Amateur Brewer Communications

HOPS
Revisited—
A Special Issue

FOR THE SERIOUS HOME BREWER

Amateur Brewer No. 12 Winter-Spring 1985

Let's welcome a new face to home brewing.

The Dutch have always loved a drop of beer. So it's hardly surprising they're so gifted at brewing it.

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LAAGLANDER

3 new recipes from Holland brought to you by

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Cover: Branch of Female Hops, from Herbert Myrick's *The Hop*, 1899 print.

Amateur Brewer Communications No. 11 Published by Fred Eckhardt
1985 Winter & Spring
Editor: Fred Eckhardt
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"We glory in the title Amateur." G.K. Chesterton.

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TALK to your BEER

Well, I tried to get this issue out on time, but as you can see.... Nevermind, we have a really fine issue here, one with more than you wanted to know about hops. It's OK, hops are a fascinating subject, and up-to-date information is scarce. This issue should be very helpful to home brewers, amateur brewers, and even microbrewers. When I did my first research on hops back in 1972, there was not much I could do besides tell folks about the various possibilities, and hop types. That was an article in the old Amateur Enologist, a Canadian Publication by Stan Anderson. When the new hop information was published, it did not take long to get suppliers educated, and before long the varieties of hops available to homebrewers began to grow, until there was quite a supply to be found all over the U.S. and in Canada, too. Then we published our last Hop issue, AB No. 4, in 1977, and there was another quantum leap forward. Now, we are doing a complete update,

(continued on page 31)

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If there's a red dot on your label, you've expired. Send money ($9, if by June 30) to renew (add $3 if you live in Canada). If you are also a **Listen to Your Beer** subscriber, and you wish to renew that publication, add another $9. (That's $18 to renew both).

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Contributors: Lee Coe, Dr. Terry Foster, Pat McMullen, and Dave Wills.

HOPMANIA

by Dave Wills, ©1985

Hops are a rough twining vine, native to South America, North America, and Eurasia. Small male and female flowers are borne on separate plants. Only the dried female hop flowers are used to flavor beer. The raw flowers are often incorrectly referred to as leaf hops. Hop leaves are of no brewing value and are only infrequently found in a bag of raw hops.

Being native to many parts of the world, hops have a diverse genetic background. When hops were first added to beer, brewers used whatever variety was available locally. Today native varieties are still a major contributor to the characteristic flavor of beers from different countries. German lagers rely mainly upon German Hallertau, Herrsbrucker, Tettnanger, Spalt, and Northern Brewer hops. English ales are brewed with English Bullion, Fuggle, and Golding hops. Australian beer is hopped almost exclusively with Pride of Ringwood hops. American beer, historically, has been hopped with the Cluster variety along with a combination of domestic and imported varieties. There are presently over 100 cultivated varieties of hops used around the world.

In the last 15 years new varieties of hops have emerged from hop breeding programs around the world. New varieties have been used by brewers to obtain new flavors, (i.e. Cascade), but also to assist the hop grower with the many new higher yielding and disease-resistant varieties. The Willamette (Wi·lam' it) was recently developed to improve the low yielding Fuggle. It maintains the same flavor profile but has greater acreage yield, along with a slightly higher alpha content. The German Hallertau hop is currently declining in acreage, not because of decreased demand but due to being decimated by the, so far incurable, disease, verticillium wilt. The resistant variety hersbrucker has replaced Hallertauer as Germany's main aromatic variety. Current research is aimed at developing a higher yielding, disease resistant,

Hallertau variety at the USDA hop farm in Corvallis, OR. New varieties developed at Wye College in England are replacing Fuggle and Bullion. These are Wye Challenger, Wye Target, and Wye Northdown.

Some brewers are only interested in basic hop bitterness (alpha acid). They use hop extract in 5 gallon cans. Extract is a major hop product, as it occupies much less volume in shipping and storage, and has a stable and consistent alpha acid. With hop extract there are no spent hops to deal with and no cold storage required. This market, which until recently was met with the unstable Bullion and Brewers Gold (alpha 7-8%), has been changed to the point where these varieties are obsolete, in favor of the new high alpha (12-16%) varieties such as Eroica, Galena, and Nugget.

Hops produce a golden yellow powder known as lupulin. These tiny waxy coated resin glands contain all of the hop's bitter alpha and beta acids, as well as over 200 aromatic oil components. Heat and oxygen deteriorate the lupulin and, for this reason, hops should be stored as cold as possible in a plastic bag or sealable container.

The hop pellet was invented to prevent alpha deterioration. Whole raw hops are hammer-milled into a powder, and pressed through a die, to create the pellets which are then vacuum packaged in 44 lb. (20-kg) foil bags. Do you buy hop pellets in a vacuum sealed package? In the pellet form, alpha acid does remain more stable than in raw hops. Unfortunatley there are some disadvantages to the hop pellet. During the pelletization process the waxy coated lupulin glands are ruptured and blended with the green petal material. The lupulin acts as a glue as the hops are rammed through the die. Heat of friction, from the process, as well as gland rupture, volatilizes many of the hop's aromatic oil components. Many of these oils may well have contributed to the flavor and aroma of a beer. Properly stored pellets are good for bittering but do not compare to raw hops for finishing.

What is a good hop? Selecting a good variety does not necessarily mean selecting a good hop. Quality is first determined in the field, where the hop must be pest and disease free, and also harvested, at optimum ripeness, in clear weather. Drying also affects quality, as too high and prolonged a temperature will cause deterioration as well as shattering of the hop cone. once in the bale, a quality hop is maintained through dry cold storage at below 36° F.

When examining the hop, the color should be green or green with tinges of golden yellow depending on the variety. Aroma is very important and is easily tested by crushing the hop between your fingers rupturing the lupulin gland. The aroma should be aromatic, clean, and characteristic of the variety. Old hops smell bland, musty, and stale. Quality hops are the key to producing a quality brew. Educate your nose and do not take hops for granted. True hop heads taste-test varieties and enjoy hops by putting a pinch of them between the cheek and gums; try it!

***

Dave Wills, of Corvallis, Oregon, was born in Minnesota, and graduated from Santa Paula (California) High School. He has a B.S. in General Agriculture from Oregon State University (1980). Dave has been a homebrewer for four years, and has worked on hop farms, and at the USDA Hop Research Farm in Corvallis. Dave Wills is a small-time hop grower, and is the owner of **FRESHOPS** (see advertisement). He also works part time in solar heating and as a painter. He has contributed to *Zymurgy* (Spring '83), and hopes, someday, to grow hops and barley and build and operate a solar powered brewery.

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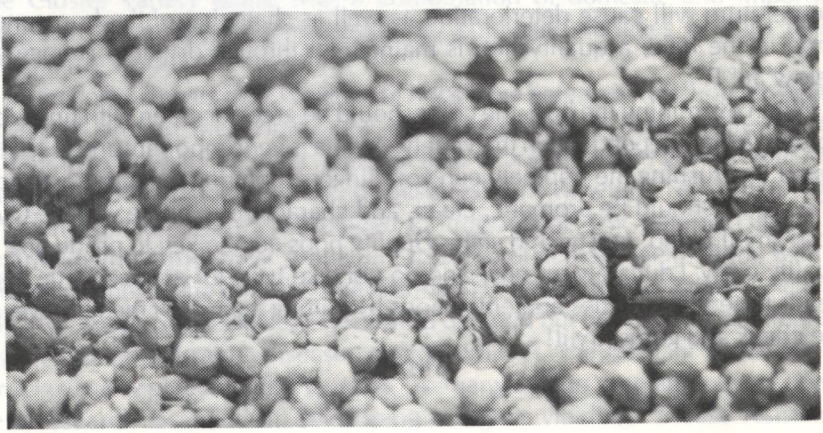


GROW YOUR OWN HOPS

by Pat McMullen, © 1985, all rights reserved

All this talk of fine hops and amazing beers may lead you down to your local supplier. But wait, all he has are *Cascades*, *Clusters*, and something yellowish brown labelled *Saaz*. Chances are it won't be this bad, but with a little bit of a green thumb and a sunny location you can have the freshest hops in town.

Colonists to the new world brought hops with them and also discovered indigent varieties. Hops have been cultivated across the US although their commercial range is between the 38th and 50th parallels. This doesn't mean hops won't grow outside of these extremes, only that they won't be as vigorous. The hop loves rich alluvial or sandy loam soil, fertilizer, water, light, heat and cultivation. Ideally they want a climate with 14+ hours of summer sun, temperatures up to 100° F, under 3000 feet elevation, and winters that don't freeze soil below a couple of inches. Don't despair, few things are ideal, and the hop is a hardy plant which survives up to 7000 feet, up to 115°F, down to −30° F. The things a hop hill does require are under your control; cultivation, fertilization, and plenty of water.

The hop is propagated from cuttings to maintain varietal integrity. The most common practice is to take root cuttings in the early spring, as they store and transport well. Commercial growers may put up to 5 rhizomes per hill, but a planting of 2 per hill is a relatively sure way of establishing a particular variety. A mature hill, of a vigorous variety of hops, trained on an 18' trellis will yield up to 31 lbs. of dry hops.

Hop varieties are generally divided into bittering and aromatic (flavoring) types; those over 6.5% alpha-acid are used as bittering hops by the home-brewer with desirable results; conversely the *Northern Brewer* with an alpha-acid of 9.5% makes a good aromatic, used in moderation. Bittering types generally have a high yield and strong aroma, while recent aroma hop releases have better yields and a higher alpha. In making your decision, on which hop to plant, another prime consideration is the harvest date; early hops mature by mid August while late varieties are harvested a month later. As you will be hand picking and using a small dryer it is crucial that you spread out the harvest.

TABLE I

ALPHA ACID GROWTH HABITS AND MATURATION OF SELECT HOPS

%∝	Variety	Habits	Harvest	Origin
14	*Nugget*	vigorous	middle	Oregon St. (§1980)
13	*Chinook*	vigorous	middle	USDA Wash. (1985)
10	*Bullion*	vigorous	middle	England* (1938)
9.5	*Brewers Gold*	vigorous	late	England* (1934)
9.5	*N. Brewer*	moderate	early	England* (1935)
6	*Cascades*	vigorous	middle	Oregon St. (1972)
5.5	*Hersbrucker*	vigorous	late	Germany (?)
5.5	*Willamette*	vigorous	middle	Oregon St. (1976)
5.5	*Stryian Golding*	moderate	middle	Yugoslavia (§1900)
5	*Tettnanger*	low yield	early	Germany (?)
5	*Fuggle*	moderate	early	England (1861)
4.5	*Hallertau*	low yield	middle	Germany (?)
4	*Elsasser*	moderate	middle	France (?)

*selections from a wild Manitoba female and an English male cross made at Wye College in 1919.

PLANNING YOUR HOPYARD

Commercial hopyards in N. America are planted with hop hills at 7'X7' spacing. This is both for machinery access and optimal growth rates for vigorous hops. Some European yards are planted with hills about 3' apart in rows 7-8' apart. The growth habits of the older aromatics (Hallertau, Saaz, etc.) and the use of more hand labor both favor this layout. Both styles of hopyard have wire or cable trellis of 12-18' with treated poles buried 3'+. For the home hopyard a 12' height is practical and in most gardens a straight trellis fits well. Prior to 1900 growers used individual poles for each hill and tied the hops on as they climbed. While 8' poles are adequate for first year growth a trellis will speed your hop hills' establishment.

STRAIGHT TRELLIS

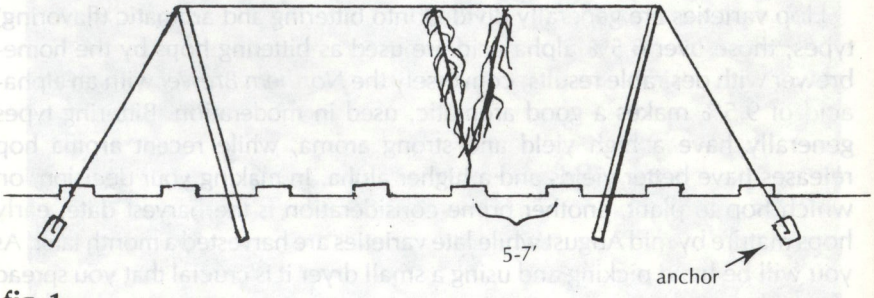


fig. 1

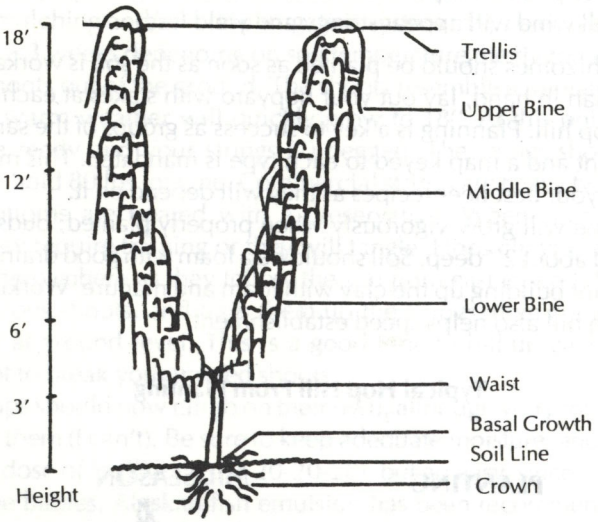


fig. 2

Straight Trellis

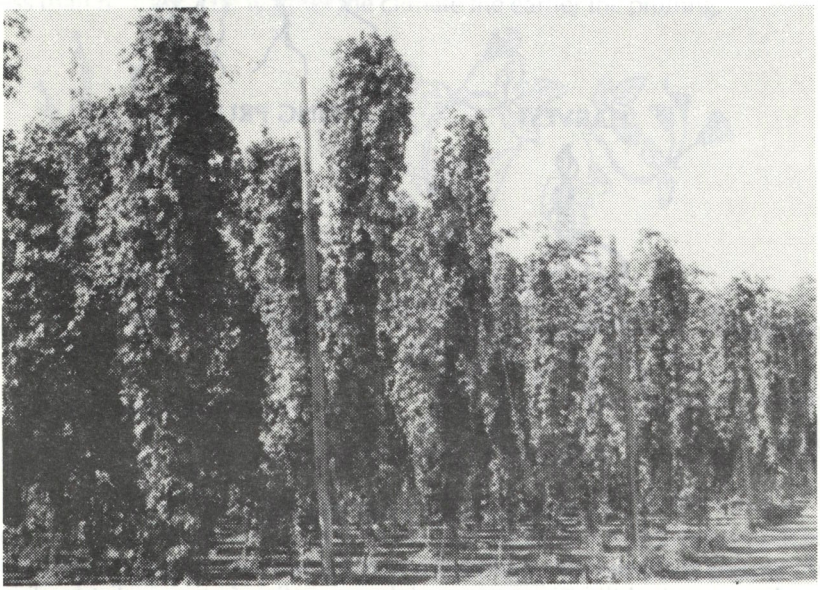


fig. 3. Hop Fields in Oregon.

The hop vine with its rapid growth and lush green foliage is an excellent summer shade plant and can be a seasonal hedge. A practical use is to shade greenhouses or patios. Property or fence lines are another possibility. Vines exposed to full wind will appear stringy and yield less.

Your hop rhizomes should be planted as soon as the soil is workable. With your trellis plan in hand, lay out your hopyard with stakes at each pole, and label each hop hill. Planning is a key to success as groups of the same variety are convenient and a map keyed to each type is mandated. This map should be filed with your best beer recipes as they will depend on it.

The rhizome will grow vigorously when properly planted; buds or shoots facing up and about 2" deep. Soil should be a loam with good drainage. In my yard this meant building up the clay with loam and manure. Working fertilier in under each hill also helps speed establishment.

Typical Hop Hill From Planting

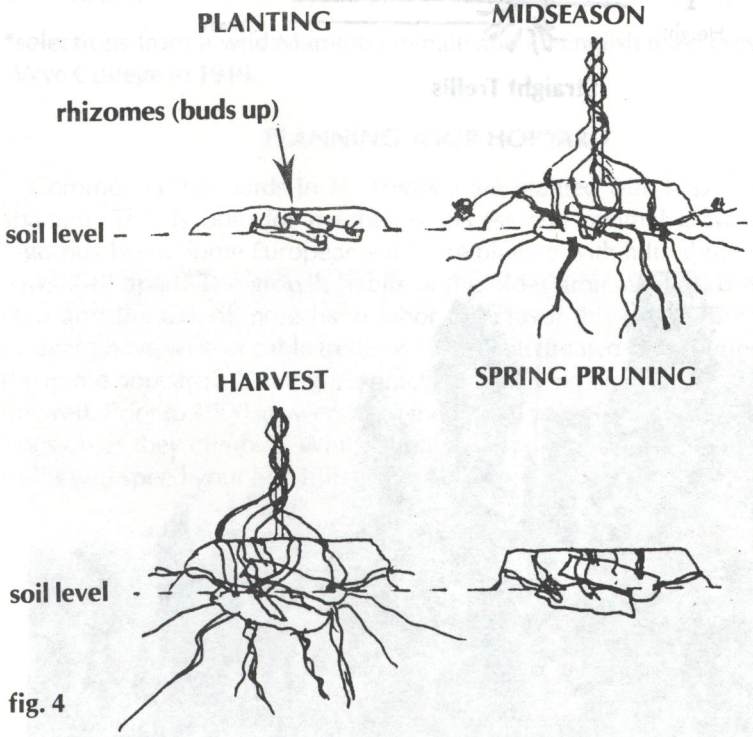


fig. 4

CULTIVATION AND TRAINING

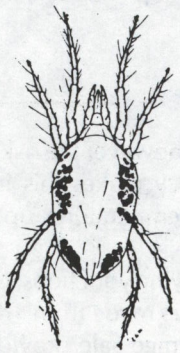
Hops enjoy a well cultivated yard and will reward the gardener who tills or hoes between the hills. The commercial grower discs in perpendicular directions leaving an area 14-18" square at each hill. Discing builds up the hill

around the crown of the hop and is commonly repeated later in early summer. The baby hop will require lots of water during establishment. A good deep soaking is superior to numerous showers. The soil should feel moist. In hot climates mulching and/or a drip irrigation system may be necessary.

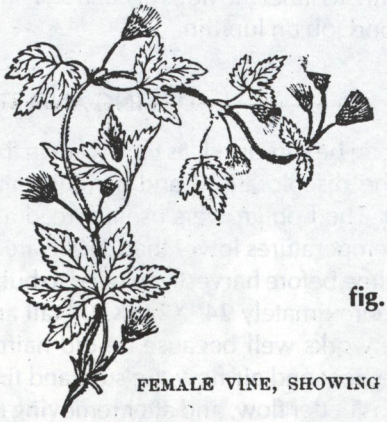
Within 2-3 weeks,depending on soil temperature,the rhizomes should start to send shoots out of the ground. The shoots resemble a miniature asparagus and with warm weather will quickly grow to 18". At this point your trellis should be ready and your strings (2) pegged. The strings should be strong enough to hold 80 lbs. of vine. Commercial strings are heavy twine or twisted paper; bottoms are treated with a preservative. When your shoots reach 18-24" they require training or they will tangle. Hops climb clockwise in the northern hemisphere as they follow the sun from east to west. Select the 4-5 most vigorous shoots, and train them up the strings, then cut the remaining shoots off at ground level. This is a good time to hill-up each plant, being careful not to break your trained shoots.

Your hops should now climb on their own, although you probably won't be able to let them (I can't). Be sure to keep adequate moisture, and this is a good time for a dose of fertilizer (I use 20-20-20), but go easy, since you don't want to burn the babies. Alaskan fish emulsion has been recommended to me by another grower, and it all but eliminates the risk of burning. When the flower burrs set in early July a dose of nitrogen is good.

Each spring the hill requires pruning to remove last year's excess growth and to lessen the chance of decay and disease. Take a sharp shovel or knife and remove 2-3" from the top of the hill and trim back the sides; here pruning goes on around March 1 or as soon as soil is workable. Usually the shoots are less than 6" long. The warmer the climate the earlier the pruning.



Adult female spider mite.



FEMALE VINE, SHOWING FLOWERS.

fig. 5

DISEASE AND PEST CONTROL

The hop plant has many pests; aphids and spider mites are common. The commercial grower will use a systemic insecticide but with timely application *Diazanon* should work. In all pest control, early control of population is essential, so watch those hops. One reason the systemic insecticides are so popular has to do with the difficulties in spraying an 18' trellis.

Hops are also affected by wilts, molds, and mildews. These diseases are very climate dependent and vary from year to year. *Downy mildew* is the disease which chased the hop industry from New York across the US before a means of control was developed. It can be recognized by a basal spike, which stimulates its lateral branches, and stunts itself (≈3'). If found, remove these spikes and the bottom 2' of leaves on adjacent plants. A soil drench with *Ridomil* or application of copperoxychloride will alleviate the problem.

HARVEST

Your baby hop may not have enough cones to be picked. Harvest starts in mid-August, here in the Willamette Valley, and typically lasts into the second week of September, but your harvest date will depend on your climate and daylength.

A mature hop cone has a springy feel, a golden-yellow lupulin (resin gland) when split down the strig, and a sweet-pungent aroma when the two halves are rubbed together. Typically a few of the cones will have brown-tipped petals.

When you have determined that your hop plant is ready to pick, take a sharp knife and cut off the vine just below the first cone clusters and remove it from the trellis. The remaining plant will continue to grow until a frost and then it should be cut off. The commercial growers then transport the vines to a picking machine and the hops are conveyed from there to the cast (hop kiln). Since a picking machine starts around $30,000 take an old pillow case or burlap bag and start handpicking cones from vines. Have plenty of homebrew nearby, preferably heartily hopped, and commence with the pickin' an' grinnin'. Be sure to label the hops at each step in processing. "Goop" handcleaner does a good job on lupulin.

DRYING AND STORAGE

Hops can be sun-dried, as they were in the middle ages; however the risk of molds, the discoloration, and a significant loss in potency makes this impractical. The hop growers use a forced air system with temperatures up to 150° F. Temperatures lower than 110° F are inadvisable.

Sometime before harvest you need to build an oast for drying your hops. My oast is approximately 24"X24"X30" tall and has 6-drawers made from 1X4. This size works well because an old hairdryer from a garage sale provides adequate heat and air flow. Be sure and find a non-hose style, as the helmet variety has better flow, and after removing the helmet, a dryer hose, and some duct tape, will direct air into your oast.

The critical factors in constructing your oast are good seals between drawers, and a nice tight door. Making your oast slightly under 24" should allow you to use one sheet of plywood (¼"-⅜") and each drawer will then use < 8' of 1X4". A good trick, for the door, is to have the top and bottom jut out, the thickness of the door, and then plane it to fit. The bottom will need a hole,

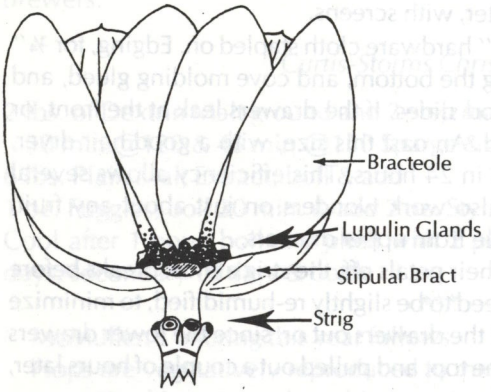


fig. 6.

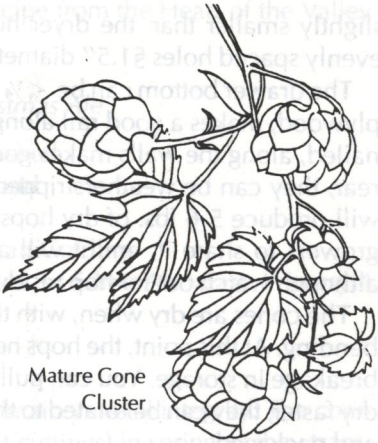


fig. 7.

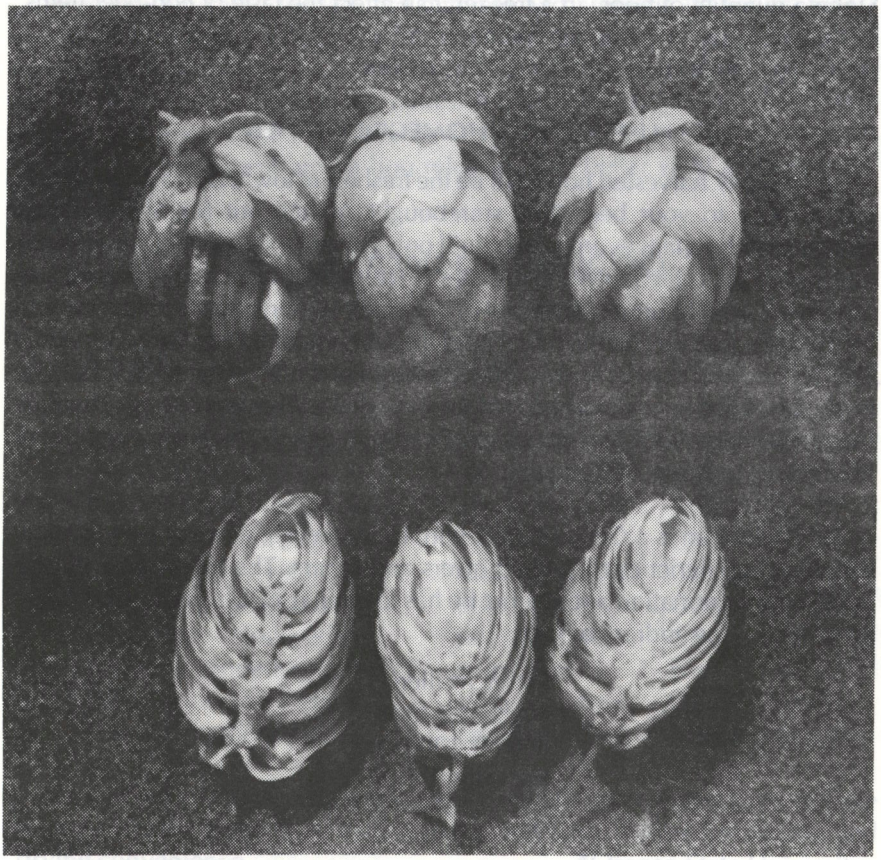


fig. 8. L to R, Fuggle, Bullion, Cascade hop cones.

slightly smaller than the dryer hose, and the top should have at least four evenly spaced holes §1.5" diameter, with screens.

The drawer bottom can be <¼" hardware cloth stapled on. Edging, for ¾" plywood, makes a good rail along the bottom, and cove molding glued, and nailed, along the walls makes good slides. If the drawers leak at the front, or rear, they can be weatherstripped. An oast this size, with a good hair dryer, will produce 5-6 lbs. of dry hops in 24 hours. This efficiency allows several growers to share it, and it will also work wonders on just about any fruit, although watch out for hop residue from upper drawers.

The cones are dry when, with their petals off, the strig almost breaks before bending. At this point, the hops need to be slightly re-humidified, to minimize breakage in storage. You can pull the drawers out or, since the lower drawers dry faster, they can be rotated to the top, and pulled out a couple of hours later, and packaged.

Commercially, after humidification the hops are pressed into 200 lb. bales and moved into cold storage. I take freezer weight Ziplock bags and stuff and stuff and then squeeze as much air out as possible before closing and freezing. Since a quantity of hops, in a freezer, can affect the taste of non-beer items, double bagging, or using that old lagering frig is a good idea. Cold storage can easily double the life expectancy of your hops.

USING YOUR HOMEGROWN HOPS

Your freshly harvested hops will be the freshest in town, and will contribute much more to your beer than storebought. **Watch out for overhopping.** Unfortunately, chances are good you'll only harvest a few ounces per hill your first year. This is the perfect excuse for dryhopping. Dryhopping doesn't add bitterness, only bouquet. After one of your famous homebrews has fermented for 10 days or more and the majority of the fermentables have been converted add ½-1 ounce, of your freshly harvested aromatic hop, to the secondary. The hops should be gently sloshed into the beer daily, this also prevents clogging the fermentation lock and bursting the carboy. I find this technique brings out all the best in a hop. Hops to you.

***

Pat McMullen is a Corvallis, Oregon, homebrewer, who is offering many different hop varieties to homebrewers and others. The following will give additional information about what he has to offer. If YOU want to grow hops, write him at the address below.

Pat McMullen
Marysville Oast
866 NE 1000 Oaks
Corvallis, OR 97330

***

Pat offers the following Christmas Ale recipe from the Heart of the Valley Brewers.

Curtis-Storms Christmas Ale

2 lbs. of Dextrin Malt ground and 2-step mashed
30 min.@120 & 45 min.@150 Sparge & add
6 lbs. Plain Malt Extract; boil & add
1 oz. Fuggles, boil 30 min. & add 2 oz. Styrian Golding
Cool after 1 hour, boil and pitch with 2 pkts. of Edme Ale yeast. Primary 4 days, secondary 10 days & bottle.

***

McMullen's offering this year follows.

Hops are vegetatively reproduced to maintain varietal integrity. The common method is to transplant rhizomes (root cuttings) in spring as they transport and store well. Commercial growers plant up to 5 rhizomes/hill for rapid establishment; we recommend 2/hill over solitary plantings. A 7'X7' spacing is good.

Hops are typically divided into bittering and aromatic (flavoring) types; types > 7.5% alpha-acid are arbitrarily considered bittering hops. Aroma types can be used as bittering hops with desirable result and the better high alpha hops can be used as aromatics. Bittering types generally have high yields and strong aroma, while aroma types yield less but have a pleasant nose. The more recent aroma hop releases have better yield and generally higher alpha.

HOPS AVAILABLE FOR SPRING 1985

% ∝	Variety — Habits	Usage	Origin	Price/ Rhizome
14	*Nugget* — vigorous, M, new	econ. bitter	OSU*	$1.50
13	*Chinook* — vigorous, M, new	aroma charac.	Wash.	$2.00
10	*Bullion* - vigorous, M	dk. ale & stout	Eng.	$1.75
9.5	*Brewers Gold* — vigorous, L	ale & stout	Eng.	$1.75
6	*Cascade* — vigorous, M	pales — Henry's	OSU	$1.50
5.5	*Hersbrucker* — vigorous, L	fullbody aroma	Germ.	$1.75
5.5	*Willamette* — vigorous, M	pale ale & lgr.	OSU	$1.75
5	*Tettnanger* — low yield, E	pilsner aroma	Germ.	$2.00
5	*Fuggle* — moderate, E, < 95°F	pales, Bud	Eng.	$2.50
4.5	*Hallertau* — low yield, E	subtle, gd. beer	Germ.	$3.00
4	*Elsasser* - moderate, M	lgr; nice aroma	France	$2.50

Habits: vigorous types yield more plus grow taller and wider; E, M, & L are relative harvest dates (E = early); spread out your harvest for picking and drying convenience.

*Oregon State University.

POSTAGE & HANDLING: $1.75/5, $2.25/10, $3.00/20 rhizomes.
Discounts: 50+ rhiz. = <10%>, 100+ rhiz. × <20%>,
club orders 25+ rhiz. <10%>.

MINIMUM ORDER IS $10.00. This includes hop growing pamphlet.

Stocks are limited so order early for best selection. On later orders closest variety in stock will be substituted with appropriate refund. Orders will be sent after March 15 to avoid freezing. Rhizomes must be refrigerated until planting.

***

This year we have a new product: hop strings made from paper and preferred by commercial growers for their lack of sag and strength. Some of you may notice that at least for this year I haven't been able to get ahold of N. Brewer or Styrian Golding rhizomes, however, a new high alpha hop has been released from USDA hop projects in Prosser, Washington. This hop has an alpha level around 13 and has aroma characteristics.

The EPA has removed Ridomil from the market and I don't know what the best combatant for downy mildew is but I will be asking the folks at OSU this coming week and will addend new information to the growing pamphlet. If anyone has a recipe that they would like to share, drop me a line.

Looking forward to serving your hop needs.

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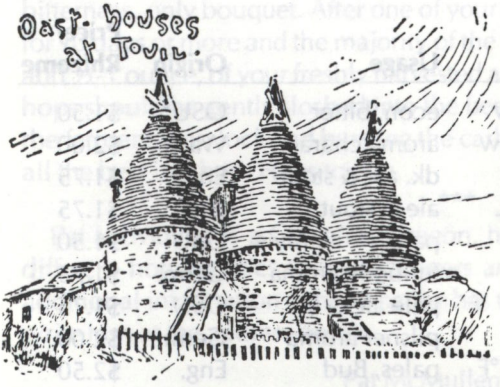

A GLIMPSE OF KENTISH OAST HOUSES.

THE USE OF HOPS IN YOUR BEER

by Fred Eckhardt

Prior to 1880, U.S. brewers used about 0.8 oz hops per U.S. gallon (∝Resin average 6%) in their beer, but by 1946 the proportion had dropped to 0.2-0.3 oz. Nowadays even less hops are used (0.1-0.2 oz/USgal). Our own home brew recipes call for 0.2-0.4 oz/USgal. We all seem to prefer our beer less hoppy than our grandfathers did. Even so, the taste of good beer is based firmly on correct use of fine hops added at the proper time. That is not an easy achievement, but it is much easier now than it was 12 yars ago, when I first looked into the hop situation in the U.S. and Canada. At that time, most merchants sold mostly hop flavored malt extracts, (usually only one variety — *Blue Ribbon*). If they had any hops, they were likely to be old, heavily compressed floor sweepings and hops that hop dealers were unable to sell to the breweries. Today we have many good choices. Most of the hop varieties available to brewers are also available to the amateur. You no longer have to accept second class hops for your beer.

As mentiond elsewhere, there are two basic ways to use hops in your beer. The most important use, that of adding the resin content to your beer for protection from souring bacteria, requires hops of good bittering power. These are called boiling or bittering hops. They are used according to their a-resin content. Hop resins are insoluble in cold water, but become soluble in boiling solutions of proper pH levels such as beer wort. The full rolling boil is very necessary to insure incorporation of the hop resins.

In British breweries, (ale and stout production), the hops are added as the wort approaches the boiling point. Sometimes all of the hops are added, and sometimes it is done in two or more additions, some hops being added 15-20 minutes before striking the kettle. The British brewers make good beer, but some American and German experts believe that their product would be improved by adding hops *after* the first break in the kettle.

In lager breweries, the practice is to add the hops during the last hour of boiling in several batches (as many as six). A suggested program for pale beers might be: 2/5 an hour before run-off or strike, 2/5 about 20 minutes before strike, and 1/5 at strike. U.S. and Canadian breweries usually follow lager procedures, for hop additions, even in the manufacture of ales.

All breweries add hops in the reverse order of their quality, that is by adding the oldest and lowest quality hops first, and the best quality hops last. Even in those breweries which use only one variety of hops in their beer, the age will vary. The oldest hops are added earlier in the brewing cycle, and the youngest last, since these are the ones that will contribute more to the flavor. Hop extract may also be added during the boil, in the same manner as hops although, if the extract is isomerized, boiling is not necessary to incorporate the resins into the beer wort.

All of our recipes call for two kinds of hops to be used; **Bittering** hops and **Aromatic** hops. The bittering hops, which may vary greatly in bittering power, should be used in accordance with that bittering power. If the hops are two years old, consider that there is only about 40% (or less) bittering power, while year old hops range from 50% to 85%, depending on the variety of hop, storage, etc. The following system will help to appraise and calculate the amount and variety of hops to be added during the boiling process, and is based on modern brewery practice using the alpha-resin content of the hops to determine quantity per gallon or litre.

HOP BITTERNESS UNITS

The hop bitterness unit (hbu) is a way to calculate the amount of hops required to produce beer with a certain level of bitterness. We can assume, as a starting point, that an American style lager beer will have minimal bitterness levels.

Indeed, published analysis of American beers show that they have an average bitterness level of about 13 ASBC (American Society of Brewing Chemists) bitterness units. Many beers (*Coors, Olympia*) have only 9-12 b.u.

We can arrive at an estimate as to how much hops, of a given alpha-resin content, are needed to produce a particular level of bitterness to match our varied palates. Assuming that 0.2 oz of 7% a-resin hops will produce 15 b.u. in a finished beer, we can assemble a working formula to give us a little more accuracy in this matter. Let us call *our* bitterness measure *hop bitterness units*, or just hbu, instead of the ASBC bitterness unit of measure, since we have no way of analyzing the actual bitterness levels of our home-made beer — the necessary equipment is quite expensive. Nevertheless, the following formula will give a fairly accurate measure, although based on an estimate.

Using figures published by the brewing industry, we can arrive at a formula for calculating hbu in a particular beer. This formula is:

$$\text{hbu} = \frac{a \times w}{K}$$

a = alpha-resin % of the hops, or pellets, or extract being used.
w = any unit of measure being used, such as oz/USgal; oz/UKgal; gm/USgal; gm/UKgal; or gm/liter.
K = a constant based on figures published by the brewing industry. There is a different K value for each of the above units of measure.

The following table gives values for constants in each of the above units of measure.

Table III — TABLE OF CONSTANTS (K)

	oz/USgal	gm/USgal	oz/UKgal	gm/UKgal	gm/liter
	KoUS	KgUS	KoUK	KgUK	KgL
K =	0.093	2.7	0.078	3.2	0.7

Now, using the above formula (hbu = $\frac{a \times w}{K}$) we can determine the bitterness level of a particular beer. Suppose we have a recipe calling for 1½-oz hops for a 5-USgal batch (0.3-oz USgal). Assume all of the hops added at least 20 minutes before strike. Suppose we are using *Bullion* hops, alpha 10%. The formula now:

$$hbu = \frac{a \times w}{KoUS} = \frac{10 \times 0.3}{0.093} = \frac{3}{0.093} = 32.2 \text{ hbu}$$

Let us suppose that you know you prefer a beer with about 25-hbu. How can you calculate the hops required to produce that beer. By transposing the formula, we arrive at the following for w (wt unit/liquid measure):

$$w = \frac{K}{(\frac{a}{hbu})}$$

Suppose, further, that you are using *Cascade* pellets, (at a.r. 7.5%). How many grams are needed for a 5-gallon batch (gm/USgal)? See Table III, K = 2.7.

$$w = \frac{KoUS}{(\frac{a}{hbu})} = \frac{0.093}{(\frac{14}{15})} = \frac{0.093}{0.933} = 0.997\text{-USgal, or just under}$$

½-oz for a 5-gallon batch. As you can see, the amount of hops used can vary greatly depending on the alpha-resin content, and the style of beer you are making. The hbu formula applies only to those hops used in the kettle, and is more applicable for hops boiled for at least 15 minutes, than for those boiled for less than that time.

HOP RATES FOR BEERS AROUND 1900

TABLE IV shows hop rates for beers at the turn of the century. In 1900 hop rates were determined by the type of hops and the amount per gallon, litre, or barrel. We are including our assessment of the hbu values so that you might compare them with your own brewing habits. The higher hbu values are not

TABLE IV — TABLE OF HOP RATES FOR BEERS ca 1900

	Trad. hop*	O.G.	O.°Ball.	1900 hbu**	Traditional hop rate oz/USgal	oz/UKgal	gm/lit.	current hbu est 1978
Continental								
Pilsner	S	1049	12	23-26	0.6-0.7	0.7-0.8	4-5	25[1]
Vienna	H-S	1051	12.5	19-28	0.4-0.6	0.5-0.7	3-4	unknown
Dortmunder	H	1062	15	19-28	0.4-0.6	0.5-0.7	3-4	19-22
Munchner	H	1051	12.5	14-19	0.3-0.4	0.4-0.5	2-3	14-19
Weizen Beer	H	1040-8	10-12	10-12	0.25	0.3	2	10-12
Modern German "Pils"	N	1046	11.8	—	—	—	—	23-29
English								
Mild Ale	F	1040	10	15-23	0.4-0.6	0.5-0.75	3-5	13-20
London Pale Ale	G-F	1057	14	62-77	0.8-1.0	1-1.2	6-8	43-53
Burton Strong[3]	G	1052-7	13-14	77-116	1-1.5	1.2-1.8	8-11	43-53
Burton Export[3]	G	1065-70	16-17	139-155	1.8-2	2.2-2.4	13-15	unknown
Porter	G-F	1057-61	14-15	25-62	0.4-0.8	0.5-1	3-6	20-40
Double Stout	G-F	1065-74	16-18	77-101	1-1.3	1.2-1.6	7-10	70-113
Imperial Stout	G-F	1081-104	19-25	101-116	1.3-1.5	1.6-1.8	10-11	100-116
Irish Stout	G-F	1062-70	16-18	74-97	0.8-1	0.9-1.2	6-8	40
American (U.S.)								
Pale Lager	Cl-C	1046	11.5	30-38	0.4-0.5	0.5-0.6	3-4	10-16
"Light" Lager[4]	Cl-S	1024-30	6-8	—	—	—	—	15-20
Dark Lager	Cl-H	1049-57	12-14	30-38	0.4-0.5	0.5-0.6	3-4	9-14
Calif. Steam	C	1045-51	11-12.5	30	0.4	0.5	3	42
Cream Ale	C	1056	14	38-60	0.5-0.8	0.6-0.9	4-6	9-14
Stock Ale	Cl-G	1064-74	16-18	75-113	1-1.5	1.2-1.9	8-12	15-45
Porter	C	1053	13	49	0.65	0.8	5	20-40
Wheat Beer	H	1040-49	10-12	—	—	—	—	—
Modern US Lager	C-F	1045	11.5	—	—	—	—	14[2]

* S = Saazer, H = Hallertauer, G = Golding, F = Fuggle, Cl = Cluster, N = Northern Brewer, **Our guesstimate

[1]has remained the same all these years! [2]75% of all U.S. beers are 10-15 b.u. [3]these high hbu beers, if analyzed, would not actually be as high, because most of the high bittering power is precipitated out during the ferment, whereas this is not as likely in low gravity beers. [4]"Light" lager = low alcohol or Low Calorie beer.

entirely accurate, because at these high hop rates, so many of the extra resins were precipitated out during the ferment, so that the high gravity of some beers requires a fairly heavy rate due to loss during ferment. We've added an extra column estimating hop rates in modern beers of the same type.

BITTERING VALUES OF OTHER HOP SOURCES

If you know the alpha-resin content of your hop pellets, hop extract, or hop powders, they may be used in the same manner as fresh or compressed hops, if not you'll have to guess. In the case of hop pellets, assume a value of 120% of regular fresh hops of that variety, if the pellets are fresh 1985 (deduct 20% for 1984 pellets).

hbu VALUES OF HOP FLAVORED MALT EXTRACTS

There is really no good way of estimating the hbu values of beer made with malt extract syrup. Experience indicates that if beer is made by their usual directions, i.e., 60% malt extract fermentables, and 40% fermentables from dextrose or sucrose, there will be about 12-15 hbu in that beer, with English and German manufactured malt extracts about 15-20% higher. An all malt extract beer, then, would have 18-24 hbu in the finished product. If hops are added to hop flavored malt extracts, the wort must be boiled with those hops for at least 30 minutes. As noted earlier and elsewhere, aromatic hop constituents may be added at the end of boil, in the ferment, or as dry hopping, or as our sugar hop krausen formula (see below).

THE HOP BREAK

The addition of the hop constituents to your beer is best accomplished by bringing the wort to a boil and waiting at least 15 minutes beyond the first "break," which is the point shortly after the wort comes to a boil, where the unstable colloidal proteins can be seen as whitish flakes being thrown, by the boiling action, against the walls of the kettle. The first portion of hops are added when the wort shows clear between the flakes being precipitated (about 15 minutes after the first hot break). Remember that some dark beers,

made from grain malts, require a long boil, and in that case the hops should be added much later, since there is nothing to be gained by boiling the hops later than an hour *before* the end of the boil, and not before at least 15 minutes *after* the first hot break in the kettle.

Each time that a portion of hops are added to the boiling wort, a new hot break is initiated. This is called a *hop* break, and causes the precipitation of additional protein and tannic constituents. Those hops added early in the wort boiling period contribute mostly soft resins to the wort, while last minute additions may contribute only aromatic oils, and retain their resins.

As the wort continues at a vigorous rolling boil, evaporation takes place, reducing the volume, and concentrating the wort. The flocculation and subsequent precipitaton of proteins continues, and the color of the wort darkens. The hop resins are incorporated into the wort, some of the tannins are precipitated, while others combine with proteins to form tannates, which may be a later cause of temporary chill hazes in the finished beer. The hop tannin, along with tannin from the malted barley is very important to the beer. The presence of tannin adds to the beer's flavor, and aids in settling and clearing the beer after fermentation, in addition to aiding the removal of proteins, as we have said.

Each addition of hops will cause a new hot break, and the release of additional protein constituents. Beers which are to be boiled for less than the optimum 1½ hours should have slightly higher hop rates. High gravity beers, and those which are to be conditioned over a long period also need a slightly higher hop rate. Less hops are desired in beers with a lower percentage of malt-to-sugar-water use, such as a low-malt home brew. Beers which are to be boiled longer with the hops, such as some types of stout, may need less of them for that reason.

USING AROMATIC OR FINISHING HOPS

These hops are added at the very end of the boil, or they are placed in the

fermentor or aging vessel for cold extraction. Aromatic hops should be selected for their aroma and flavor, and not for bittering power (*Hallertauer, Saazer, Fuggle, Cascade,* or some of the English varieties). If you intend to keep them into ferment, they should be wrapped in cheesecloth for easy removal at skimming. Hops may be added at bottling time by the *sugar-hop krausen* method. Use about 0.1-0.25 oz/gal. or about ½-1½ for a batch. Boil about 2 cups beer, add the carbonation dextrose, or dry malt extract, and boil 2-3 minutes before adding the hops, which are to be boiled about 5 minutes longer. This is to be strained, sparged (rinsed with beer to extract all of the sugar), cooled a little and added to the beer to be bottled.

DRY HOPPING

Until you have sampled a dry hopped beer (such as *Sierra Nevada Pale Ale*), you are not likely to appreciate the value of that process. Any beer can be dry hopped, but fine ales and strong lagers respond best, and it is normally not done to dark beers. Use any good fresh hops or pellets, such as *Fuggles, Cascades, Hallertauer, Saazer, Savinja Goldings*, or the new *Willamette* or *Columbia* varieties. Good English hops are imported *East Kent Goldings*, or domestic *Goldings, Northern Brewer, Bullions*, etc. The important point is *FRESHNESS*. The rate is 2½-gm/USgal (2.2-gm/UKgal; 0.7-gm/litre) for beers in the OG 45 – 55 range, such as lagers and mild ales, (11.5-14°Ball). The dry hopping procedure is really best suited to strong ales OG 55 or higher using 30-60 gm for the batch of 5-6 gallons (5-10 gm/USgallon). The higher the gravity, the more hops used in dry hopping. If you used pellets in the kettle, use fresh hops. I tend to prefer fresh hops for dry hopping (being a traditionalist), but pellets are probably just as good.

Add the hops loose, (see pellet article about their use) in the secondary fermentor a couple of days after racking. Place the fermentor in the coldest place you can (regarding the yeast minimum temperatures), and rotate the fermentors daily in each direction.

DETERIORATION OF HOPS AND HOP PELLETS

It is very important to store your hops properly, especially regarding light, air and temperature, and away from moisture. According to the *Brewer's Digest*, a trade journal, and other sources, hop deterioration is caused mainly by oxidation and light, so exclusion of air and light is the most important protection for your hops, during storage, followed in decreasing importance by low temperatures and moisture content. Temperature is more imporant in the first six months, and after that air exposure is more important. Hops stored in strong opaque polyethylene bags will deplete existing oxygen, and then be protected from that. The best protection then is storage, in opaque bags, at low temperature.

Other studies have shown that hop pellets lose essential hop oils if stored at normal room temperatures and over a long period of time they may develop off-odors. Hop pellets should be stored below 54°F (12°C).

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TABLE V, DOMESTIC HOP VARIETIES

Variety	Type*	Aroma**	% alpha	State	Comments
Brewer's Gold	E	strong pungent	8½-11	OR WA	Golding type, unstable
Bullion	E	pungent	8½-11	OR WA	poor stability
Cascade	A	pleasant fragrant	5-6½	WA	
Early Cluster	B	mild pleasant	7½-8	WA	Industry standard
Late Cluster	B	mild	5½-7½	WA ID	
Comet	B	strong	9½-10½	WA	very bitter
Eroica	B	strong pleasant	10½-11½	WA ID	Brewers Gold type
Fuggle	A	spicy, mild	4-6	OR	high seed content
Galena	B	strong	12½-13½	WA ID	Brewers Gold type
Hallertauer (med. early)	A	pleasant spciy	5-6½	WA ID	poor stability
Hersbrucker	A	spicy	5-6½	WA	Hallertauer replacement German developed
Northern Brewer	E	strong fragrant	9½-10½	WA OR	very bitter
Nugget	B	strong	9½-13	OR	Hallertauer type
Perle	B	strong fragrant	9-11	OR	N. Brewer type German dev.
Pride of Ringwood	E	mild	5½-7	ID	Australian dev.
Talisman	B	Strong	7½-9	WA	Cluster type
Tettnanger	A	mild fragrant	4-6½	ID OR WA	traditional lager unstable
Willamette	A	pleasant fragrant	5-6	OR	Cascade replace

TABLE VI, IMPORTED HOP VARIETIES

Variety	Type*	% alpha	Country	Comments
E. Kent Goldings	E	9-10	England	Dr. Foster's Favorite Classic English not avail.
Savinja Goldings	A	6-7	Yugoslavia	Seedless Fuggle
Hallertauer	A	7-8	Bavaria (WG)	Good, traditional Bav'n being phased out with Brewer's Gold, N. Brewer, & Hersbrucker
Bav'n N. Brewer	A	7	Bavaria (WG)	seedless disease resistant replacement for Hallertauer
Saazer	A	6-7	Czech	Original Pilsner hops death penalty to steal in old times!
Tettnanger	A	7-8	W. Ger.	Traditional lager

Keys: table V & VI, *A-Aromatic, B-Bittering, E-English type with both bittering and aromatic qualities. **Aroma becomes more intense with over-maturity on the vine, and seedlessness.

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★★★

ABOUT HOP PELLETS

by Lee Coe
father of Home Brew legalization in 1978

In the past few years, there has been a considerable change in the way hops are used by commercial breweries. Many breweries now use pellets rather than the traditional compressed hops.

EXTRACTS are made by using organic solvents, usually methylene chloride or hexane, to dissolve resins out of the hops, then hot water to obtain tannins, sugars, gums and proteins. Most of the solvents are then removed from the extract by evaporation; traces may remain, but they do not contaminate beer because they are boiled off in the brew kettle. Partly because of the possible presence of traces of solvents, extracts cannot be used for dry-hopping, which, despite its name, is the practice of putting unboiled hops into beer during or after fermentation.

Experience in the brewing industry shows that hops, whether compressed or pelletized, usually produce better beer flavor than extracts do. The use of extracts has declined in recent years.

PELLETS: Hops for home brewers are available in three forms: loose, compressed, and pelletized. Pellets, the size of peas or small beans, are composed of finely-pulverized hops, tiny particles bonded together. There is nothing in pellets except hops — the "glue" holding them together is hop resin from lupulin glands ruptured by pressure when pellets are formed.

There are three kinds of pellets: regular, concentrated and standardized. Home brew supply stores sell only the regular pellets, which are composed of hop "powder" as it comes from the machine that pulverizes the hops.

For concentrated pellets, used in some commercial breweries, the "powder" is processed: Part of the non-resinous material is removed; then the remainder is pressed into pellets; this is done to reduce weight and volume,

which cuts shipping costs and conserves space in commercial brewery storage.

Home brewers can get regular pellets made from several hop varieties, including *Clusters, Cascades, Fuggles* and *Bullions*. The character of the pellets is decided by the character of the hops, of course. For example, the content of alpha acids varies normally from 9 to 14 per cent. But some breweries want pellets with no such variation, so hop firms blend varieties to make what are called standardized pellets, which have an alpha acid content of 10 per cent.

In most home brewing and in some commercial breweries, pellets are preferred to hops — because they can give us better beer. Reason: exposure to air deteriorates hops. So does an undesirable amount of moisture in the air. Compressed hops do not deteriorate as fast as loose hops, and pelletized hops do not deteriorate as fast as compressed hops. Especially is this true of hop pellets packaged in a nitrogen atmosphere; they are not exposed at all to air or undesirable moisture in the months they spend in a brewery warehouse or on a dealer's shelf.

It is true that *fresh* hops are as good as or better than pelletized hops — but fresh hops are obtainable only in the final months of a calendar year. The amateur should buy this year's supply at that time.

CONCLUSION: Dealers should stock only those pellets that come in sealed packages containing nitrogen rather than air. Home brewers should insist on this.

CONCLUSION: Dealers now take pellets from big sealed containers and re-package them in small plastic envelopes. They should do so in small amounts, because deterioration accelerates on exposure of pellets to air. That is, *re-packaging should occur only a few days before pellets are sold.*

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Lee Coe is retired and lives in Berkeley, CA. His health no longer permits him to drink beer, but it was Lee Coe who almost single-handedly managed the legalization of home brewing in this country. He is indeed the father of homebrewing in America. Lee is the author of *The Beginner's Home Brew Book*, now out of print.

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LAMENT FOR THE GOLDING

by Dr. Terry Foster, © 1985

My beer, which is just coming to krausen today, puts me at a watershed. I have now made exactly the same number of brews in America as I did in England. Which means that I have watched our craft, in both countries, grow from obscurity and illegality into maturity.

Since I came to the U.S., the quality of malt extracts available has improved markedly. Most good suppliers offer both U.S. and English grain malts, as well as fresh, properly-stored, hops from Europe and America. It has become much harder to blame bad brews on raw material quality.

Yet, we still cannot obtain good quality English hops, despite the sophistication of the industry serving the British private brewer. This despite the fact that England led the world in the development of modern hop-breeding techniques, through Professor Salmon at Wye College.

Appropriately, I am writing this in 1984, a year made famous long before its time by George Orwell. He once made the traditional holiday pilgrimage, of the poor of London's East End, to the Kentish hop-fields, and wrote about the experience of hop-picking in his essays and novels. He probably picked the famous East Kent Goldings, of which more later.

Fred Eckhardt (**AB** No. 4, Fall 1977) bitched mightily about English hops. He made me blush, but it had little effect on English suppliers. Dave Wills, of Freshops, recently tried to get me some English Goldings, but changed his mind when he saw their quality. He wrote me that he would have been run out of business if he had tried to sell them in this country!

It's not just that I'm nostalgic, because I am perfectly happy, most of the time, using American hops. I want some good Goldings, because I serve most of my beers on draght, and these are the classic aroma hop for pale and bitter ales. More specifically, Goldings are pre-eminent when it comes to dry-hopping ales.

Which makes a nice lead-in to the question of what aroma hops are, and how they should be used. They are hops which contribute nothing to bitterness, because they are added at such a stage in the brewing process that no significant conversion of their alpha-acid content can occur. Instead, they are responsible for hop aroma and character in beer.

In this sense 'aroma' is self-explanatory, but 'character' is not. It is a fragrant, fruity flavour which is related to, but not a direct function of, aroma. In fact, there is a continuum between these two sensations, for a given hop, depending upon the stage of the brewing process when it is added.

Hop aroma and character come from the plant's essential oils. These are complex mixtures, whose amount and composition depend upon the hop variety, and, for a given variety, vary from year to year. Despite recent research, (Jack Riehl, **AB** No. 10, Winter, 1983), it is still not entirely clear which components of these mixtures are responsible for hop aroma and character.

What is quite clear is that the oils are volatile, and that some components are more volatile than others. Clearly, if the hops are added at the beginning of the boil, all the oils will be evaporated, and such hops will contribute nothing to the aroma of the beer.

For hops added towards the end of the boil, a fair amount of their oil will be lost. The remaining, less volatile, oil constituents will give the beer hop character, but little in the way of aroma, which is typical of this 'late-hopping' process.

Some brewers, including commercial practitioners, like to add the aroma hops at the end of the wort boil. Obviously, more of the volatile oil constituents are going to go into the wort, than if the hops were added during the boil. So, beer brewed in this way, while still having hop character, will also have a good deal more aroma than late-hopped beer.

It is also possible to add the aroma hops during fermentation, and I know of at least one commercial brewer who does this. Hops added in this way will result in both character, and aroma, in the beer, in a manner similar to those added at the end of the boil. In both cases, a fair amount of the volatile components of the hop oil will be lost due to the vigorous purging action of the carbon dioxide evolved.

The final method of addition is that of dry-hopping. Traditional British practice is to add these hops, along with primings, to the cask, as the draught beer is racked from the primary fermenter. The cask is then bunged down and shipped off to the pub. Since very little oil is lost by this procedure, dry-hopping will result in beers with very strong hop aroma.

Interestingly, it has been shown that even this procedure takes 21 days contact before oil extraction reaches a maximum. Even then only some 30% of the hop oil will have been extracted into the beer. Further, in current British brewing practice, most draught beer is drunk within 1-2 weeks after delivery to the pub, which is a much shorter maturation time than for most privately-brewed beers.

Before I get into what makes a good aroma hop, let me make an unusual point about them. They are generally held to be applicable only to pale beers. While it is true that some magnificent brews can be made in this way, let's not forget dark beers. Munich-style lagers, brown ales, and even stouts can benefit from the addition of aroma hops in my experience, and their strong

basic flavours offer a fruitful field of experimentation if, like me, you find hop aroma one of the most intriguing characteristics of a good beer.

Aroma hops must be fresh. They should smell clean and fragrant; anything harsh, musty, or in any way unpleasant is likely to contribute that unwanted flavour and aroma in the beer. This is particularly true in the case of dry-hopping, where off-odours and flavours will go directly into the beer and spoil it.

Commercial brewers select their aroma hops on the basis of past practice and experiential judgement. Most common aroma varieties are low in alpha-acid, because they are not expected to contribute towards bitterness, and because high alpha-acid varieties often have a very coarse aroma. However, some of the newer varieties, such as Eroica, Galena, and Challenger couple high alpha content with good aroma qualities.

Aroma hops are usually split into two classes — 'spicy' and 'floral' - according to how most people perceive their effect on beer. Among the former come the European lager hops — Hallertauer, Saaz, Styrian Goldings, Tettnanger, and Hersbrucker. Cascades are the classic floral hop, though I would include Eroica, Galena, and even Goldings in this group.

Exactly how you are going to use aroma hops depends upon your taste, and your serving process. Dry-hopping is for draught beer only; it just does not work for the bottled variety. Fermentation-hopping, too, can cause problems if you are bottling, unless you use pellets, or suspend the leaf hops in a nylon bag in the wort.

Boiler-hopping is straightforward– just turn off the heat at the end of the boil, stir in the aroma hops, cover, and leave for ½-hour or so before force-cooling the wort. In the case of late-hopping, simply add the aroma hops some ten to twenty minutes before the end of the boil. Both of these techniques are obviously suited to the production of either draught or bottled beer.

Quantities are clearly subjective. I suggest you err on the side of caution, unless you are really sure you like lots of hop character and aroma. For boiler and late-hopping, ½-ounce (5-gallon batch) is about right. For fermentation addition, ¼-½ ounce (7-15 gm) should be plenty, while for dry-hopping ¼-ounce may be on the high side. British brewers use 1 ounce per barrel (about 43 U.S. gallons), or 0.1 ounce per 5 U.S. gallons (173 mg/litre).

Frankly, I consider boiler-hopping the best way to go for aroma, for most purposes. It doesn't complicate the brewing process, gives very consistent results, and works well with any good aroma hop. In contrast, dry-hopping is a much more difficult technique to handle. It can actually give unpleasant results and, even if it does not, is very easy to introduce such a strong aroma as to overpower every other flavour component and to completely unbalance the beer.

Dry-hopping may be a source of infection and off-flavour to beer. Many writers advocate sterilization of aroma hops, by pre-boiling them with water for a few minutes, then straining them prior to addition to the beer.

It seems to me that this may defeat the whole purpose of the exercise, since it must result in the loss of at least some of the volatile oils. Therefore, I have never sterilized my dry-hops. No less a person than Fritz Maytag, of *Anchor* Brewery fame, has gone on record saying this is unnecessary, since beer-spoilage organisms grow only in beer, and not in anything else! However, as with all aspects of hygiene in brewing, it is as well to minimize the risk, which is perhaps another argument in favour of boiler-hopping.

Yet, some of the best beers with hop character and aroma, that I have ever drunk, have been English draught dry-hopped ales. Which is why I want to dry-hop my pale and bitter ales with Goldings. If only I could get my hands on some good quality English Goldings! Is there no one out there who can pressurise English suppliers into answering this heartfelt plea?

***

Terry Foster has been brewing for over 25 years. He is married to an American lady, lives in Milford, Connecticut, and likes his beer "real ale style." He thinks Americans drink their beer too cold, and that American beer is too bland. He is a genuine hop-head. Dr. Foster is a chemist, specializing in applications of flocculants (called 'finings' in brewing) in the mining industry. His job takes him all over the world to sample beers of all nations. Terry is the author of numerous articles in English and American publications, such as Amateur Winemaker, the Home Beer and Winemaking, and Zymurgy, as well as previous efforts in this publication (**AB** No. 7, and **ABNL** 8-4). He is a student of the brewing industry and brewing history, and the author of *Dr. Foster's Beer Book* (1979).

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Point of hop addition.	Effect of this addition.	Suggested varieties.
BOIL	Bitterness.	All.
	Hop character.	Hallertauer, Cascades.
END OF BOIL	Hop character plus aroma.	Hallertauer, Cascades, Eroica, Saaz.
FERMENTATION	Moderate hop character, stronger aroma.	Saaz, Cascades,
CONDITIONING IN CASK	Some hop character, strong aroma.	Eroica, Hallertauer, (Goldings).

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(continued from page 1)
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