPERIMENTAL BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by U Brew Corp., Millburn, N.J.

JOE NEWCOMER
LAS CRUCES, N.M.
"BRYCES HONEY LAGER"
CLASSIC-STYLE SPECIALTY BEER

Ingredients for 5 U.S. gal (19 L)

4	lb Muntons light dry malt extract (1.81 kg)
2	lb clover honey (0.91 kg)
1	oz Hallertauer Hersbrucker whole hops, 4.2% alpha acid (28 g) (60 min.)
2/5	oz Hallertauer Hersbrucker whole hops, 4.2% alpha acid (11 g) (30 min.)
1/4	oz Hallertauer Hersbrucker whole hops, 4.2% alpha acid (14 g) (five min.)
	Wyeast No. 2124 Bohemian lager yeast
	force carbonate in keg

- Original specific gravity: 1.046
- Final specific gravity: 1.010
- Boiling time: 75 min.
- Primary fermentation: 34 days at 46 degrees F (8 degrees C) in glass
- Secondary fermentation: 29 days at 40 degrees F (4 degrees C) in glass
- Tertiary fermentation: 30 days at 34 degrees F (1 degree C) in keg
- Age when judged: three months

Brewer's Specifics

Boil extract and honey for 75 minutes.

Judges' Comments

"Sweet malt, some DMS, subtle honey aroma comes through. Delicate hop aroma."

"This is a very good Pilsener. The mesquite honey works in the nose, but dries out the beer a bit much. Very enjoyable beer."

"Honey adds nice touch to flavor profile."

"Nice drinkable and very clean beer. Good effort!"

Brewer's Comments

"I hadn't brewed an extract batch for so long I had forgotten how easy it is," Newcomer says. "Use reverse-osmosis water with just a pinch of gypsum for this beer. Be sure to remove the cold break trub, and don't forget a diacetyl rest before lagering."

Runners-up

Silver Medal: Jack Miller, Casper, Wyo., "Peachy Keen Wheat"
Bronze Medal: David Zukoff, Alvin, Texas, "Alvin Style Breakfast Stout"

CALIFORNIA COMMON BEER

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Anchor Brewing Co., San Francisco, Calif.

ERIC P. CHRISTENSEN
ANNAPOLIS, MD.
"GYPSY STEAM"
CALIFORNIA COMMON BEER

Ingredients for 5 U.S. gal (19 L)

6 3/5	lb Northwestern gold malt extract (3 kg)
1	lb light dry malt extract (0.45 kg)
1	lb CaraMunich malt (0.45 kg)
6	oz toasted Munich malt (170 g)
1	oz Cluster pellet hops, 6.5% alpha acid (28 g) (60 min.)
1/2	oz Cluster pellet hops, 6.5% alpha acid (14 g) (30 min.)
1/2	oz Cascade pellet hops, 4.4% alpha acid (14 g) (30 min.)
1/2	oz Hallertauer pellet hops, 3.5% alpha acid (14 g) (10 min.)
1/2	oz Cascade pellet hops, 6% alpha acid (dry)
	Wyeast No. 2112 California lager yeast
	force carbonate in keg

- Original specific gravity: 1.054
- Final specific gravity: 1.013
- Boiling time: 60 min.
- Primary fermentation: seven days at 60 degrees F (16 degrees C) in glass
- Secondary fermentation: three weeks at 40 degrees F (4 degrees C) in glass
- Age when judged: three months

Brewer's Specifics

Steep CaraMunich and toasted Munich malts at 155 degrees F (68 degrees C) for 35 minutes.

Judges' Comments

"Clean, light malt aroma with some hops."

"Fresh, pleasant, woody hop aroma, some toasty and caramel notes."

Brewer's Comments

Touring Anchor Brewing Co. gave Christensen great insights into brewing this style. He says temperature is critical to the proper character, as is a three-week lagering period. He prefers a mix of lager and ale hops and suggests torrified wheat to improve head retention.

Runners-up

Silver Medal: Jim Dilldine, Craig, Colo., "Cold Springs Steamer"
Bronze Medal: Bob Thompson, Murrieta, Calif., "California Gold"

TRADITIONAL MEAD AND BRAGGOT

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Brandywine Farms, Novi, Mich.

AL KORZONAS
PALOS HILLS, ILL.
"NEW BUFFALO LINDEN TREE MEAD"
STILL TRADITIONAL MEAD

Ingredients for 4 U.S. gal (15.14 L)

11 1/2	lbs linden tree honey (5.22 kg)
3	gal water (11.36 L)
	Premier Cuvée yeast
2	tsp Fermax™ yeast energizer

- Original specific gravity: 1.116
- Final specific gravity: 1.004
- Boiling time: none
- Primary fermentation: six months at 65 to 70 degrees F (18 to 21 degrees C) in glass
- Age when judged: two weeks

Brewer's Specifics

Add the linden tree honey to boiling water and remove from heat. Stir, chill to 65 degrees F (18 degrees C) oxygenate and pitch yeast.

Judges' Comments

"Very aromatic. You have captured linden/basswood very adeptly."

"I like linden and I like this. Good balance of acid/honey flavor and mouthfeel. Good aging and conditioning. No pronounced off-notes. Flavor matches aroma well."

"Beautiful mead. Congratulations."

"Very complex, balanced flavors. Slightly hot, big body. Honey and grape come through. Woody tones. Excellent."

"Very complex, would love a full bottle. Excellent complexity."

Brewer's Comments

"The mead maker's specifics are extremely simple. The key is the varietal honey."

Runners-up

Silver Medal: Thomas J. O'Connor III, M.D., Rockport, Maine, "J. Duck's Sparkling Mead"
Bronze Medal: Ron Johnson, San Diego, Calif., (untitled)

FRUIT AND VEGETABLE MEAD

GOLD MEDAL

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by the National Honey Board, Longmont, Colo.

ROBERT WIKSTROM
DERBY, KAN.
(UNTITLED)
SPARKLING CYSER

Ingredients for 5 U.S. gal (18.93 L)

- 10 lb honey (4.54 kg)
- 4 gal apple juice (15.4 L)
- 8 cinnamon sticks
- Wyeast No. 2206 Bavarian lager yeast
- 1 cup honey (237 mL) (to prime)

- Original specific gravity: not available
- Final specific gravity: 1.030
- Boiling time: five min.
- Primary fermentation: 21 days at 68 degrees F (20 degrees C) in glass
- Secondary fermentation: 21 days at 68 degrees F (20 degrees C) in glass
- Age when judged: four months

Brewer's Specifics

Boil the honey and apple juice for five minutes.

Judges' Comments

"Sweet honey flavor with quite a lot of apple flavor and a more subtle cinnamon edge than I expected, given the aroma profile. Balanced, but definitely to the sweet side."

"Outstanding drink! Nice, well-balanced flavor."

"Sweet up front. Definitely a fresh cinnamon-stick flavor here. Could use a bit more acidity to support the sweetness."

Brewer's Comments

Wikstrom says this is a simple recipe to make. Just heat and skim the honey. He keeps his apple juice refrigerated so when the two are combined, the temperature equalizes perfectly for pitching. He also says you don't necessarily need to use a lager yeast – wine or mead yeast may be substituted, depending on how dry you want the finished cyser.

Runners-up

Silver Medal: Byron Burch and Neva Burch, Santa Rosa, Calif., "Tandem #1"
Bronze Medal: Gunther Jensen, Pacoima, Calif., "Arabian Nights"

HERB AND SPICE MEAD

GOLD MEDAL

1997 Meadmaker of the Year

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Golden Grail Meadery, Dallas, Texas

RON BADLEY
RENO, NEV.
"CINCO DE MEADO"
STILL METHEGLIN

Ingredients for 1 U.S. gal (3.79 L)

- 5 lb Joanne's Apiary crimson clover honey (2.27 kg)
- 1 gal water (3.79 L)
- Lalvin No. 1118 and 1122 yeast
- 3/4 tsp yeast nutrient (3.7 mL)
- 1 to 2 chipotle chiles (smoked jalapeño peppers), chopped

- Original specific gravity: 1.155
- Final specific gravity: 1.040
- Boiling time: five min.
- Primary fermentation: eight days at 80 degrees F (27 degrees C) in glass
- Secondary fermentation: 30 days at 60 to 80 degrees F (16 to 27 degrees C) in glass
- Age when judged: 20 months

Brewer's Specifics

Boil honey and water for five minutes and cool.

Judges' Comments

"Get the honey; pepper would be unidentifiable if I didn't know it was there. It comes out after it warms up a bit."

"Good fruity honey character. Chili pepper has an interesting warming in the finish."

"Good spicy honey aroma. Noticed subtle smoke."

"Good honey expression. Nice applelike tone. Very clean. Pepper obvious, yet smokiness is not unpleasantly phenolic. Sugars and smoke in good balance. Good acidity."

Brewer's Comments

Badley's winning chipotle mead started out as a high-gravity traditional mead. The crimson clover honey he used was from an Oregon apiary – the quality of the honey makes all the difference in the fine floral aroma in mead, Badley says. His son David helped him adjust the level of spiciness in "Cinco de Meado."

Runners-up

Silver Medal: James A Gebhardt, Carl Eidbo, Ray Taylor and James Jordahl, Fargo, N.D., "Mint Mead"
Bronze Medal: Eric Drake and J. Woody Drake, Columbus, Ohio, "Apple Pie Metheglin"

CIDER

GOLD MEDAL

1997 Cidermaker of the Year

AHA 1997 NATIONAL HOMEBREW COMPETITION

Category award sponsored by Lyon's Brewery of Dublin, Dublin, Calif.

FRANK A. SALT
STATEN ISLAND, N.Y.
"FARMER GREY'S CRAZY RABBIT SPARKLING CIDER"
SPARKLING CIDER

Ingredients for 5 U.S. gal (19 L)

- 3 gal Cortland, Rome, Stamen and Winesap apple juice (11.4 L)
- 1 gal Red Delicious and Macintosh apple juice (3.8 L)
- 3 qt Jonathan apple juice (2.8 L)
- 1 qt crabapple juice (0.9 L)
- 2 lb corn sugar (0.91 kg)
- 1 lb brown sugar (0.45 kg)
- Wyeast No. 1056 American ale yeast culture
- 8 Campden tablets (55% sulfur dioxide)
- force carbonate in keg

- Original specific gravity: 1.064
- Final specific gravity: 1.014
- Boiling time: none
- Primary fermentation: 48 hours at 68 degrees F (20 degrees C) in glass
- Secondary fermentation: 30 days at 68 degrees F (20 degrees C) in glass
- Tertiary fermentation: two days at 33 degrees F (1 degree C) in glass
- Age when judged: not available

Brewer's Specifics

Blend all ingredients except 1056 ale yeast. Pitch 1056 after 48 hours. Rack, force carbonate and lager for two days.

Judges' Comments

Not available.

Brewer's Comments

Salt's brew club, The Homebrewers of Staten Island, went to several orchards for the special blend of juice used in this recipe. They procured 300 gallons of juice and split it up among the members. He believes the variety of apples used – some for tartness, some for aromatics, and some for astringency – contributed to its success. In spite of the quality of this cider, Salt considers himself a beer brewer.

Runners-up

Silver Medal: Rocky and Charles Bennett, Enid, Okla., "CranApple"
Bronze Medal: Thomas J. O'Connor, III, M.D., Rockport, Maine, "J. Duck's Sweet Still Cider"

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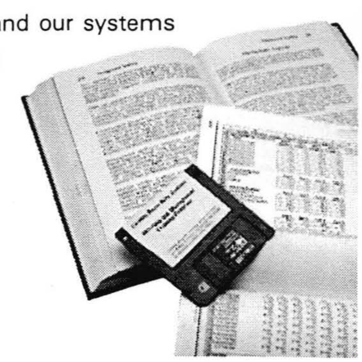

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