2 Classic Styles: Perfect Pilsner and Big Barleywine

Brew

MARCH-APRIL 2004, VOL.10, NO.2

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MARCH-APRIL 2004
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ON THE COVER: Petra Hanson, lead singer for the band Gaijin a Go-Go (gaijin55.com). Photographed by Eric O'Connell

Brew Your Own

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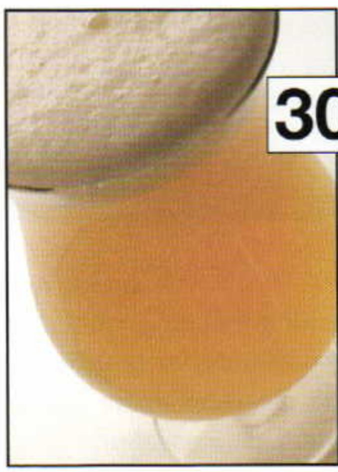
Beer kits are a popular choice for many homebrewers. But many kit makers may wish to start brewing "outside of the box." We'll take a cue from a famous TV chef and show you how to kick your kit up a notch.

30 Yeast Strains *by Dr. Chris White*
Brewer's yeast transforms bittersweet wort into our favorite beverage, beer. As homebrewers, we have access to a wide variety of yeast strains. Find out more about the diversity of beer yeast strains and how to use them to get the right flavors and aromas in the beer style of your choice.

34 Sweetness: Brewing Sugars and How to Use Them
by John Palmer
Sugars add strength to beer without bulking up the body. John Palmer conducts a survey of sweetness to help you choose when to use sugar and which sugar to use. From Belgian candi sugar to xylose, it's all here.

40 Big, Bad Barleywine *by Horst Dornbusch*
Lots of malt. Lots of hops. Lots of yeast and, potentially, lots of frustration. Barleywine is a highly challenging, but highly rewarding, beer style to brew at home. From mash tun tricks to extended aging tips — we'll show you how to get this bad boy in your carboy with the least amount of hassles. **Plus:** three detailed homebrew recipes for two barleywines and a big brown ale.



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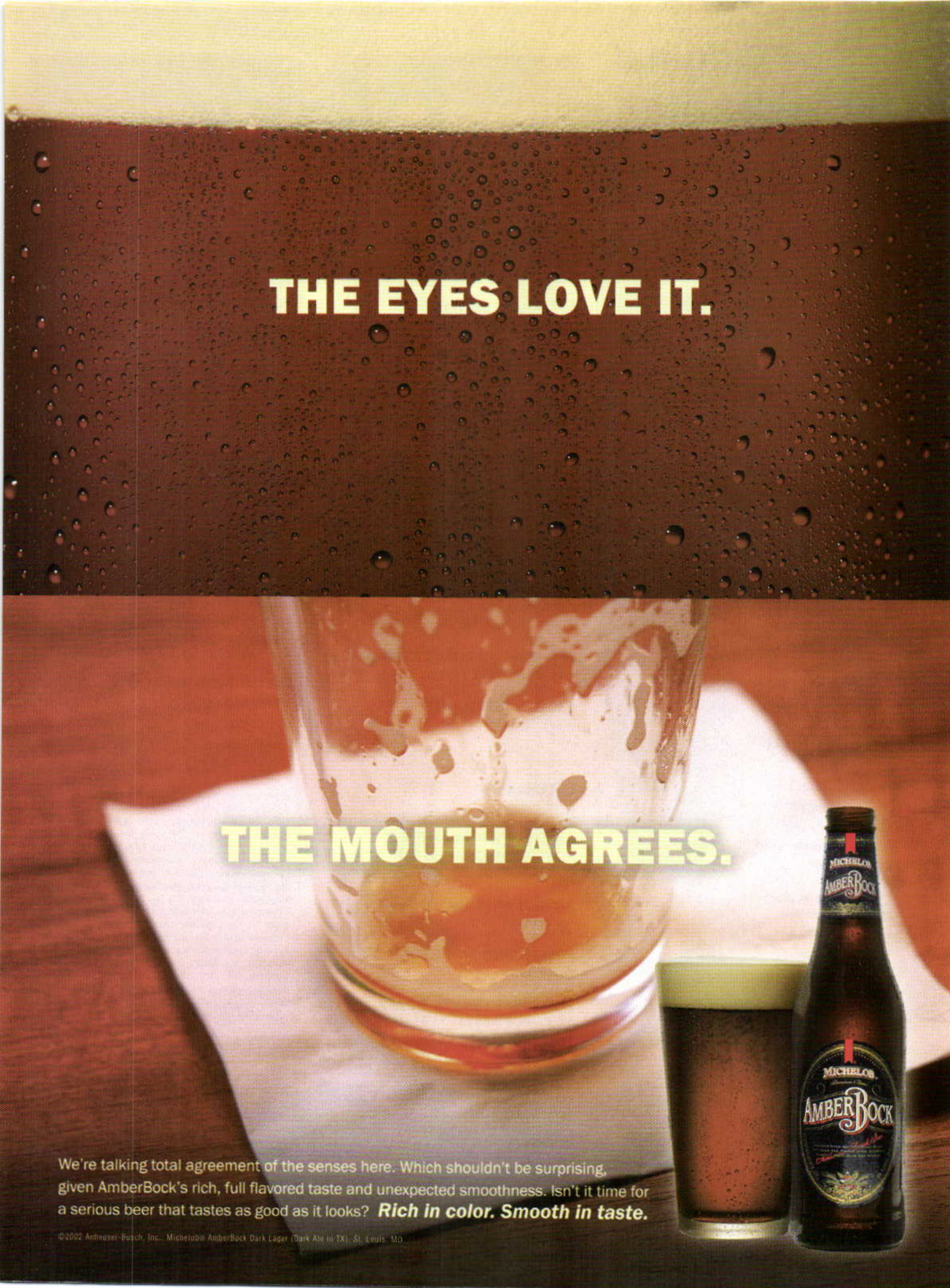

THE EYES LOVE IT.
THE MOUTH AGREES.
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Brew Your Own

THE HOW-TO HOMEBREW BEER MAGAZINE

EDITOR
Chris Colby

ART DIRECTOR
Coleen Jewett Heingartner

ASSOCIATE EDITOR
Garrett Heaney

TECHNICAL EDITOR
Ashton Lewis

EDITORIAL INTERNS
Michael Parker, Miki Johnson

CONTRIBUTING WRITERS
Steve Bader, Thom Cannell, Chris Colby, Horst Dornbusch, Joe and Dennis Fisher, Colin Kaminski, Ashton Lewis, Thomas Miller, Steve Parkes, Tess and Mark Szamatulski

CONTRIBUTING ARTISTS
Don Martin, Ian Mackenzie, Shawn Turner, Jim Woodward

CONTRIBUTING PHOTOGRAPHER
Charles A. Parker

CANINE ASSISTANTS
Heidi, Duff

PUBLISHER
Brad Ring

ASSOCIATE PUBLISHER & ADVERTISING DIRECTOR
Kiev Rattee

ADVERTISING MANAGER
Michael Pollio

NEWSSTAND DIRECTOR
Carl Kopf

How to reach us

Editorial and Advertising Office
Brew Your Own
5053 Main Street, Suite A
Manchester Center, VT 05255

Tel: (802) 362-3981
Fax: (802) 362-2377
E-Mail: BYO@byo.com

Advertising Contact
Kiev Rattee
kiev@byo.com

Editorial Contact
Chris Colby
chris@byo.com

Subscriptions Only
Brew Your Own
P.O. Box 469121
Escondido, CA 92046

Tel: (800) 900-7594
M-F 8:30-5:00 PST
E-mail: byo@pcspublink.com
Fax: (760) 738-4805

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BYO RECIPE STANDARDIZATION

Extract efficiency: 65%
(i.e. — 1 pound of 2-row malt, which has a potential extract value of 1.037 in one gallon of water, would yield a wort of 1.024.)

Extract values for malt extract:
liquid malt extract (LME) = 1.037
dried malt extract (DME) = 1.045

Potential extract for grains:
2-row base malts = 1.037
wheat malt = 1.037
6-row base malts = 1.035
Munich malt = 1.035
Vienna malt = 1.035
crystal malts = 1.033-1.035
chocolate malts = 1.034
dark roasted grains = 1.024-1.026
flaked maize and rice = 1.037-1.038

Hops:
We calculate IBU's based on 25% hop utilization for a one hour boil at specific gravities less than 1.050.

Contributors

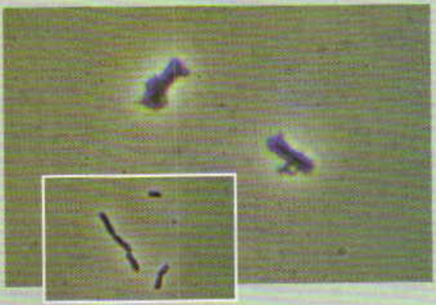
Dr. Chris White, Ph.D founded White Labs in 1995 after conducting years of research and development on an entire library of brewers yeast strains from around the world. Chris received an undergraduate degree in biochemistry from the University of California at Davis, where a course in brewing and malting science led by Dr. Michael Lewis inspired him to start brewing. He relocated to San Diego for graduate studies in biochemistry and started homebrewing regularly.

Chris' doctoral thesis focused on developing high cell-density growth techniques for an industrial yeast strain. Combining his research with his love of craft brewing, Chris developed a process to grow pitchable quantities of liquid brewers yeast. White Labs now provides high-quality, concentrated, liquid brewers yeast to breweries and homebrewers worldwide.

We at ***BYO*** would like to congratulate **Mr. Wizard**, whose brewery won a gold medal at this year's Great American Beer festival. We can't say which category it was without giving away his secret indentity, but it wasn't his first time winning in that category. What else can we tell you about Mr. Wizard? Well, long time readers of ***BYO*** know that he has been writing for ***BYO*** ever since the magazine started back in 1995. This year, as in the past, "the Wiz" ranked as one of our most popular columnists in our annual reader survey. In recent issues, Mr. Wizard has admitted that he is a professional brewer, but you probably already suspected that. So what alse can we tell you to narrow it down? Well, we can definitely say that Mr. Wizard did not play the part of Jerry Lundegaard, the car salesman who had his wife kidnapped, in the movie "Fargo." That was William H. Macy. Mr. Wizard is not part of Martha Stewart's defense team nor does he wander the American wilderness with his big, blue ox named Babe. Not helping? Well then, you'll just have to read Mr. Wizard's column on page 15 of this issue and watch upcoming issues of ***BYO*** for more clues as to his identity. Also, keep an eye out for William H. Macy in "Fargo II: Jerry's Revenge — Oh jeez, this time it's real personal now." (OK, we made that last part up, but how cool would that be?)

Jim Woodward found his favorite beer in Heidelberg, on a Volkswagen bus brewery crawl of West Germany. He attended The Art Institute of Boston and has contributed many illustrations to ***Brew Your Own*** and its sister magazine ***WineMaker***. His favorite color is orange. His influences are Disney, Warhol, Mom & Dad and Rock & Roll. Of all the medium he's worked in over the years, he considers vinyl records and turntables his ultimate artform. A club DJ since the Carter administration, the Bennington, Vermont slightly-hearing-impaired Woodward sites the importance of sound as well as sight for inspiration in his work.

Looking for Lysozyme



I am a subscriber to your magazine and also a member of the board of directors of the Swedish Homebrewers Association, based in Stockholm, Sweden. We publish four issues per year of our brewing magazine called "Homebrewer" for our almost 1,000 members. The article by Jessica Just about lysozyme (January-February 2004 *BYO*) is extremely interesting reading. Could you perhaps assist us here in Sweden as to where we can get our hands on some of this stuff?

David Meadows
Stockholm, Sweden

A search of the internet for the terms "lysozyme" and "beer" will yield several homebrew and home winemaking shops that sell lysozyme. We didn't see any Swedish shops, but we're sure a U.S. store could ship to you. If you have a local home winemaking shop, look in their winemaking additives section. Winemakers have been using lysozyme for awhile, so the shop may carry it. Incidentally, an internet search for "lysozyme" and "brewing" will bring up a link to an abstract for another article on lysozyme in brewing, this one in the MBAA (Master Brewers Association of the Americas) Technical Quarterly.

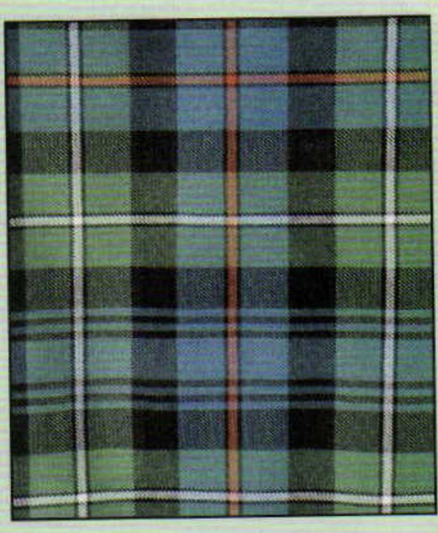
High Gravity All-Grain?

I have been trying to get started brewing all-grain beers with my limited equipment. From Chris Colby's article on blending (January-February 2004 *BYO*), it looks like I can brew a high gravity wort and boil it in my 20-quart pan on the stove then dilute it to 5 gallons just as I would with an extract beer. Why wait for bottling to dilute the wort or beer?

Robert Bonetti
Lakeville, Michigan

Author and BYO editor Chris Colby responds: "In all-grain brewing, you collect your wort by draining the mash. The gravity of that wort is not that high and it decreases as you sparge (add water to rinse the grains). The initial gravity of your runoff depends on mash thickness, extract efficiency and other variables. However, you would be hard-pressed to extract a thick enough wort to be able to boil a concentrated wort and dilute it for fermentation, as extract brewers do. Using typical all-grain procedures, you could perhaps mash 8 lbs. (3.6 kg) of malt and collect 4 gallons (15 L) of wort at a gravity of 1.049–1.056 in your 20 quart (5 gallon/19 L) pot. Diluted to 5 gallons (19 L), this would yield beer with a virtual OG of 1.039–1.046. If you added more grain, but still collected 4 gallons (15 L) of wort (and accepted the lowered extract efficiency), you could brew to somewhat higher gravities. But, you would still be limited to brewing low to moderate gravity beers. If you want to get started in all-grain brewing, but don't have a large brewpot, you have a couple options.

You can learn the techniques of all-grain brewing — and yield a significant percent of your fermentables from grain — by doing a mini-mash (a large partial mash). In a mini-mash, you mash from 4–6 lbs. (1.8–2.7 kg) of grain and collect around 2–3 gallons(7.5–11 L) of wort from the mash. This wort is then spiked with malt extract. Another option for all-grain brewing with a smaller kettle is to make your wort in shifts. You could do twomini-mashes and combine the worts to make a 5-gallon (19 L) batch. See my October 2003 article, "The Texas Two-Step Method," for some information on combining worts. And, of course, you can simply brew smaller batches of beer. You may find that the effort required to get around the limitations of a small brewpot aren't worth it. In that case, consider upgrading. I've never met an all-grain brewer who regretted taking the leap."



If it's not Scottish . . .

I think Horst Dornbusch has confused the descriptions for Scotch and Scottish ales in his article on dry stout (January-February 2004 *BYO*). He states that "a Scottish ale, on the other hand, should be much more alcoholic than the average stout." Just above, Mr. Dornbusch describes Scotch ale as "dry, like a dry stout, but its roasted chocolate notes should be much more subdued." My references tell me that the moniker "Scotch" should be reserved for the strong Scottish ales, and "Scottish" should be applied to the lower alcohol ales.

Also, I enjoyed reading the article on batch sparging by Denny Conn. In my mash tun, I also use the mini-keg bungs he describes as through-wall fittings. In addition to the tubing that Mr. Conn uses through the mini-keg bung, a 1/4" threaded pipe nipple and 1/4" ball valve will only marginally increase the cost of the project yet ease the connection between the hose-clamped stainless steel braid "manifold." (You can tighten the hose clamp all you want.) Depending on the cooler design, you may want to add a second mini-keg bung on the outside of the cooler for increased stability when stirring the mash, especially if the wall of the cooler is thinner where the manufacturer places the tap.

Rob Hanson
Cheverly, Maryland

Our kilts must have been itching us when we were editing that article as nobody caught the Scotch/Scottish switcheroo. Thanks for pointing this out. Also, thanks for your modification suggestion for a batch sparge mash tun. Denny's article was called "Cheap and Easy batch Sparging," so he went with the most economical route for construction. Your idea, however, sounds like an affordable upgrade.

Orval Yeast

I have recently gotten into homebrewing and now have the fever. I found a recipe for one of my favorite beers, Orval, but it does not specify a yeast. Can you possibly suggest one?

Dave Morrison
Nampa, Idaho

Orval — a Belgian Trappist ale — is bottle conditioned, reputedly with the same strain of yeast as it uses during fermentation (some bottle-conditioned beers don't). As such, you can culture the yeast from the bottle and use it in your homebrew. To culture and use this yeast, prepare a very small yeast starter by boiling a tablespoon of dried malt extract in 8–10 oz. (237–296 mL) of water. Cool this wort and add it to a sanitized beer bottle. Cover the bottle with tinfoil until you are ready to use it.

Pour the Orval into glass — the preferred glassware is a goblet — being careful not to disturb the sediment on the bottom of the bottle. Leave about a half ounce (15 mL) of beer in the bottle. Swirl this around to loosen the yeast sediment. With a butane lighter, flame the lip of the yeast starter bottle then pour in the yeast sediment from the Orval bottle. Put some tin foil over the bottle and let it sit at room temperature for a few days. When you see some activity in the starter, step the starter up to a 1–2 qt. (~1–2 L) yeast. This should be enough yeast to pitch for a 5-gallon (19-L) batch. ■

BYO Homebrew Nation

brewer PROFILE

Brother Gabriel Hodges, O.S.B. (Order of St. Benedictine) • St. Meinrad, Indiana

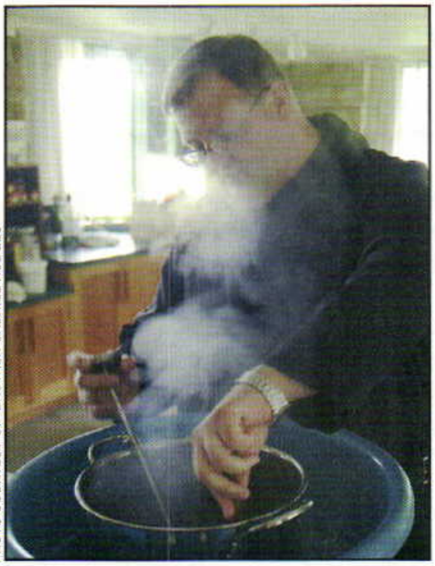


PHOTO COURTESY OF BROTHER GABRIEL HODGES

Brother Gabriel Hodges of the Saint Meinrad Archabbey chills wort during a brew session.

As a monk in the Saint Meinrad Archabbey, I am proud to continue the long tradition of monastic brewing. In 1854, when the Abbey of Maria Einsiedeln in Switzerland founded the Archabbey, the first monks brought the sacred art of brewing with them to what is now St. Meinrad, Indiana. Though the Meinrad monks' 1855 plan to build a brewery was spoiled by forerunners of the early 20th century prohibition laws, the brothers successfully created a brewery in 1860 — this time in the name of health. The monk who constructed the brewery said the beer would aid in the digestion of bacon, which dominated the brothers' diet.

Although the monks finally succeeded in building their own brewery, their first brew was a total failure. The mash was fed to the hogs, which enjoyed much improved digestion, no doubt. In 1861 the abbey leased its brewery to a gentleman in town. It soon became primarily a town operation, its former location now marked by Brewery Street in Saint Meinrad.

I joined the abbey and its brewing tradition in the summer of 2001. Since I enjoy cooking, my novice master suggested that I try brewing beer. It sounded like fun and my first batch of homebrew — a simple wheat beer — was very exciting. I began fermenting in a glass carboy fitted with an airlock. The day after I pitched the yeast, I discovered foam spewing from the airlock. To fix the situation I quickly replaced the air lock with a plastic tube and ran it into a bucket. On beer-bottling day I probably spilled more than I got into the bottles, but when the day to taste my creation arrived, I popped a top, took a swig and decided it was very good. Only later did I discover I hadn't allowed the beer to complete fermenting. To his (and my) surprise, when one of the superiors opened a bottle it commenced to spray all over him.

I now brew for holidays and feast days. I've brewed two wheat beers (one a raspberry wheat), a honey porter, an Oktoberfest, a Dogfish Head clone from Replicator of November 2002's *Brew Your Own* called "Midas Touch," and a Belgium Rye.

I really didn't care for beer until I began brewing my own. Now my hope is to develop and distribute a brew that Saint Meinrad Archabbey would like to put its name on.

The archabbey opened its first brewery in 1860 on what is now Brewery Street.

reader RECIPE: Brother Gabriel Hodges, O.S.B.

July Ryes
(5 gallons/19 L, partial mash)
OG = 1.049 FG = 1.012
IBU = 19 ABV = 4.8%

Ingredients:

3.3 lbs. (1.5 kg) light LME
1.0 lb. (0.45 kg) extra-light DME
2.0 lbs. (0.9 kg) rye malt (crushed)
1.0 lb. (0.45 kg) pale malt (6-row)
0.5 lbs. (0.23 kg) carapils malt
3.2 AAU Hallertauer hops (60 mins)
(1.0 oz./28 g at 3.2% alpha acids)
1.6 AAU Hallertauer hops (45 mins)
(0.5 oz./14 g at 3.2% alpha acids)
1.6 AAU Hallertauer hops (45 mins)
(0.5 oz./14 g at 3.2% alpha acids)
1 pkt. Muntons Gold Dry Ale yeast or
White Labs WLP001 (California Ale)
5 oz. (140 grams) priming sugar

Step by step

Place crushed grains into 1.5 gallons (5.7 L) of cold water. Bring to 122 °F (50 °C) and hold temperature for 20 minutes. Increase temperature to 155 °F (68 °C), stirring constantly and hold for 40 minutes. Increase temperature to 168 °F (76 °C) and hold for 10 minutes. Remove and rinse grains with 2 pints (940 mL) hot tap water. Remove from heat and add malt extracts. Stir and bring back to boil. Add hops as specified. Cool covered wort then pour into fermenter. Add pre-boiled water to reach 5 gallons (19 L). Temperature of your total 5-gallon (19-L) wort must be below 80 °F (27 °C) before pitching the yeast. Make a yeast starter and stir into your wort. Vigorously stir in the yeast. Ferment for 7 days at 65 °F (18 °C). Rack beer into secondary for 14 days. Transfer beer to bottling bucket. Dissolve priming sugar in 2 cups (~500 mL) of water and boil for 5 minutes. Cool and add to beer. Bottle and condition for 2–3 weeks before serving.

BREWER'S DICTIONARY

I is for . . .

IBU (International Bitterness Unit): unit of measurement used to express a beer's bitterness as milligrams of iso-alpha-acid (a compound created when alpha acids are boiled) per liter of beer.

Immersion heater: a heating device used to maintain a constant temperature in the mash tun.

Infusion mashing: the traditional British method of mashing, primarily used in ale brewing. It occurs at a single temperature and is carried out in a combination mash-lauter vessel called an infusion mash tun.

Invert sugar: a mixture of fructose and glucose produced by chemically breaking down sucrose; used for priming.

Irish moss: a red seaweed added at the end of the boiling process as a fining agent.

Iron: an ion that causes haze and oxidation and hinders yeast.

Isinglass: a gelatinous substance derived from the swimming bladder of sturgeon fish, also used as a fining agent.

J is for . . .

Jetting machine: an automatic machine used to wash bottles.

Jingle: a beverage consisting of ale that is sweetened and flavored with nutmeg and apples.

Jockey box: a beverage-dispensing system, often used to serve beer, consisting of a picnic cooler with an internal cooling coil and one or more externally mounted taps. The cooler is filled with ice, and the beverage is chilled as it passes through the coil to the tap.

homebrew CLUB

The Bay Area Mashers

San Francisco, California

The Bay Area Mashers (BAM) grew from the San Francisco Bay area's professional roller derby team of the late '60s and early '70s. As the team grew older and crippled by injuries, three of the skaters (Devil Doug, Ty-Rex, and Bonecrusher Bob) along with their manager (Burner) became ardent homebrewers.

Their early brewing efforts were hampered by a lack of literature on brewing techniques and sources for proper ingredients. For a short time, Ty-Rex took a job at the nearby megabrewery to smuggle yeast and malt out of the facility to support our hobby. Increased availability of quality ingredients in the early '80s eventually allowed Ty-Rex to cease his smuggling activities and pursue his current career as a figure-skating coach.

The four brewers eventually attracted other homebrewers to their group and formed an official club in 1983. The name "Bay Area Mashers" reflects both the group's full–mash brewing style and the roller derby team that brought its original members together.

In roller derby lingo, "mashing" describes a tactic where two players trap an opponent against the wall while a third party slams into a helpless victim. From the original four founders, the club has grown to more than 40 active members.

BAM believes that brewers must first learn to judge beer properly in order to achieve the high quality of brewing we stress in our membership. For this reason we expend great efforts to assist members in learning to judge.

At our monthly meetings, members participate in a prepared discussion of beer styles and a formal beer judging. More than 80% of our members have obtained a BJCP rating of "certified" or higher. Our annual World Cup Homebrew Competition is one of the few Masters Championship of Amateur Brewing (MCAB) qualifying events.

Jerry Howard (top) and Mike Schwartzbart, Ray Francisco and Emil Campos (bottom) slurp oysters and beer.

Today our club has expanded its activities to reflect members' diverse interests. You can view photographs from many of our activities at our Website: www.bayareamashers.org. Though our roller derby skates have been retired, our brew-kettle flames are still burning.

—Thomas E. Pape, President

replicator

by **Steve Bader**

Dear Replicator,

Last year my brother moved to Seattle and I visited him on the Fourth of July. I experimented with funny named beers that I had never heard of, but took the most delight in the LaConner Pils. On tap or out of the bottle, it is incredible. Can you help a homebrewer clone this Czech-style Pilsner?

Ben Jayne
Des Moines, Iowa

Brewer Arlen Harris at LaConner Brewing describes this beer as "the northwest flare on the German Lager style." It has the wonderful German lager maltiness, with the aggressive piney, floral hop flavor associated with the Pacific Northwest.

Arlen uses equal amounts of Weyermann (German) and Dingeman (Belgian) Pilsner malts and does a single infusion mash. Arlen adds the hops to the wort as it is running off of the mash tun, and keeps it in the wort during heating. For more information, visit the LaConner Website at: www.laconnerbrewing.com.

LaConner Brewing – Pilsner

(5 gallon, extract with grains)
OG=1.051–1.056 FG=1.013–1.014
IBU = 37 SRM= 5 ABV = 4.9–5.4%

Ingredients

6.6 lbs (3.0 kg) Coopers light malt extract syrup
0.75 lb. (0.3 kg) Dingeman Pilsner malt
0.75 lb. (0.3 kg) Weyermann Pilsner malt
1 tsp. Irish moss
9.0 AAU Northern Brewer hops (bittering hop/60 mins) (1.0 oz./28 g of 9.0% alpha acid)
3.5 AAU Czech Saaz hops (flavor hop/20 mins) (1.0 oz./28 g of 3.5% alpha acid)
4.7 AAU Hallertau Hersbrucker hops (aroma/finishing hop) (1.0 oz./28 g of 4.7% alpha acid)
3.5 AAU Czech Saaz hops (aroma/finishing hop) (1.0 oz./28 g of 3.5% alpha acid)
White Labs WLP830 (German Lager) or Wyeast 2206 (Bavarian Lager) yeast
O.75 cup of corn sugar for priming

Step by step

Steep crushed grains in 3 gallons (11.4 L) of water at 150 °F (66 °C) for 30 mins. Remove grains from wort, add Northern Brewer hops, malt syrup and bring to a boil. Add Irish moss and boil for 60 mins. Add the first addition of Czech Saaz hops for last 20 mins of boil. Add Hallertau Hersbrucker and final addition of Czech Saaz for last 5 mins. of boil.

When done boiling, add wort to 2 gallons (7.6 L) cool water in a sanitary fermenter and top off with cool water to 5.5 gallons (20.9 L). Cool wort to 75 °F (24 °C) aerate the beer and pitch yeast. Allow the beer to cool over the next few hours to 65 °F (18 °C) and hold until the yeast has started fermentation. When fermentation starts, reduce temperature to 50 °F (10 °C) and hold until beer has dropped to final gravity. This should take about 3 weeks. Bottle your beer, lager at 45 °F (7 °C) for 4–6 weeks and Enjoy!

All-grain option:

This is a single infusion mash. Use 4.75 lbs. (2.1 kg) of Dingeman Pilsner and 4.75 lbs. of Weyermann pilsner malts. Mash grains at 151 °F (66 °C) for 60 mins. Collect enough wort to boil for 90 mins. and have a 5.5-gallon yield. Lower the amount of Northern Brewer boiling hops to 0.66 oz. (18.5 grams) to account for higher extraction ratio of a full boil. LaConner Brewing uses the first wort addition method of hopping, so add the Northern Brewer hops to the wort when the runoff is finished, and leave them in the beer during the boil. The remainder of the recipe is the same as the extract.

homebrew calendar

March 5–6
Harpoon St. Patrick's Day Festival
Boston, Massachusetts

Harpoon, Boston's largest brewery, will celebrate St. Patrick's Day with live Irish and rock 'n' roll bands, corned beef, cabbage and, of course, beer. 21+ only. Door charge is $10. Call 617-574-9551 ext 3 or visit Harpoon's Website at www.harpoonbrewery.com/events/st_patricks_day/index.htm.

April 7–16
Entry deadline for the AHA's 26th Annual National Homebrew Competition
Las Vegas, Nevada

First round judging will be held from April 23–May 2. For a complete list of locations around the country that are accepting entries and to download entry forms, visit the competition's Webpage at www.beertown.com/events/nhc/index.html. All other questions can be emailed to Gary Glass at gary@aob.org.

April 14–17
13th Annual Crescent City Competition and Crawfish Boil
New Orleans, Louisiana

The organizers of this competition invite you to "come suck the heads and pinch the tails." First round judging begins at 6:00 p.m. April 14–16. Second round and Best of Show begin the 17th at 9a.m., the crawfish will be served at 3:00 p.m. and the award presentation will begin at 6:00 p.m. Entry dates are March 15 through April 2. Fees are $6 per entry. For further information contact Chris Day via email at ciday@bellsouth.net or visit Crecent City's Website at www.hbd.org/crescent.

homebrew SYSTEMS that make you DROOL

Jens P. Maudal • Konnerud, Norway

(Top and middle): An interior and exterior view of Maudal's self-constructed hop-back. (Bottom): The entire brew system assembled in his home in Norway.

My brewing equipment has developed from a simple saucepan and cooling bag to what it is today. But while a good system makes the brew day more simple, I have found that advanced brewing systems are no guarantee for good beer — they still depend on a good brewer.

I must say it was a big disappointment when I first changed from the old immersion chiller to the counter flow chiller (CFC). I thought my beers lacked the hop aroma that I was used to with the old chiller and a test arranged by the Norwegian Home Brew Society confirmed my fears. Cooling with the simple immersion coil just after adding the aroma hops gives the best result. This led me to construct my own hop back or "hop percolator," with which I could pump the hot wort directly from the kettle through the aroma hops, then cool the wort immediately in the CFC. My brews improved immensely with the new system and I now experience hop aromas like never before.

I am also pleased with my RIMS setup. It works like a charm and gives me total control over the mash temperature as long as I don't crush my grains too fine. If that happens, the circulation slows and produces too little flow to perform the heating process. As long as the crush is kept fairly coarse, I have no problems with flow, even with wheat beers. Cleaning is tedious and boring, so I use the pump to help me out. A 2% caustic and water solution at 180 °F (80 °C) is pumped around the system using the kettle as the heat source. The solution is pumped from the kettle, through the RIMS heater to the mash tun, back to the kettle and finally through the CFC into the drains. At the end I rinse with clean, cold water in the same manner. To see more visit my Website at www.home.c2i.net/bottomsup/enter.htm.

(Top): The counterflow chiller allows Jens' control of his wort temperature.
(Bottom): A close-up of the RIMS heater and mash tun.

Honey and Candi

How sweet it is to be brewed with you

by Thomas J. Miller

Got a sweet tooth? If so, then the mere mention of sugar probably sends an anticipatory tingle through your limbs. Brewing sugars on the other hand play a role in beermaking that every serious homebrewer should learn. So relax, grab some Easter candy and discover how sugar makes for one sweet brew!

Brewer: Jim Olen started homebrewing in 1990 and attended Siebel Institute of Technology in 1994, completing a Diploma Course in Brewing Technology. In 1994 he started working as assistant brewer at Gray's Brewing Company in Janesville, Wisconsin. In 1996 he opened Titletown Brewing Company in Green Bay, Wisconsin and worked as brewmaster. From there he came to the Milwaukee Ale House when it first opened in 1997, and has been head brewer there ever since.

I have mainly used two brewing sugars over the past six years at the Milwaukee Ale House. The first is honey, which is used in the Downtown Lites Honey Ale (our most popular beer) and the second is Belgian candi sugar — used mainly for our seasonal Belgian style beers.

My use of honey as a brewing sugar is twofold: The main reason is to give the beer a certain lightness and drinkability. Secondly, it has a "pure and natural" appeal to our customers — we use 60 pounds of real Wisconsin honey in each 15-barrel batch.

Honey is about 95% fermentable, whereas the sugars derived from the mash are only 65–75% fermentable (this percentage depends on the temperature and thickness of the mash). Honey has the effect of producing wort that will result in a lower final gravity (than if all the sugars in the wort were from an all malt mash.)

I have found it best to add the honey at the end of boil. It is important to be sure to dilute the honey with very hot water (I dilute by 50%) before adding to the brew kettle, or the honey may stick to the bottom of the kettle and scorch. Adjust your recipe with this extra amount of water in mind.

Adding honey at the end of the boil kills any wild yeast or bacteria in the honey and neutralizes the natural diastatic enzymes, so as not to degrade the dextrins (non-fermentable malt-derived sugars) produced in the mash. Because the honey was not boiled, some honey flavor and aroma nuances can come through, though this may be difficult to detect. If you actually want to smell or taste honey, simply increase the amount you use in the recipe. Personally, I use honey to lighten the body, not necessarily for flavor or aroma.

For homebrewing I offer the following tips: Most homebrewers will want to have honey complement the flavors of the beer, not compete or overpower it. As a percent weight of the total grain bill, I recommend using 3–10% honey, which contributes a subtle honey flavor to the ale or lager. 11–30% provides a distinctly noticeable honey note. Keep this in consideration when thinking about what hops and specialty grains you'll use. Over 30% and the flavor of honey will likely dominate the other flavors in your beer and push it closer to the mead category. I use almost 7.5% honey by weight as a percentage of the grist bill for the Downtown Lights. The grist bill itself is comprised of two-row base brewers malt, some pale ale base malt for additional color and malt aroma and Carapils or dextrin malt, to add some body to the finished beer. For extract brewers, it is recommended that 6–9% of honey is used in with liquid malt extract, and up to 10% more for a more defined honey flavor.

Belgian candi sugar is crystallized beet sugar and usually comes in light, amber and dark — with the differences (from my palate) being solely in color and not flavor. It's widely used in strong Belgian (or Belgian-style) beers and is used to achieve alcoholic strength without letting the beer become too sweet. Belgian candi sugar is similar to honey in that it is highly fermentable, with most of the carbohydrates being converted into alcohol (and CO_2) by the yeast during fermentation. Candi sugar, unlike honey, does not contribute much flavor (other than alcohol flavor) itself used in higher amounts.

In producing a Belgian style hombrew, the beer does not necessarily have to be high in alcohol. You can use the sugar like honey to lower your final gravity and produce a flavorful beer that is lighter in body. Try some imported Belgian beers and let their flavor and body be a guide. Note the strength, and to be truly authentic, buy true Belgian yeast strains from your favorite local homebrew shop. Also, try cultivating some yeast from the bottom of a bottle of a Belgian import.

For homebrew calculations in using Belgian candi sugar: One pound of candi sugar will yield a gravity of 11.25 Plato, or a specific gravity of 1.045, in one gallon of water. Adjust the grain and extract requirements of your recipe accordingly if you add candi sugar. You can add the candi sugar at any point in the boil, keeping in mind that the sugar crystals are quite large and may require some stirring with a large spoon. At the Milwaukee Ale House, I used 66 pounds of light Belgian candi sugar in a Belgian style double that weighed in at almost 7% alcohol by volume.

Brewer: John Gillooly started his brewing career in 1995 at Redhook in Seattle, Washington. From 1997– 2002, he worked at Golden Pacific Brewing in Berkeley, California and Mendocino Brewing Co. in Ukiah, California. He has been with Dogfish Head in Lewes, Delaware since 2002.

The main reason for the use of kettle sugars is to lighten the flavor and body of higher gravity beers. This happens because the sugars are almost entirely fermentable — thus leaving behind little to no residual sweetness or body in their wake, only alcohol. The sugars also contribute distinct aromas to the beer.

In Belgium, candi sugar is the most traditional of the kettle sugars. It is a very pure sugar, made from recrystalized, concentrated sugar syrup. It comes in pale, medium and dark grades. The color comes from the degree of caramelization of the sugar syrup. Dark candi sugar is often used to darken beers, more so than specialty malts.

At Dogfish Head, we use candi sugar in two of our beers: Raison D'Etre, which uses dark candi sugar, and Au Courant, which uses pale candi sugar. In the Raison, we feel that the candi sugar contributes to a complex, toasty and caramelly aroma, while lightening the body of this 19.5 °Plato beer to the point that it is stealthy in its alcoholic punch.

In the Au Courant, the candi sugar plays a somewhat different role. As it was conceived as a 7% beer, we felt that getting all that extract from malt alone — even Pilsner malt — would leave too much malt and sweetness in the way.

If you want to get a good handle on how Belgian candi sugar impacts a beer, I recommend a simple experiment:

Make 5 gallons (19 L) of pale, 18 °Plato wort using about 12–13 lbs. (5.4–5.9 kg) Pils malt if all-grain or 10-11 lbs. (4.5–5.0 kg) pale malt extract. Only use bittering hops, at about 25 IBU. Split the wort in half at the end of the boil, adding 1 lb. (0.45 kg) pale candi to one half, and 1 lb. (0.45 kg) dark candi to the other half. Ferment with the ale yeast of your choice — something fruity and alcohol tolerant. Both White Labs and Wyeast have multiple strains that would be acceptable.

After fermentation, you will have two wonderful beers — a Belgian brown ale and a Tripel. You will also have learned a lot about the impact of candi sugar on a beer. ■

Head retention

"Help Me, Mr. Wizard"

Overhauling HERMS and more conical queries

Frothless wheat stout

For the past few batches I have been having difficulties with carbonation and head retention. I brew all-grain and recently brewed an oatmeal stout. Anticipating the problem, I mashed a half-pound of wheat to help. I bottled when the batch reached 1.024 with ¾-cup of corn sugar. After my two weeks in bottle, I was expecting a nice, fine frothy head. When I opened it, I heard the tell tale hiss of carbonation. But when I poured it into a clean glass, almost no head. I thought by brewing a stout, along with the wheat addition, I would be okay. What can I do to solve this problem?

Christopher Haas
San Jose, California

Beer foam is one of those things that seems to come magically when things are going right. Just as it can come without doing anything special it can also be frustratingly absent even when trying to lure it atop of a brew. The foam formula is really simple; you need to have foam-positive proteins and carbonation to produce beer foam. Hop acids improve lacing and highly hopped beers typically have better foam adhesion to the glass than those with lighter hopping. Foam is affected in a negative way by oils, fats and certain sanitizers. Oats contain considerably more oil than barley or wheat, and oats are frequently cited as foam-negative. Thus, it is highly probable that this is the problem with your stout's carbonation.

Foam seems so simple when explained briefly. It seems that any all-malt beer should produce good foam, but that is not the case. Although all brewers like to talk about foam, the reality is that some beers have better foam than others. Belgian, German and Czech beers all have great foam. Certain beers in England have good foam, but pints served in London have been known for being served with little if any foam because of local preference. I believe the foam found on cask beers is largely influenced by beer dispense. Nitrogen (from air "sparklers") is primarily responsible for the type of foam found in British ales. Continental beers have fluffier, drier foams that at times look like meringues.

One key difference between traditional British ales and continental lagers and ales is the type of malt used. Malts produced from barley grown on the British Isles are known for even and complete modification, whereas continental malts are known for their low level of modification. These differences explain why British brewers traditionally use infusion mashing and the European brewing tradition uses decoction and step mashing. While fully modified malts certainly are easy to mash, they do have different "proteins" than malts that are not as modified.

I put "proteins" in quotes because there are no native, malt-derived proteins found in beer. There are all sorts of polypeptides, formed from the breakdown of these proteins, with different sizes and properties. Although the entire foam story has not been completely explained by brewing researchers, most agree that foam-positive polypeptides are medium to large molecular weight molecules (25–100 kiloDaltons) with a strong hydrophobic character. It is also generally believed that under-modified malts contain more foam goodies than do fully or over-modified malts.

So what does this all mean? Brewers of all sizes sometimes over look the importance of their base malt. If you are brewing with fully modified ale malt, you may be getting the best foam you can from that particular ingredient. I brewed a Pilsner a few years ago with Briess Pils malt, which was new at the time. Although Mary Anne Gruber was as secretive about that malt as their Cara-Pils, she did tell me that modification was intentionally limited. The wort in the kettle had amazing white, fluffy foam as did the finished beer. Other than the malt and the hop variety, this recipe was very similar to our helles lager brewed with a fully modified pale malt. The foam quality however was markedly different.

You mention using malted wheat as a foam booster. A better ingredient for help with foam is unmalted wheat. Unmalted wheat can be milled and added to the mash just like wheat malt. The difference is that the unmalted wheat has much larger proteins and a more pronounced impact on foam. This ingredient is commonly used in Belgian ales. I use it at the rate of 0.75 pounds (0.34 kg) per 5-gallon (19 L) batch for an American-style wheat beer that has a beautiful foam. I've used the same basic recipe but without the unmalted wheat for a German-style hefeweizen and found that the foam was not as tight or stable as the American-style wheat. Again the main differences in these two beers are the unmalted wheat and the yeast strain.

If I were you I would be looking at the malt. Of course, it goes without saying that if you use inappropriate sanitizers, dirty beer glassware or have flat beer, you will have foam problems. I don't think you have those problems based on the information you have provided.

HERMS away!

I am about to switch to all-grain brewing and, after some success, I

plan to build a HERMS (Heat Exchanging Recirculating Mash System) style brewery. I would like the ability to do recirculating step mashes with my system, but I've heard that because of the long ramp time involved with the recirculation between each mashing step, that it is unwise to do anything other than a single infusion mash. What are the ill effects of this long ramp time? Is there anything I can do to avoid this in my design stage? I have heard the suggestions of doing a decoction mash or raising the temperature with boiling water, but then, what is the point of having a HERMS in the first place.

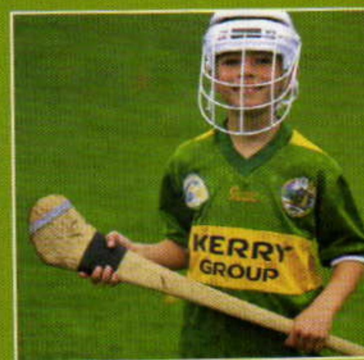
Craig Jones
Vincennes, Indiana

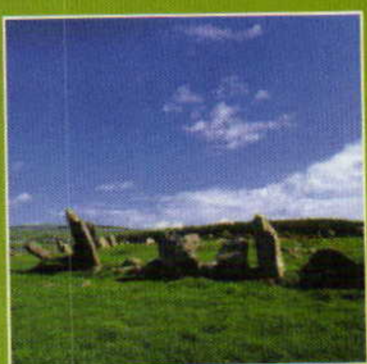
Let me start by stating that I have never personally used this method of mashing and my answer is based strictly on my review of the technique. The key parts are of the system are: a) a standard infusion mash tun with ball valve for wort flow control, b) a wort grant that serves as an atmospheric break between the mash tun and a pump, c) a centrifugal pump used for recirculation and wort transfer to the kettle, d) some sort of heat exchanger, e) an in-line thermometer to measure wort temperature and f) a supply of hot water to the heat exchanger. The system is identical to the RIMS setup except that the RIMS uses an electric heating element as the heat exchanger and not a water-based heating system.

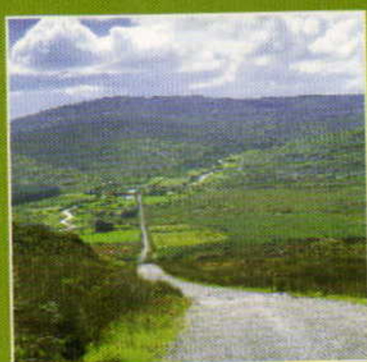
Everyone is entitled to his opinion, but I personally never liked the RIMS design because of the electric heating element. I judge designs largely by their similarity to equipment used in the commercial food and beverage industries and electric heating elements are not commonly used to transfer heat directly to edible products. When electric heaters are used in commercial food and beverage plants there is usually a secondary component used in the heating loop, typically water or oil. This makes heating control easier and eliminates fouling of the electric heating element. The HERMS design is really not much different than RIMS, it just uses a different style of heating. In fact, an electric heating element could be very conveniently used to heat the water required by the HERMS design.

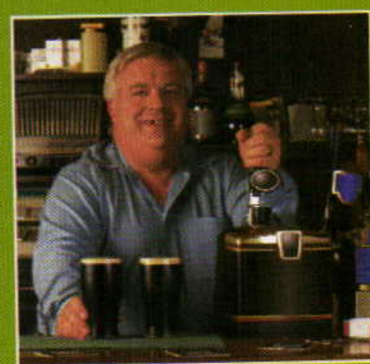
Ramp time is an important variable in a mash profile. A long mash ramp, specifically in the 140 °F (60 °C) to 158 °F (70 °C) range is the key to making highly fermentable worts associated with dryer beers. If you do not want this type of wort you need to minimize your ramp time or completely eliminate the rest at 140 °F (60 °C). With that said, I would recommend this method for brewing beers with a higher degree of wort fermentability than a standard, single temperature infusion mash. The key to the design is the heat exchanger itself and controlling the exit temperature of wort from the heat exchanger.

So how hot does the wort need to









MOUNTMELLICK BEERKITS

THE GENUINE ARTICLE

be for the unit to work? Ideally the wort temperature should not exceed the denaturation point of whatever enzyme rest you are heating toward. For example, if you are heating up for a beta-amylase rest at 140 °F (60 °C) you don't want the wort temperature exiting your heater to exceed about 145 °F (63 °C) because beta-amylase begins to denature around that temperature. The other key part of the denaturation equation is time because proteins denature at a given temperature after an elapsed time period. In both the HERMS and RIMS techniques, the wort is quickly returned to the mash and is cooled down by the mash volume. This concern is somewhat tempered. However, I strongly recommend a conservative heating approach.

I want to show a simple energy balance that permits one to estimate heating time. In this system there are two components being heated, malt and wort, and these components are being heated with the wort recirculated through the heat exchanger. I apologize for those with a phobia for metric units, but I need to jump into metric to keep this simple! The energy balance can be expressed with the following:

$$(MC_p\Delta t)_{\text{malt in mash}} + (MC_p\Delta t)_{\text{wort in mash}} = (MC_p\Delta t)_{\text{wort required for heating}}$$

Where M is mass in kilograms, Cp is specific heat expressed as kJ/kg*K (4.2 for water and 1.8 for malt) and Δt is temperature difference in Kelvins (which is the same difference if we simply use °C since K = 273 + °C). If this is confusing, just follow the math and it will make more sense!

In this example we have 12 kg of water (1 L water = 1 kg) and 4 kg of malt in the mash. The specific heat of wort and water are very close (wort is a bit lower than water) so I will treat wort as if it were water for this example. I want to know how long this will take to heat. In order to do this I first must determine how much wort must be cycled through the heat exchanger to accomplish the heating goals. This is where the brewer sets the rules. In this example I want to heat from 60 °C (140 °F) to 68 °C (154 °F) using hot wort at 72 °C (162 °F), which according to German brewing texts is not above the denaturation temperature of alpha-amylase. OK, time to plug and chug through the equation. The units in this equation all cancel out properly and I have stripped the units off of the numbers to make this easy to follow:

$$(4)*(1.8)*(68-60) + (12)*(4.2)*(68-60) = (x)*(4.2)*(72-68)$$

$$x = 27 \text{ liters } (7.1 \text{ gallons})$$

This means that 27 liters (7 gallons) of wort need to be recirculated to heat the mash assuming that the heat exchanger works properly and there is no heat loss to the environment. If the mash tun can flow wort at 1 liter per minute (0.3785 gpm) without collapsing the bed, then this ramp time is 27 minutes. This heating time is slow compared to what commercial breweries use for most brews and is best suited for dry beers. The standard heating rate of commercial mash mixers is 1 °C per minute compared to this calculated heating rate of 0.30 °C per minute. That is how the math works out for the heating side.

The heart to this topic, however, is the performance of the heat exchanger. A pot of hot water with a copper coil carrying wort, for instance, is a lousy heat exchanger. This is true because the water is not moving. An ideal heat exchanger has turbulent flow on both the product and utility (hot or cold water) sides of the heat exchange surface. If the flow is not turbulent the heat transfer coefficient or "U-value" suffers. In a system where the heating water is just sitting around, the U-value becomes ridiculously low because a film of cool water builds up around the copper coil and interferes with the objective at hand. The U-value is important since the required heat transfer area increases proportionally as the U-value decreases ($Q=UA\Delta t$, where Q is total energy exchanged, U is U-value, A is area and Δt is temperature change).

If I were to design or buy a HERMS set-up I would only accept a heat exchanger with counter-current flow like those used for wort chilling. The cheapest type of counter-flow heat exchanger is a tube-in-tube design. A more effective type (also more expensive) is the plate heat exchanger. Plate heat exchangers are used in commercial breweries for wort cooling. Lots of good information is available on this engineering topic and you can read more at the library if needed. Good luck and happy brewing!

Conical shmonical

Your reply to the "Quizzical on Conicals" question in the January-February 2004 issue was the most useful information I've read in years. About a year and a half ago I bought a polyethylene cylindroconical fermenter and I haven't brewed a really good beer since. I couldn't figure out where the off flavors were coming from but I now have a pretty good idea.

I have two additional questions on the same subject to round out my learning. In sanitizing the fermenter I have been putting in a gallon or so of diluted Iodophor and scrubbing the sides with a stiff brush — the kind you scrub out the john with (albeit I bought it new for this purpose and it has never seen the bowl). Am I creating microscratches that could be working against me? Once I filled it with water and dumped in a stiff shot of chlorine bleach but it stunk of chlorine for weeks. Secondly, how do you recommend dry hopping with such a fermenter?

William P. Winter
Silver Spring, Maryland

I am glad to hear that you found my information useful and that you now have more questions about your equipment. I think asking a lot of questions is a great way to expand your knowledge. Extremely stiff bristles can scratch plastic if applied with enough force. I just examined my toilet brush made by Rubbermaid and it has pretty soft bristles and no metal parts. Some brushes use a twisted wire design to hold the bristles together and also to act as a handle. These are the types of brushes that can scratch plastic, metal and glass. If you simply want to swab the sanitizer across the surface of your equipment you could use one of the sponges with a plastic handle used to clean glasses and not have to worry about scratches.

Another problem with plastics that I failed to mention in the last issue is their ability to hold aromas. You found this to be true with chlorine. The same thing can happen with other aromatic compounds such as raspberry and root beer flavors used by many homebrewers. Not only can these ingredients leave trace aromas in plastic fermenters, but they can also do the same with draft lines.

With respect to dry hopping, I would suggest doing that in either glass or stainless steel because of the oxygen ingress issue I discussed in the last issue. When I dry hop, I like to limit the time that the beer sits on the hops. This means removing the hops from the beer. Several methods can be used for hop removal and include racking and popping the lid off of the keg and fishing the hop bag out. I prefer racking because opening the lid of a keg exposes beer to oxygen and I do everything I can to minimize the chance of oxidation. Thanks for the feedback and the followup questions! ■

Do you have a question for Mister Wizard? Write to him c/o Brew Your Own, 5053 Main Street, Suite A, Manchester Center, VT 05255 or send your e-mail to wiz@byo.com. If you submit your question by e-mail, please include your full name and hometown. In every issue, the Wizard will select a few questions for publication. Unfortunately, he can't respond to questions personally. Sorry! Who is Mr. Wizard? Stay tuned!

Bohemian Pilsner

The world's first blond lager

by Horst D. Dornbusch

There are scores of ordinary beer styles, dozens of good beer styles, but perhaps only a handful of truly great ones. Among these really great beer styles, some cognoscenti would argue that there is only one that occupies the very pinnacle of beerdom: Bohemian Pilsner.

There are many styles, such as bockbier, hefeweizen, lambic, porter, rauchbier and stout, that are outstanding. Considering what makes a beer style truly great, the Bohemian Pilsner qualifies perhaps more than any other for top billing.

Today, Pilsner-style beers are made in just about any country in the world by breweries both large and small. When brewed to resemble the style's signature brand, the Pilsner Urquell from the city of Plzen in the Czech Republic, it produces an unmistakable and thrilling taste experience. Pilsners have shown staying power and are clearly not a passing fad. They have been drunk by kings and paupers alike for more than one and a half centuries.

To be sure, there are enormous variations in character and quality among beers that call themselves Pilsner (or Pilsener or Pils) on the label. As many as nine out of 10 beers in the world are brewed in the Pilsner way. A true Pilsner is a beer of exceptional delicacy and gentleness of palate. It should have a rich golden color, a clean, mellow, full-bodied malt flavor from the best two-row summer barley and a dry but soft, rounded hop bitterness, with an aftertaste that is allowed to linger in delightful reverberations.

bohemian pilsner by the numbers

OG	1.044–1.048 (11–12 °P)
FG	1.010–1.012 (3.5–4 °P)
SRM	usually 3–6
IBU	usually 40
ABV	usually 4.4–4.6%

Ode to Plzen

The name Pilsner derives from Pilsen, the German name for the Bohemian city of Plzen. Bohemia is part of the Czech Republic. All beers from Plzen are spelled without the middle "e." Pilseners with a middle "e" owe their spelling to German grammar: In theory, though not in universal practice, the name Pilsner implies that the beer is made in Pilsen, while the name Pilsener implies that it is made elsewhere, but like a beer from Pilsen. Finally, Pils is the abbreviated name for a Pilsner-like beer.

The good burghers of Pilsen had been brewing beer at least since 1295, when King Wenceslas II of Bohemia founded the city and gave inhabitants the right to brew. There is documentary evidence suggesting that by 1307 Pilsen already had its first commercial brewery. In gratitude, the brewers of Pilsen soon elevated their king to the lofty position of patron saint of their profession. All the early beers brewed in Pilsen under Wenceslas' saintly privilege were dark ales — and this quality remained well into the 19th century.

Apparently, the erstwhile glory of Pilsen ales had taken a nosedive about 200 years ago. We know, for instance, that in 1838, the city council even ordered 36 casks of the ale be dumped in public, because they were judged unfit to drink. Imported bottom-fermented brews from neighboring Bavaria and Austria, by contrast, were rising in popularity.

As the local brews were losing ever more market share to these lager imports, the citizens of Pilsen stuck their heads together and hatched a drastic plan: They would invest in a state-of-the-art brewery. In the 1840s, that meant a brewery capable of making Bavarian-style lagers. They named the new installation Mestansky Pivovar (Burghers' Brewery).

Because Bavarian brew masters were held in high regard, citizens of Pilsen sent Martin Stelzer, the head of

RECIPE

Groll's Pilsner

(5 gallons/19 L, all-grain)
OG = 1.046 FG = 1.011
IBU = 40 SRM = 3.5 ABV = 4.4%

Ingredients

- 7.33 lbs. (3.3 kg) pale Pils malt (such Weyermann Pilsner) (1.5–2 °L)
- 0.75 lbs. (340 g) Weyermann Acidulated malt (1.7–2.8°L)
- 0.75 lbs (340 g) Weyermann Carafoam or Briess Carapils (2 °L)
- 0.5 lbs. (225 g) Munich malt (10°L)
- 9.3 AAU Czech Saaz hops (bittering) (2.33 oz./66 g of 4% alpha acid)
- 1 oz. (28 g) Czech Saaz hops (flavor)
- 0.5 oz. (14 g) Czech Saaz hops (aroma)
- 0.3 oz. (8.5 g) Irish moss
- 1 package of Czech-style lager yeast (such as Wyeast 2278, Wyeast 2124, White Labs WLP800 or White Labs WLP802)
- 1 cup DME or corn sugar (for priming)

Step by Step

The above grain bill of is calculated for a net kettle volume at the end of the boil of 5 gallon (19 L). The wort OG of 1.046 (11.5 °P) is produced in a brew system with an extract efficiency of approximately 65 percent. Adjust grain quantities if your system is more or less efficient.

Dough in with roughly 2.33 gallons (8.8 L) of brewing liquor to make a thick mash of approximately 100 °F (38 °C). Let rest for about one hour. At this temperature, an enzyme called phytase will become active and slightly acidify the mash. Then use direct heat and a boiling water infusion of 1 gallon (3.8 L) to raise the temperature to approximately 120 °F (49 °C).

This temperature is within the proteolytic conversion range. Rest for

continued on page 22

Bohemian pilsner recipes continued

continued from page 21

20 minutes. Again, use direct heat and a boiling water infusion of 1 gallon (3.8 L), this time to raise the mash temperature to approximately 150 °F (66 °C). This temperature is within the peak beta-amylase conversion range. Rest for 20 minutes.

Repeat the infusion to raise the mash temperature to approximately160 °F (71 °C). This temperature is within the peak alpha-amylase conversion range. Rest again for 20 minutes. The next infusion brings the mash to the mash-out temperature of about 170 °F (77 °C). Start lautering.

Sparge with the remaining water while maintaining the mash-out temperature. Discontinue the sparge when the kettle gravity reaches about a gravity of roughly 1.042 (10.5 °P).

Boil for 90 minutes. After evaporation losses during the boil, the kettle gravity should be at the target OG of 1.046 (11.5 °P). Add the bittering hops 15 minutes into the boil, the flavor hops 60 minutes into the boil and the aroma hops and Irish moss 10 minutes before shutdown. Let the wort settle for 30 minutes and heat-exchange to the fermentation temperature of roughly 50 to 55 °F (10 to 13 °C).

Aerate and add the yeast. Ferment for two weeks. Rack into a clean vessel for lagering. Pull the temperature down as close to the freezing point as you can. Lager for at least six weeks. In the "old days," Pilsners were lagered for about three months in 25-hectoliter wooden casks in sandstone cellars underneath the brewery. At the end of the lagering period, rack again, prime and package.

Groll's Pilsner

(5 gallons/19 L, partial mash)
OG = 1.046 FG = 1.011
IBU = 40 SRM = 6 ABV = 4.4%

Ingredients

6.1 lbs. (2.8 kg) Weyermann Bavarian Pilsner LME
0.75 lbs. (340 g) Weyermann Acidulated malt (1.7 – 2.8 °L)
0.5 lbs. (225 g) Munich malt (10 °L)
9.3 AAU Czech Saaz hops (bittering) (2.33 oz./66 g of 4% alpha acid)
1 oz. (28 g) Czech Saaz hops (flavor)
0.5 oz. (14 g) Czech Saaz hops (aroma)
0.3 oz. (8.5 g) Irish moss
1 package of Czech-style lager yeast (such as Wyeast 2278, Wyeast 2124, White Labs WLP800 or White Labs WLP802)
1 cup DME or corn sugar (for priming)

Step by Step

Crack the 0.75 lbs. (340 g) Weyermann Acidulated malt and 0.5 lbs. (225 g) and place them in a muslin bag. Immerse the bag in about 2 gallons (7.5 L) of brewing water at about 170 °F (75 to 77 °C) for about an hour. Rinse the bag with 2–3 cups of cold water, but do not squeeze it. In the kettle, bring the grain tea to a boil, then turn off the heat. Stir in the LME. Top of with brewing liquor to the desired volume and bring to a boil. Follow the all-grain instructions for adding the hops and Irish moss. At the end of the boil, liquor the wort down to the required target gravity of OG 1.046. For heat-exchanging, fermenting and packaging, follow the all-grain instructions.

Groll's Pilsner

(5 gallons/19 L, extract with grains)
OG = 1.046 FG = 1.011
IBU = 40 SRM = 5 ABV = 4.5%

Ingredients

6.25 lbs. (2.8 kg) Weyermann Bavarian Pilsner LME
0.75 lbs. (340 g) Weyermann Acidulated malt (1.7–2.8 °L) (OPTIONAL)
9.3 AAU Czech Saaz hops (bittering) (2.33 oz./66 g of 4% alpha acid)
1 oz. (28 g) Czech Saaz hops (flavor)
0.5 oz. (14 g) Czech Saaz hops (aroma)
0.3 oz. (8.5 g) Irish moss
1 package of Czech-style lager yeast (such as Wyeast 2278, Wyeast 2124, White Labs WLP800 or White Labs WLP802)
1 cup DME or corn sugar (for priming)

Step by Step

Crack the optional 0.75 lbs. (340 g) Weyermann Acidulated malt and place them in a muslin bag. Immerse the bag in about 2 gallons (7.5 liters) of brewing water at about 170°F (75 to 77 °C) for about an hour. Rinse the bag with 2 – 3 cups of cold water, but do not squeeze it. In the kettle, bring the grain tea to a boil, then turn off the heat. Stir in the LME. Top off with brewing liquor to the desired volume and bring to a boil. Follow the all-grain instructions for adding the hops and Irish moss. At the end of the boil, liquor the wort down to the required target gravity of OG 1.046. For the rest, follow the all-grain instructions. Enjoy!

the Mestansky Pivovar, across the border to hire a Bavarian lager brewer. Stelzer's choice fell on a 29-year old fellow named Josef Groll, whom he found in the Bavarian village of Vilshofen (some 100 miles northeast of Munich). Little did Stelzer know that they had just written the first act of a drama that would revolutionize beermaking throughout the world.

Josef Groll mashed the first brew at his new place of employment on October 5, 1842 and it was unlike any beer that had ever been made. Instead of using the standard dark malts of his day, Josef took protein-rich summer barley from Moravia (like Bohemia, a part of the Czech Republic) and malted it to a very pale color — a technique that had only recently been perfected in Britain.

Groll's brewing liquor came from a well with extremely soft water. He flavored his brew exclusively with the finest local hops from the Zatec region in northern Bohemia, which produces some of the most fragrant and aromatic of all noble hop varieties. Today this hop is known as Saaz, which is the German name for Zatec.

He fermented his wort with Bavarian lager yeast that had been smuggled into the country. What gave Groll his inspiration for these innovations nobody knows, but the result was an aromatic, golden-blond, full-bodied lager, which he served to the public for the first time on November 11, 1842, during the city's Saint Martin's Day celebration.

Groll's lager created an instant sensation. Initially, it was called Plzensky Prasdroj, meaning "Pilsen's original source." Later, the brewery changed its name from Mestansky Pivovar to the Czech name of its beer Plzensky Prasdroj, but translated the name of its beer into German, Pilsner Urquell.

Ur means "original" and quell means "source" in German. In either language, the name is fitting for a beer that was the world's very first blond pale lager that was to evolve into perhaps the greatest beer style ever.

If imitation is the most sincere form of flattery, the lager from Pilsen is clearly unrivalled. As a style, it has been copied with some local modification — though never equaled — in virtually every country in the world. Many of the worldwide imitators may be good in their own right, but Pilsner Urquell will always remain distinctive.

Water, Malt and Mash-pH

There are few beer styles in which water plays as great a role as in a Bohemian Pilsner. In fact, among all the great brewing centers of the world, Pilsen's water ranks at the soft extreme of the scale, while Dortmund and Burton-on-Trent waters, for instance, rank at the opposite, hard extreme.

While hard water accentuates up-front hop-bitterness, extremely soft water suppresses it. Because of the soft water, this beer is rounded, not rough, in spite of the relatively high hop loading. For the home Pilsner maker, therefore, it is best to purchase distilled water as brewing liquor. Because of water losses both with the spent grain and from evaporation during the kettle boil, all-grain brewers should probably purchase at least 7.5 gallons (roughly 28.5 liters), while extract brewers can probably get by with about 6 gallons (roughly 23 liters).

Next, add 10 percent of your grain bill in acidified pale Pils malt. Partial-mashers and extract brewers should steep 0.75 pounds (340 grams) of cracked acidified malt in 2 gallons (7.5 L) of brewing water at 170 °F (75–77 °C) for an hour.

It has a color rating of 1.7 to 2.8 °L. If used by itself, it makes a mash with a pH of 3.3 to 3.6. This malt contains between 1–2 percent lactic acid and usually reduces mash pH by approximately 0.1 units for each 1 percent addition of this grain to the malt bill.

To give the Pilsner its full-bodied mouthfeel, add another 10 percent of a very pale caramel malt to the grain bill. Good choices are Weyermann Carafoam or Briess Carapils. These malts have a color rating of approximately 2 °L. Partial mashers and extract brewers do not need to worry about the pale caramel component, if they choose the recommended Weyermann Bavarian Pilsner Extract, because this LME already contains the necessary caramel malt.

> If imitation is the most sincere form of flattery, the lager from Pilsen is clearly unrivalled.

The Weyermann product is made entirely from a decoction mash of Weyermann Pilsner Malt and Weyermann Carafoam. At an OG of 1.046 (11.5 °P), this LME makes a blond brew with a color rating of 5.3 to 6.2.

Finally, to give the Pilsner a touch of golden color, add about 6–7 percent 10 °L Munich malt to the grain bill. The rest of the grain bill is composed of two-row pale Pils malt. Good choices are Pilsner malts from Weyermann or Briess. They have a color rating of 1.5–2 °L. Do not use pale ale malts though — their color rating of 2.5–3.5 °L is just a touch too dark for a typical Bohemian blond.

Discussions about the original Bohemian Pilsner always seem to lead to the topic of modification. It is true that the malts of the mid-19th century, made from such Moravian barley varieties as Hanna, were indeed undermodified by modern standards. "Undermodified" simply means that the barley's proteins have not been fully degraded in the malt house and must be degraded in the brew house.

While undermodified malt was the norm in Josef Groll's day, you now have to ask for it specifically. One of the best methods of processing undermodified malt is a double or triple decoction. Some traditionalists maintain that a lengthy multiple decoction is the only way to brew an authentic Bohemian Pilsner. Others argue that this is quite unnecessary with modern ingredients. Our recipe takes the compromise route.

It is formulated for well-modified malt conveniently mashed in a multi-step infusion. If you wish to optimize the flavor of your Pilsner, though, you get better results with continental European Pils rather than North American Pils malts. The former are made from barley varieties that are more suitable for European-style lager brewing (such as Scarlett, Barke, Steffi or Alexis), while the latter are often made from such two-row malts as Harrington, which is more suited for ale brewing.

Hops

The hops prescription for Bohemian Pilsner could not be simpler: Saaz, Saaz and Saaz — for bittering, flavor and especially aroma. The original Czech Saaz tends to be slightly more expensive than its North American grown equivalent. It also has more aroma oils and lends more of the soft, flowery and round Saaz finish. However, whenever you have a choice between domestic and imported hops, it is wise to buy the freshest regardless of origin.

Yeast

Bohemian Pilsners, though originally fermented with Bavarian lager varieties in the 19th century, have since developed their own signature yeast strains. This being said, you should ferment your Bohemian Pilsner with a specialist such as Wyeast 2278 (Czech Pils) or White Labs WLP800 (Pilsner Lager) yeast. ■

Horst Dornbush is the author of "Prost! The Story of German Beers" (1997, Brewers Publications) and BYO's Style Profile columnist.

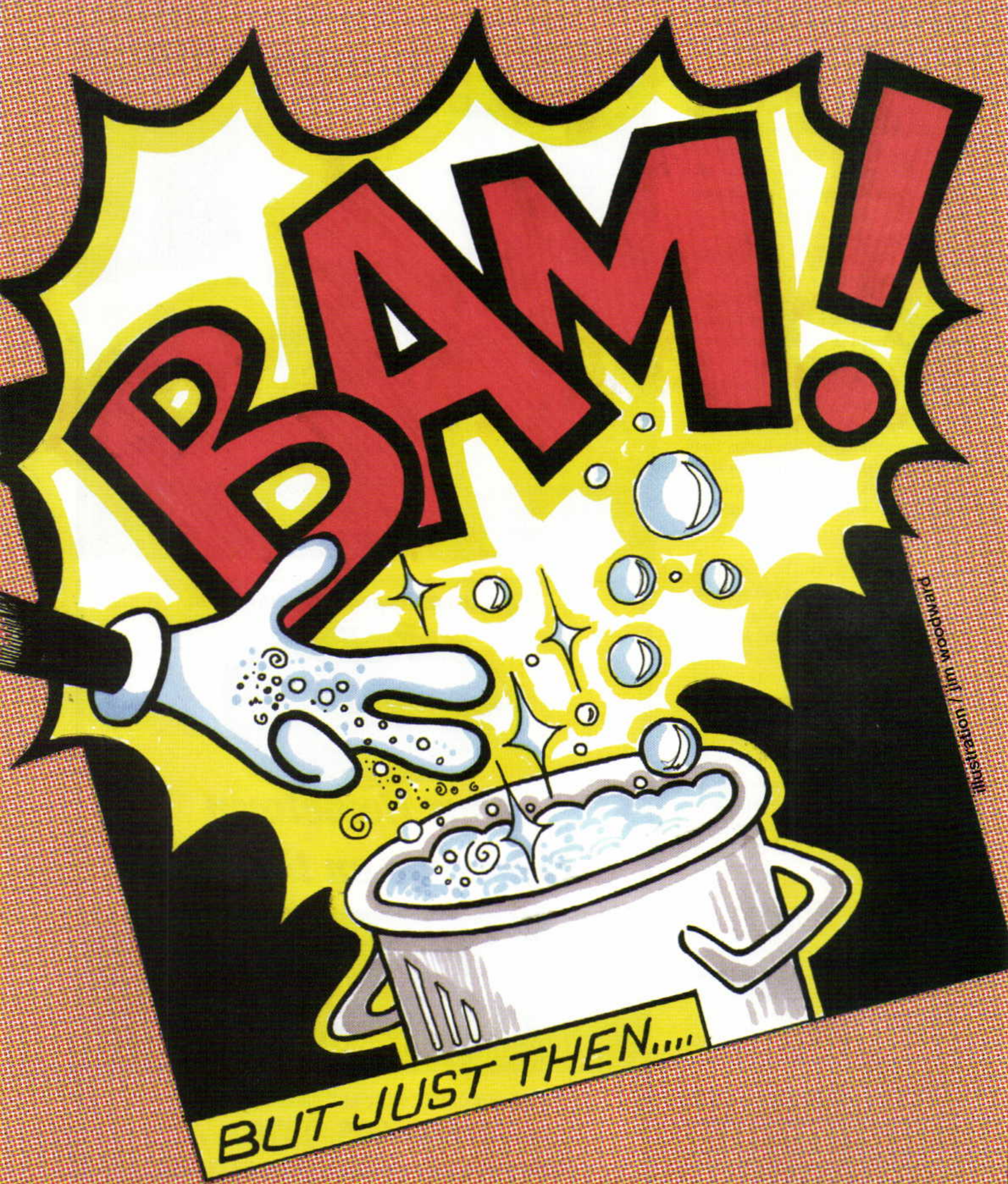


illustration / jim woodward

KICK UP your kit

Learn how to take your kit up a notch

TV chef **EMERIL LEGASSE** likes to take a plain recipe and soup it up, no pun intended. He will flip a pinch of spice into the pot from behind his back while mugging: **"BAM!** Let's kick it up a notch!" Any kit brewer — whether using simple, all-extract kits or "complete" kits that include malt extract, specialty grains, hops and a tube of liquid yeast — can "kick it up" by adopting one or more of the following "pinches of spice" offered here. Oh Boy! Here we go!

by **Marlon Lang**

Types of Beer Kits

The most basic beer kit consists of a 3.3 pound (1.5 kg) can of liquid extract and a packet of dry yeast. Often these kits direct you to combine the extract with a few pounds of sugar. Many homebrew shops offer more advanced kits that contain one or more types of specialty grain, liquid or dry malt extract, hops for bittering, flavor and aroma and priming sugar. (Sometimes these "kits" are really recipes from the shop's recipe book.) There are even beer kits that emulate wine kits with liquid wort packaged in large bags. Kits are definitely capable of producing great beer. Whatever type of kit you have, there are always enhancements available that will improve your beer.

Tip1. Malty or Dry? Does your kit instruct you to add sugar along with your malt extract? If so, you may have an opportunity to improve upon the recipe formulation. If the kit specifies a lot of sugar — anything over 1.5 lbs. (0.68 kg) — you can swap some or all of the sugar for dried malt extract. Adding dried malt extract (DME) in place of sugar gives the beer a maltier flavor. If you want a very malty beer, replace all of the sugar with dried malt extract. (You can swap the amounts one for one and not seriously change the projected strength of the kit.) If you want a moderately full-bodied beer, reduce the amount of sugar to less than a pound and replace the rest with dried malt extract. If you're trying to make a light-bodied beer, keep up to two pounds of sugar in the formulation and replace the rest with dried malt extract.

Tip 2. Add Specialty Grains. Does your kit contain a little bag of crushed grain? If not, you can kick up your beer flavor a bit by adding some specialty grains. If you are making a golden or light-colored beer, try adding 0.25 lb. (0.11 kg) of CaraPils or light crystal malt (with a color rating of 10–20 °L) to your recipe. For a red or amber ale, add 0.5 lb. (0.23 kg) of moderately dark crystal malt (30–40 °L). For darker beers, you can add a bit of crystal along with some darker malts; 0.5 lb. (0.23 kg) of crystal along with 0.25 lb. (0.11 kg) of chocolate malt would improve any all-extract porter. Likewise, adding 0.25 lb. (0.11 kg) pound of roasted malt to all-extract stout can add some roastiness. Adding a small amount of specialty malt will not drastically alter the character of your beer. It will just make the beer a little darker and little stronger — but is that such a bad thing? More importantly, the flavor of your beer will improve.

Tip 3. Steep small. Does your kit instruct you to steep your specialty grains in the full amount of brewing water? This is a good way to get the most flavor from the grains, but it's also a good way to extract harsh tannins from the grain. For a better steep, place your crushed grains in a nylon or muslin steeping bag and add only enough water to your brewpot to cover the grains. Steep the grains at temperatures anywhere from 130–170 °F (54–77 °C). When you are done, lift the grain bag out and let it drip for 15 seconds or so. If you steep the specialty grains in a separate small pot, you can be heating the bulk of your brewing water in your big brewpot during the steep. Just add the "grain tea" from the little pot to your big pot when it's ready — in about 30 minutes.

Tip 4. Do a Partial Mash. Think you can handle a "small steep?" If so, you should consider trying a partial mash. Here's one way to do it: Add a small amount — either 1.0 lb. (0.45 kg) or an amount equal to the weight of the specialty grains combined, whichever is larger — of crushed 2-row pale malt to your grain bag. (You can also use pale ale malt or Pilsner malt.) Now, follow the steeping instructions above with one small change — keep the temperature between 148 and 158 °F (64 and 70 °C) and let the grains "steep" for 45 minutes to 1 hour. That's it — BAM! You're partial mashing. A partial mash beer is going to have a better grain flavor than a beer with only steeped specialty grains. Adding a pound of 2-row malt will make your beer slightly stronger, of course. If this worries you, just subtract 0.66 lbs. (0.29 kg) LME or 0.50 lbs. (0.23 kg) DME from the recipe. Or, don't worry about it and enjoy a beer that not only tastes better, but is slightly stronger.

Tip 5. Add Hops. Does your kit contain a little bag of hop pellets? Do you like hops? I think you can see where this is going. All-extract kits are not typically hopped to the level that American homebrewers prefer. If your kit lacks a hop addition — and the kit instructs you to boil the wort — a sprinkling of hop pellets can boost your beer's bitterness. Hops added near the beginning of a boil add hop bitterness. For English ales, such as bitters or pale ales, add between 0.5—1.0 oz (14–28 g) of hop pellets of either East Kent Golding or Fuggles. Add up to 1.5 oz. (43 g) for IPAs. For American style ales, try 1.0–2.0 oz. (28–57 g) of Cascades or 0.25-1.0 oz. (7–28 g) of Chinook (a more strongly bitter hop variety). For German style beers, which are typically not as bitter as English or American styles, try up to 0.75 oz. (21 g) of Hallertau, Tettnanger or Saaz hops.

A 0.5–1.0 oz. (14–28 g) addition of any of these hops at 15 minutes remaining boil time will add hop flavor to your beer. A 0.5–1.0 oz. (14–28 g) addition at 5 minutes or less will add hop aroma to your brew. As before, you're not totally altering the beer — you're just kicking it up a notch.

Tip 6. Make a Yeast Starter. If you use liquid yeast from a tube or slap-pack, making a starter a day or two ahead of brew day will insure that you have a healthy and plentiful family of yeasty-beasties to start chewing up the sugars in your wort. I did a web search for "yeast starter" and got 2794 hits. Here is one way to do it: Dissolve one cup of extract in 1 qt. (~1 L) of water and bring to a boil. Let cool to room temperature then put a 0.5 qt. (0.5 L) of each into two sterile Mason jars. Shake each vigorously to aerate, then combine with the yeast back into one Mason jar. Cap, but leave the lid slightly loose to permit CO_2 to escape. Add your yeast to this starter 2–3 days before brewing. Add the whole thing to your wort once it's cooled. If you use dried yeast, pitching a couple packages should give you a sufficient cell count.

Tip 7. Filter Your Water. Beer is 97% water — so use good quality water when you brew. A simple, faucet-mounted carbon filter will remove most of the compounds in treated municipal water that can negatively impact your beer.

Tip 8. Boil Bigger . . . or at Least Better. Just as there's more than one way to peel garlic, there's more than one way to boil your wort. Let's run down your options.

A full wort boil: My definition of a full wort boil is boiling the entire volume, less evaporation losses, of wort that will go into the fermenter. A full wort boil lets you extract more bitterness from your hops and darkens your wort less. If you can manage a full wort boil, this is the way to go. To boil your full wort, you either need a pot big enough to hold your entire wort or to boil the wort in shifts. If your boiling pot is not large enough to hold all your wort, plus a few gallons of headspace for foaming, see Chris Colby's "Texas Two-Step Method" article (October 2003 *BYO*) for a way to produce your wort in two steps.

Add the extract late: Even if you're saddled with a small brew pot, you can still tweak some boil variables to get a better boil. If your kit contains liquid malt extract, you can add the bulk of it at or near the end of the boil. To do this, add one or two pounds of your malt extract to the kettle at the beginning of your boil, but withhold the rest. Add your hops at the times specified in the recipe. With 15 minutes left in the boil, turn off the heat and stir in the remainder of the extract. Resume heating for the remaining 15 minutes, but don't worry if the wort doesn't return to a boil. See Steve Bader's "Boil the Hops, not the Extract," (October 2002 *BYO)* for another variation on this theme, in which you add the liquid malt extract at knockout.

Adding the extract late lets you brew pale ales that are actually pale, not red. Plus, you don't have to add a whole hopper of hops to get the degree of bitterness you want. This advice runs counter to much homebrew lore, but many liquid malt extracts are already boiled during their production. Remember the mantra, "Don't fix what ain't broke?" In this case, it translates to "Don't boil what don't need boiling."

Tip 9. Cool it! Many kits instruct you to pour hot wort directly into your fermenter. Some even want you to pour it through a strainer. Don't do this. Always cool your wort prior to transferring it from your brew kettle. Moving hot wort around darkens it and may make your beer go stale faster. Cool your wort first, then move it to your fermenter.

Finally, don't forget your Emeril Legasse imitation. When you add flavor hops to your pot, why not flip them in from behind your back and say, "BAM! I just kicked it up a notch!" ■

Marlon Lang wrote about PID control in the November 2003 issue of BYO.

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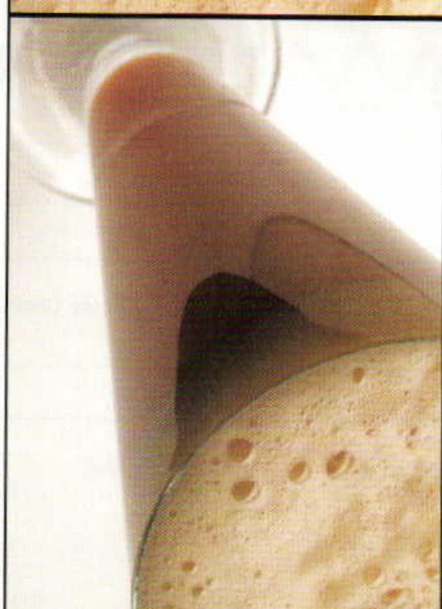

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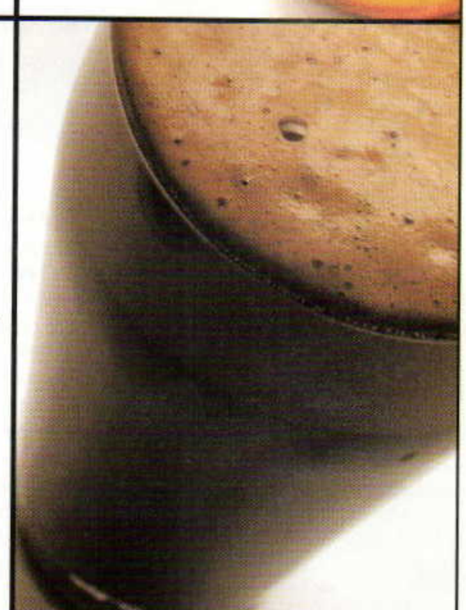


photography by CHARLES A. PARKER

By Dr. Chris White

We spend a lot of time classifying beer into certain styles, such as American pale ale and European dark lager. The yeast a brewer selects plays a big part in defining the flavor and aroma of most beer styles. In this article, we'll take a look at different types of yeast and how they influence the beers we brew with them.

Ale yeast

Ale has been brewed since at least ancient Egyptian times. Ale yeast goes by the latin name *Saccharomyces cerevisiae* and this species includes bread yeast, distillers yeast and many laboratory yeast strains. Ale yeast is distinguished by their unique flavor production. The use of bread yeast or other "wild yeasts" by brewers would result in phenolic tasting beer. Ale yeast, as well as lager yeast, do not produce phenolic tasting beer because they have a natural mutation that prevents it from production of phenolic off flavors. (Specifically, brewers yeasts — sometimes called POF (-) strains — lack ferulic acid decarboxylase, the enzyme that decarboxylates ferulic acid to produce 4-vinyl guaiacol.) Ale yeast do what a brewer wants: they ferment quickly, consume the correct profile of sugars, tolerate moderate alcohol levels and can survive the anaerobic conditions of fermentation.

There are a huge variety of ale yeast strains. In fact, all wheat and Belgian strains are classified as ale yeast. For the purposes of this article, however, they will be treated separately. Because of the large variety of ale yeast strains, there are many differences in performance among these yeasts. They flocculate differently, attenuate differently and produce different flavor profiles.

They do have some similarities, however. Almost all ale strains have an ideal fermentation temperature that hovers around 68 °F (20 °C). Most ale yeast will tolerate conditions to 95 °F (35 °C), but they produce the best flavors when they ferment at 68 °F (20 °C). Flavors that ale yeast produce are varied. If they produce a small quantity of these flavor compounds, they are known as "clean" fermenters. The more esters and fusel alcohols, the "fruitier" the yeast is considered. The late George Fix — in his book, "An Analysis of Brewing Techniques" — uniquely labeled these as group 1 and group 2 ale yeasts, respectively. Examples of clean, group 1 yeasts offered by White Labs include WLP001 (California Ale), WLP029 (German Ale/Kölsch) and WLP051 (California V Ale). The clean fermenting ale strains are very popular, because they can produce lager-like beers using ale techniques and fermentation times. They usually ferment a little slower than other ale yeast and exhibit medium flocculation properties, which ensure they will be in the beer long enough to condition it properly. They can also produce trace sulfur, but not as much as lager yeast strains.

Ale yeast are famous for their ability to top ferment. After the first 12 hours of fermentation, many ale yeast strains will rise to the surface and ferment from the top of the beer for 3–4 days. This allows brewers to collect the yeast from the top, a practice called top cropping. The advantage of top cropping is a great crop of yeast, healthy and with little protein mixed in. The disadvantage of this method is the exposure to the environment. If the fermentation room is not sanitary, the yeast can easily be contaminated. There are few homebrewers that top crop, but I suggest giving it a try. The strains WLP001 (California Ale), WLP004 (Irish Ale), WLP013 (London Ale) and WLP300 (Hefewiezen) are strains that are particularly well suited for this. Homebrewers that ferment in glass will have trouble cropping the yeast through the small opening, but if fermenting in plastic buckets, this can be done with good cleaning practices. It is worth doing as an experiment, and you the brewer can evaluate its effectiveness.

Ale yeast that produce fruitier beers are less versatile, but extremely interesting. The strains WLP002 (English Ale), WLP004 (Irish Ale) and WLP005 (British Ale) are examples of fruity, group 2 yeasts. These are yeasts of distinction and can add a lot of character to your beer. They ferment at the same temperature as clean fermenters, but in doing so create more compounds that are excreted from the yeast cell. They usually flocculate quickly, which aids in leaving acetaldehydes and diacetyl in solution. It's fun to produce a beer with highly flocculent yeast because it looks different while fermenting. (Lots of chunks!) Then the yeast drops out right when fermentation is done. The beer can be bottled and consumed rapidly. These strains usually do not top crop as well because they flocculate too quickly.

For ale yeasts, a pitching rate of 5–10 million cells per milliliter promotes cell growth and good beer flavor. For a 5-gallon (19 L) batch of beer, this corresponds to the amount of yeast from a 1–2 qt. (~1–2 L) yeast starter.

Lager yeast

Lager yeasts ferment best at colder temperatures than ale yeasts — in the 50–55 °F (10–13 °C) range. Lager yeast is classified as *Saccharomyces cerevisiae*, same as ale yeasts, but many brewer still use the old classification of *S. carlsbergensis* or *S. uvarum*. This special yeast was first isolated in the Carlsberg Laboratories under the direction of Emil Christian Hansen, in 1881. Hansen was the first to develop

WYEAST strains

Like White Labs, Wyeast offers a wide variety of yeast strains for the homebrewer. Here are some Wyeast yeast strains that are good representatives of the categories mentioned in the article.

Clean Ale Yeasts
These yeasts produce fewer esters relative to the fruity yeast strains and reduce diacetyl well.
1056 (American Ale)
1272 (American Ale II)
2565 (Kölsch)
1007 (German Ale)

Fruity Ale Yeasts
These ale yeasts produce distinctive estery fermentation characteristics especially suited to English-style ales. Strains 1084 and 1187 can leave residual diacetyl in beer.
1968 (London ESB)
1028 (London Ale)
1084 (Irish Ale)
1187 (Ringwood Ale)

Top Croppers
These yeast rise to the top of the fermenter early in fermentation. They can be skimmed to yield a healthy pitch for another batch of beer.
1010 (American Wheat)
1318 (London Ale III)
3638 (Bavarian Wheat)
3787 (Trappist High Gravity)

Lager Yeasts
These yeasts ferment at lower temepratures, producing far fewer esters than ale yeasts but with a hint of sulfur.
2007 (Pilsen Lager)
2124 (Bohemian Lager)
2278 (Czech Lager)

Wheat Beer Yeasts
For the distinctive taste of a German hefeweizen, you'll need to use one of these strains of wheat yeast.
3068 (Weihenstephan Wheat)
3333 (German Wheat)
3638 (Bavarian Wheat)

Belgian Strains
As with wheat beers, Belgian Trappist-style or Abbey ales require special yeast strains to produce the characteristic aromas and flavors of the beers.
3787 (Belgian Trappist Ale)
1214 (Belgian Abbey Ale)

pure culture techniques, techniques that we still use today in microbiology laboratories. Not only was Hansen able to grow this new yeast, lager yeast, in pure form, he was able to store it for long periods of time on a combination of wort and agar, which creates a semi-hard surface. This long-term storage allowed lager yeast to be transported all over the world, and soon lager brewing overtook ale brewing worldwide.

Why did lager beer become so popular? At the time lager yeast was discovered, most ale fermentations contained some wild yeast and bacteria and the resulting beer had a very short shelf life. Lager beer could be fermented cool, which suppressed the growth of wild yeast and bacteria. (Modern lager brewers tend to have problems with *Pediococcus* because of the slower fermentation, but they likely have less problems than pre-modern ale brewers.) Lager beer therefore had a longer shelf life, which meant greater distribution area and increased sales. Breweries probably began to switch to lager brewing to increase their sales.

But what makes lager yeast so different than ale yeast? Unlike many ale yeasts, lager yeast does not usually collect on the top of the fermenting beer. Lager yeast is known as bottom fermenters because of their nature to ferment from the bottom of the tank. But as in everything else in science — there are always exceptions! For example, White Labs WLP800 (Pilsner Lager) forms a yeast cake on the top of the fermentation even though it is a true lager yeast. Even though most lager yeast ferment from the bottom, they are not known as high flocculators. In fact, most of the yeast stays in suspension and most lager strains are low to medium flocculators. Lager yeast needs to stay in suspension in order to 'lager' the beer, aging it with some yeast in order to reduce the sulfur and diacetyl levels produced during the cold fermentation.

The cold fermentation has many consequences for lager beer. Since the yeast ferment in a cool environment, usually 50–55 °F (10–13 °C), they produce fewer esters and fusel alcohols. But the cool temperature keeps more sulfur in solution and it makes it harder for the yeast to absorb diacetyl. A good diacetyl rest near the end of fermentation will greatly reduce this. Here is a good procedure for a diacetyl rest: Ferment at 50–55 °F (10–13 °C). When the beer reaches a specific gravity of 1.022–1.020, let the fermentation temperature rise to a maximum of 68 °F (20 °C). The fermentation will reach completion, usually in the specific gravity range of 1.010–1.014. Let it sit at this temperature for 3–5 days post terminal gravity, then cool over the next day to 50 °F (10 °C). Keep at 50 °F (10 °C) for one day, then lower to lagering temperature, usually 41–45 °F (5.0–7.2 °C).

The optimal pitching rate for lagers is roughly double the rate for ales, between 15–20 million cells per milliliter.

Wheat beer

Traditional European wheat beer use special yeast strains, which produce lots of flavor. The flavors are what we usually classify with wild yeast, phenolic and clove. But these strains produce a pleasing amount of flavors that blends well the other wheat beer ingredients. There are not a lot of different wheat beer strains, perhaps half a dozen. They differ in small ways due to different flavor compounds. For example, White Labs has two regular wheat beer strain offerings. One, WLP300 (Hefeweizen), has a dominant banana ester character that can be dialed in and out with fermentation temperature. The other, WLP380 (Hefeweizen IV), produces very little banana ester regardless of fermentation temperature. For WLP300, temperatures in the 65–68 °F (18–20 °C) range yields little banana; fermenting above 70 °F (21 °C) greatly increases the level of banana esters.

Wheat beer strains produce little alpha-acetolactate, the pre-cursor to diacetyl, and they absorb diacetyl quickly. So butterscotch flavors are rarely a problem. Wheat strains will also produce sulfur. It is important to let the fermentation go to completion before capping it. Some brewers like to cap the fermentation near the end to trap the remaining CO_2 as a way to carbonate the beer. If you do this, you will trap the sulfur in the beer and it will never go away. This applies to lager brewing as well. It takes approximately 24 hours post fermentation at fermentation temperature to scrub all the sulfur out of solution.

Most wheat beer strains do not flocculate well. This is a desired characteristic, which leaves the traditional cloudiness of wheat beers. Wheat malt, with higher protein content, also contributes to this. You still want the yeast to drop out some; otherwise the beer will be milky like a yeast culture. The pitching rate for wheat yeasts is the same as that for ale yeasts.

Belgian strains

Many Belgian beers are brewed with unique yeast strains. There are many different strains used, so it is impossible to generalize about them. You could make a Belgian style wit beer with a normal lager yeast if you like, it will just not have the nose and taste of a Belgian wit fermented with an authentic Belgian wit yeast strain. These strains usually produce a lot of phenol and clove flavors, as with wheat beer yeast. Many Belgian style yeast go beyond just phenol and clove and produce a lot of esters, fusel alcohols and earthy flavors. The balance of these compounds helps determine the flavor profile of these strains. These strains would be ones that are used to make Belgian style Trappist beers, for example. White Labs WLP500 (Trappist Ale) has a good balance between esters and phenolics, while WLP530 (Abbey Ale) ferments faster and produces fewer esters. Many Belgian strains, as with wheat beer strains, do not flocculate well. I recommend a higher pitching rate — between 10–15 million cells per milliliter — for most Belgian strains.

Creativity is key when trying to create Belgian style beers. In fact, creativity is the key to brewing beer. Mix in a little science, good cleaning, and you have the recipe for great beers. ■

Christopher E. White, Ph.D., is the President of White Labs Inc.

SWEETness

photography by CHARLES A. PARKER

brewing SUGARS and how to USE THEM

by **John Palmer**

Belgian strong golden ale has an **original gravity** of 1.065–1.080 and uses **Belgian candi sugar** to achieve a brilliantly clear, **high alcohol, yet light-bodied beer**.

Brewing beer is all about working with sugars — glucose (dextrose), fructose, sucrose, maltose, verbose and all the rest. If you are like me, you want someone to cut to the chase and explain what's what without referring to the fact that fructose differs from glucose by having a ketone rather than an aldehyde carbonyl group. You probably want answers to questions like: What is corn sugar? What is cane sugar? What is beet sugar? Can I prime my beer with table sugar? Honey? Maple Syrup? These are the sort of questions I intend to answer.

What is Sugar?

But before I can answer the questions above, I do need to lay some groundwork and describe the different building blocks. It won't take long and once you understand what everything is made of, it becomes a lot easier to understand the answers. All sugars are carbohydrates, molecules that contain both carbon (carbo-) and hydrogen (-hydrate) atoms. Carbohydrates have the general formula of $C_nH_{2n}O_n$, meaning they have one carbon (C) and one oxygen (O) to every two hydrogens (H_2). In sugars, the "n" usually equals 5 or 6. For example, glucose has the formula $C_6H_{12}O_6$, meaning it is constructed of six carbon atoms, twelve hydrogen atoms and six oxygen atoms. Incidentally, fructose also has the formula $C_6H_{12}O_6$, but the atoms are arranged differently in the molecule.

The most common type of sugar is called glucose (aka. dextrose, blood sugar, corn sugar). Glucose is a monosaccharide, hexose-type sugar, meaning that it is a single molecule consisting of six carbon atoms. Other hexoses relevant to brewing are fructose and galactose. Elementally, these monosaccharides are all the same, but they are isomers of each other i.e., their chemical structure and arrangement gives them different properties. For instance, an isomer of glucose called fructose (also known as fruit sugar), tastes sweeter than glucose.

Let's examine the sugars found in a typical beer wort made from 2-row barley base malt. The main constituent of wort is maltose, which typically comprises around 50% of the total carbohydrates in wort. This is followed by maltotriose, which comprises around 18% of the total carbohydrates. The remainder of the wort is made up of glucose (10%), sucrose (8%), fructose (2%) and finally assorted dextrins, which together account for 12% of the wort carbohydrates.

Maltose is a glucose disaccharide, which means that it is made up of two glucose molecules. Sucrose is another disaccharide and consists of one glucose and one fructose. Sucrose is a naturally occurring plant sugar, and is used as table sugar worldwide. Sources include sugar cane, beets, maple sap and nectar. Maltotriose is a trisaccharide consisting of three glucose molecules. Dextrins (aka. oligosaccharides) are larger carbohydrates consisting of more than three monosaccharide groups. Monosaccharides are sweeter tasting than polysaccharides. In descending order of sweetness: fructose is sweeter than sucrose, which is sweeter than glucose, which is sweeter than maltose, which is sweeter than maltotriose. See the table on the next page (page 36) for further description of these sugars.

Fermentation

Yeast are apparently very methodical little organisms. Even though sucrose usually comprises only a small percentage of the wort, studies have shown that most brewers yeast strains seem to

photo by **ERIC O'CONNELL**

Monosaccharide	Constituents	Comments
Glucose	---	The most common monosaccharide.
Fructose	---	Most commonly found in fruit and honey.
Galactose	---	Another fermentable isomer of glucose and a component of lactose.
DISACCHARIDES		
Maltose	Glucose-Glucose	The primary constituent of wort. Broken down into two glucose by the enzyme maltase.
Sucrose	Glucose-Fructose	The most common disaccharide found in nature. Broken down by the extracellular enzyme invertase.
Lactose	Glucose-Galactose	Commonly known as milk sugar. It is unfermentable by yeast unless broken down by the (bacterial) enzyme lactase.
TRISACCHARIDE		
Maltotriose	Glucose-Glucose-Glucose	Typically the last sugar to be fermented by yeast after the others have been removed from the wort.
SACCHARIDE		
Dextrin	Various glucose chains	Unfermentable dextrin typically comprises 12% of the wort.
Starches	Various glucose chains	Wort sugars are created by amylase enzyme action on the malt starches — amylose and amylopectin.
Cellulose	Various glucose chains	Cellulose are structural isomers of starches, differing in the molecular attachment sites.

work on it first — breaking it down into its glucose and fructose components. Once the sucrose has been broken down, the yeast cells consume the glucose first, followed by fructose, maltose and finally maltotriose. Some yeast strains behave differently; consuming maltose at the same time as the monosaccharides, but this seems to be the exception.

Most yeast strains are glucophilic, utilizing most of the glucose in the wort before consuming the other monosaccharides. They also ferment most of the monosaccharides before fermenting maltose and subsequently maltotriose. In fact, it is known that high levels of glucose and fructose in a wort (e.g. >15–20%) will inhibit the fermentation of maltose. This repressive behavior is probably a common cause of stuck fermentations in worts containing a lot of refined sugars — the yeast have fermented the monosaccharides and then quit, leaving more than half of the total sugars unfermented.

Yeast metabolize the different wort sugars in different ways. To consume the disaccharide sucrose, the yeast utilizes an enzyme called invertase, which works outside the cell to hydrolyze the molecule into its components — glucose and fructose. The glucose and fructose molecules are then transported through the cell wall and metabolized inside the cell. Conversely, maltose and maltotriose are transported into the cell first, and then are broken down into glucoses by the enzyme maltase. Even though the enzyme for both sugars is the same, maltose is typically consumed first, indicating that the cell wall transport mechanism for the two sugars is different. Maybe maltotriose is too big to get through the maltose door!

The take-home message is that all fermentable sugars are broken down into monosaccharides like glucose before being utilized by the yeast, and that yeast evidently prefer to eat their sugars one course at a time. This has big implications for wort formulation in our pursuit of new recipes and unique styles.

Sugars Used in Brewing

Lots of different sugars can be used in brewing, and now that we know what the yeast want to eat and when, we can make better choices for their use. Which brings us to a good starting point — why would we want to use anything other than the sugars that come naturally form the barley? Well there are a few reasons that may apply in some circumstances:

a.) To raise the alcohol level without increasing the body of the beer.

b.) To lighten the body of the beer while maintaining the alcohol level.

c.) To add some interesting flavors.

d.) To prime the beer for carbonation.

Reasons "a" and "b" are two sides of the same coin of course, but they do illustrate two different styles of refined-sugar adjunct beer. Belgian Strong Golden Ale has an OG of 1.065–1.080 and uses Belgian candi sugar to achieve a brilliantly clear, high alcohol, yet light-bodied beer. American Light Lager recipes have an OG of 1.035–1.050, and use corn sugar, cane sugar, or rice syrup solids to obtain a very light-bodied beer of average alcohol content that is perfect for a day with the lawnmower. Most American brewers use corn or rice in the mash. Those that do use syrups usually use corn syrups that have a carbohydrate spectrum very similar to all-malt wort. Simple sugars are typically used for low-carb beers.

Various sugars have various flavors. The monosaccharides do not have a definable flavor other than sweet. But other natural sugars like honey and maple syrup, and processed sugars like molasses have characteristic flavors that can make a nice accent for a beer. This is what homebrewing is all about, really — taking a standard beer style and dressing it up for your own tastes. You can make a maple syrup porter, or a honey raspberry wheat, or an imperial Russian stout with hints of rum and treacle. The possibilities are myriad. On the other hand, I have coined a phrase that will serve you well in your experimentation, "The better part of flavor is discretion." A beer with 20% molasses is going to taste like fermented molasses, not beer.

And lastly, priming — the addition of 2-3 gravity points of fermentable sugar per gallon to carbonate the batch. Most folks did their brewing at the boiling stage, they don't want to change their flavor profile at this stage, they simply want an unobtrusive sugar to carbonate the beer. Other brewers actually look at this last stage of fermentation with an ulterior motive; they want to add character with this final step. Whatever your goal, you can select one of several sugars to accomplish it.

Glucose-type Sugars

The most common example of a simple brewing sugar is the corn sugar that is commonly used for priming. Corn sugar is about 95% solids with 5% moisture. The solids are about 99% glucose. Corn sugar is highly refined and does not contain any corn character. Brewers seeking a corn-like character, for example in a classic American Pilsner, need to cook and mash corn grits as part of an all-grain recipe.

As I mentioned before, it is known that a relatively high proportion of glucose in a wort (more than 15–20%) will inhibit the fermentation of maltose. The fermentation can be impaired or become stuck if the yeast is underpitched or there is a lack of free amino nitrogen (FAN) or other nutrients in the wort.

Rice syrup solids are another glucose product, and there are different types. For example, one high glucose type is about 75% fermentable sugars (50% glucose, 25% maltose), 20% other carbohydrates (dextrins), and 5% moisture. A high maltose type could contain only 5% glucose, 45% maltose, 45% other carbohydrates and the same 5% moisture. Extract brewers seeking to brew a Budweiser clone can use rice syrup solids to obtain a similar character to the real thing.

Sucrose-type Sugars

Pure sucrose is the reference standard for all fermentable sugars because it contributes 100% of its weight as fermentable extract. It does not contain the 5% moisture as glucose does. One pound of sucrose dissolved in enough water to make one gallon (3.8 L) yields a solution with a specific gravity of 1.046. In the homebrewing lingo, it has an extract yield of 46 points per point per gallon (or 46 point gallons per pound, to use better terminology for the units).

Lots of different brewing products are made from sucrose or the semi-refined byproducts of sucrose. Both sugar cane and sugar beets are used to make table sugar and the refined products are indistinguishable from one another. However, you do not get useful brewing byproducts from beets, only sugar cane. Molasses is a common byproduct and is used to make brown sugar as well. The fermentation of molasses produces rum-like notes and sweet flavors. Brown sugar, which only contains a small amount of molasses, will only contribute a light rummy flavor to beer.

Belgian candi sugar is sucrose that has been caramelized to some degree, depending on the color. Dark candi sugar will have more of a caramel taste than the amber variety. Aside from the caramel notes, it will behave exactly like table sugar.

Invert sugar syrups, such as Lyle's Golden syrup, are made from sucrose that has been hydrolyzed to separate the glucose and fructose. This has two effects: first, it makes the sugar more syrupy and less likely to crystallize. Secondly, it makes it sweeter. Invert sugar syrup is like artificial honey without the characteristic honey flavors. Golden syrup type products tend to be a bit salty tasting due to the acid -base reactions during manufacture. Treacle is partially inverted molasses combined with other syrups. The flavor contributions from treacle can be strong, so it is best to use it in heavier bodied beers like English strong ales, porters, and sweet stout. One half cup per 5-gallon (19-L) batch is a recommended starting point.

Maple Syrup

Maple sap typically contains about 2% sucrose. Maple syrup is standardized at a minimum of 66° Brix, and is typically 95% sucrose or more. Grade B syrup can contain 6% invert sugar, while Grade A Light Amber will contain less than 1%. You will get more maple flavor from the Grade B syrup. The characteristic maple flavors tend to be lost during primary fermentation, so adding the syrup after primary fermentation is over is recommended to retain as much flavor as possible. This practice will also help the beer to ferment more completely because it will not trigger the maltose inhibition discussed earlier. For a noticeable maple flavor, 1 gallon (3.8 L) of Grade B syrup is recommended per 5-gallon (19-L) batch of beer.

Honey

The sugars in honey are 95% fermentable, typically consisting of 38% fructose, 30% glucose, 8% various disaccharides and 3% unfermentable dextrins. Honey contains wild yeasts and bacteria, but its low water content — usually around 18% — keeps these microorganisms dormant. Honey also contains amylase enzyme, which can break down larger sugars and starches into fermentable sugars like maltose and sucrose. For these reasons, honey should be pasteurized before adding it to the fermenter. The National Honey Board (www.nhb.org) recommends that honey be pasteurized for 30 minutes at 176 °F (80 °C), then cooled and diluted to the wort gravity. To retain the most honey flavor and ensure best fermentation performance, the honey should be added to the fermenter after primary fermentation.

The National Honey Board recommends the following percentages (by weight of total fermentables) when brewing with honey: Add 3–10% honey

Sugar	Extract Yield (ppg)	% Fermentability	Constituents	Comments
Corn Sugar	42	100%	Glucose (~5% moisture)	Can be used for priming or as a wort component to increase the alcohol while lightening the body of the beer.
Rice Syrup Solids	42	Varies by grade, high glucose grade is ~80%	Glucose, maltose, other (~10% moisture)	Can be used for priming or as a wort component to increase the alcohol while lightening the body of the beer.
Table Sugar	46	100%	Sucrose	Can be used for priming or as a wort component to increase the alcohol while lightening the body of the beer.
Lyles Golden Syrup	38	100%	Glucose, Fructose (18% water)	An invert sugar that has been broken down to fructose and glucose. A bit salty due to acids and bases used during processing.
Molasses/ Treacle	36	Varies about 90%	Sucrose, invert sugars, dextrins	Degree of fermentability is unknown, probably around 50-70%. Can cause rum-like or winey flavors.
Belgian Candi Sugar	46	100%	Sucrose	Belgian Candi sugar has been slightly to moderately caramelized depending on color. Often used in the brewing of Belgian Strong Ales and Tripels.
Lactose	46	---	Lactose (<1% moisture)	Lactose is an unfermentable sugar. Is used in Milk Stouts to impart a smooth sweet flavor.
Honey	38	95%	Fructose, Glucose, Sucrose (~18% water)	Honey is high fructose mixture of sugars, which will impart honey-like flavors that depend on nectar source.
Maple Sugar	31	100%	Sucrose, fructose, glucose (~34% water)	Maple syrup is mostly sucrose. Grade B syrup will provide more maple flavor than Grade A syrup.
Maltodextrin	42	---	Dextrins (5% moisture)	Maltodextrin powder contains a small amount of maltose, but is mostly unfermentable. Adds mouthfeel and some body.

for a subtle honey flavor in most light ales and lagers. Add 11–30% for a distinct honey flavor note to develop. Stronger hop flavors, caramelized or roasted malts, spices or other ingredients should be considered when formulating the recipe to balance the strong honey flavors at these levels. At levels of 30–66%, the flavor of honey will dominate the beer. These levels are associated with braggot, which is considered by the Beer Judge Certification Program Style Guidelines to have maximum honey to malt ratio of two to one. If your beer contains 66–100% it is considered to be a form of mead, according to the BJCP.

Priming

As mentioned earlier, you can choose either of two paths when deciding on a priming sugar — do you want to keep the priming sugar hiding in the wings or do you want to bring it onstage? The monosaccharides and plain sucrose allow you to carbonate the beer without changing the existing flavor profile. The other sucrose-based sugars: Belgian candi sugar, invert sugar syrups, honey and maple syrup, will add some degree of flavor accent to the beer. The next big question is, "How much to use?"

The most commonly quoted answer to this question is 3/4 cup (~4 oz./113 g by weight) of corn sugar for a 5 gallon (19 L) batch. This will produce about 2.5 volumes of carbon dioxide in the beer, which is pretty typical of most American and European pale ales. Three ounces (by weight) will produce a little lower carbonation level of about 2.0 volumes, and five ounces will produce about 3.0 volumes. For more information on carbonation volumes, see Chapter 11 of my book, "How To Brew," available online at www.howtobrew.com. The point is that 4 oz. (133 g) of glucose is typically used to carbonate five gallons, and this is the basis for calculating amounts of other priming sugars. For example, let's calculate how much honey to use to equal 4 oz. (113 g) of corn sugar. Honey is about 18% water and is quoted as being 95% fermentable.

Priming equation

To find this out, we first set up the equation:

(Weight of A)(Percent Solids of A)(Fermentability of A) =
(Weight of B)(Percent Solids of B)(Fermentability of B)

In the equation, the variable A represents a sugar for which the weight, percent solids and fermentability is known. In our equation, we'll use corn sugar as we know these details. The variable B represents a sugar for which the percent solids and fermentability are known. Substituting in the numbers gives us:

(4 oz)(90%)(100%) = (X)(82%)(95%)

If we solve for X we find that it equals 4.62 oz. (131 g) So, priming with 4.62 oz. (131 g) of honey should give carbonation equal to priming with 4 oz. (113 g) of corn sugar.

Another way to approach this problem is by looking at sugars according to their extract yield — what the specific gravity of a solution will be if a pound of the sugar is added to water to make a gallon (3.8 L) of solution. The table on the facing page (p. 38) lists the extract yields of several common brewing sugars. The extract yield allows you to calculate the amount your original gravity will be boosted by adding this sugar. The fermentability — also given in the table — describes what percentage of the sugar can be utilized by your brewers yeast.

Using the extract yield numbers from the chart on page 38, our example becomes:

$$(4\ oz)(42)(100\%) = (X)(38)(95\%)$$

Solving for X, we get 4.65 oz. (291 g) of honey. The calculation for other sucrose products are very straightforward because the sugars are usually 100% fermentable, except in the case of partially refined sugars like molasses where there is a lot of other material present other than sugar. Malt extract typically has a significant proportion of unfermentable sugars, varying from 60–85%, depending on brand and yeast strain. A typical fermentability for extract is probably about 75%.

Summary

Brewing is all about utilizing sugars and those sugars always end up as monosaccharides when they are fermented. However, the yeast process each type of brewing sugar differently as it is being broken down into glucose and fructose, and these differences will effect our fermentation performance. Usually a high percentage of glucose and fructose in the wort will inhibit the fermentation of maltose and maltotriose, and this can lead to a stuck fermentation.

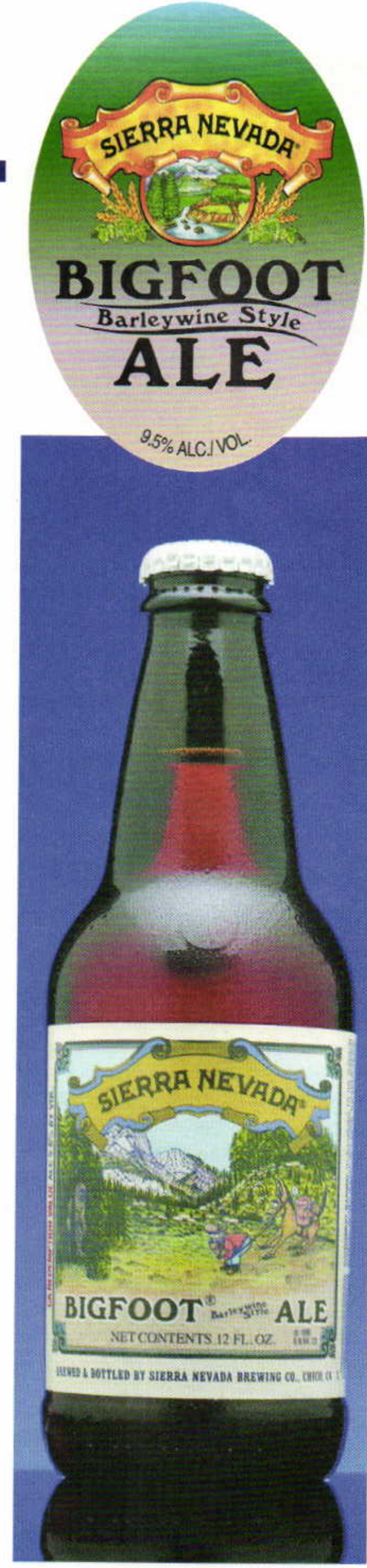
Therefore, brewing adjuncts high in monosaccharides should be added after primary fermentation has finished. These sugars can be used for priming though, with allowances made for the percent moisture and degree of fermentability. Hopefully this article has provided a better understanding of how to use sugars in your brewing. ■

John Palmer is the author of "How to Brew" (2001, Defenestrative).

BIG Bad Barleywine

the BIGGEST of the Ales

by Horst Dornbusch



PHOTOS COURTESY OF SIERRA NEVADA BREWING CO.

BARLEYWINE by the numbers

OG	preferably at least 1.090
FG	often between 1.020 and 1.032 (5–8°P)
SRM	can vary between 10 and 20
IBU	anywhere between 20 and 100
ABV	decidedly high; 8%–14+%

BARLEYWINE is both a very old and a very young style. It is old, because its origins lie in the ancient British custom of taking several runnings from the same mash and fermenting them separately — a technique known as partigyle brewing. It is young, because its modern name and definition have evolved only in the early part of the twentieth century. The oldest known designation of a barleywine is Bass #1 beer, dating from 1903. Number one was their beer made from first runnings. Bass, and many other English breweries, had numbered beers ranging from barleywines to old ales and on down to mild ales. The higher the number, the weaker the beer.

When the marketing wizards searched for a name with mass appeal, they stumbled upon the suggestive term "barleywine." The suffix "wine" is of course a misnomer, because this brew has nothing to do with fermented fruit juice. It is pure essence of grain! In this context, it is interesting to note that barleywine has been marketed not only with the "high-brow" comparison to wine, but in very low brow ways that simply hyped its alcoholic strength. Whitbread, for example, used to advertise its Gold Label as "twice as strong as a double Scotch, and half the price." Health-inspired advertising regulations put a halt to such come-ons. As is apparent from the box "Barley Wine by the Numbers," however, there is very little that seems to be definite about the style's specifications.

Any style description is by its very nature a broad generalization. This is the more so with barleywine. So here is a very short, simple and vague — albeit accurate — prescription for the barleywine maker: Make the strongest-possible, barley-based, blond-to-brown beer that your system will allow. Hop it any way you wish. Then ferment it with any type of ale yeast that is sufficiently resilient to finish the job.

Many brewers, however, wish to be more specific. They divide barleywine into two subcategories, English and American. The American style tends to have more hop bitterness, often with a liberal use of flavor and aroma hops. Anchor's Old Foghorn, first brewed in 1975, paved the way for modern American barleywines, but Sierra Nevada's Bigfoot is perhaps the standard bearer for this substyle. Bass #1, long an excellent example of the English substyle, was phased out in 1995. Perhaps, like Thomas Hardy Ale, which was out of production for the 2000–2003 vintages, it will be revived.

There is a wide variation in starting and finishing gravities of commercial barleywines. Most begin at specific gravities of 1.090–1.100 and finish in the lower 20's (SG 1.020–1.023), yielding levels of alcohol by volume (ABV) of 8–10%. However, you don't have to search too hard to find much stronger examples, many up to 14% ABV. The biggest barleywine is Sam Adams Utopia MMII at a whopping 25% ABV.

The bigger the barleywine, the higher its final gravity (FG) tends to be. Many of the biggest barleywines have FGs into the mid-30s. On the opposite end of the spectrum, you don't have to look too hard for smaller beers labeled as barleywine, either. Young's Old Nick's Barleywine, for example, has a mere 7.25% alcohol.

The barleywine's original gravity target is, of course, more of a challenge to the dedicated all-grainer than it is to the extract brewer. All-grain brewers, will want their systems to deliver first runnings of as high a gravity as possible, perhaps up to 1.090. The wort can be further thickened by extended boiling or by adding malt extract.

The extract brewer, by contrast, just has to keep that can opener handy to bump up their kettle gravity.

In the fermentation department, on the other hand, brewers of both the all-grain and the extract persuasion have the same problem of yeast husbandry. You have to be nice to the little critters to coax the last bit of alcohol out of their metabolic system. Like wine from grapes, the alcoholic strength of a barleywine should be at least 8% alcohol by volume (ABV). For the signature characteristics of this beer, you should also be able to taste the alcohol, which again means an alcohol level of at least 8% ABV. To achieve this result, you have to make a brew with a gravity drop between at least 65 points during fermentation!

As a high-alcohol brew, barleywine needs to be aged like a good grape wine before it reaches its full potential. How long is up to you, but you should consider six months in the bottle for a brew with greatness. Reputedly the best barleywines can be kept for a quarter century before they are over the hill. At least, that is what Thomas Hardy Ale bottles used to proclaim. Traditionally breweries have released their barleywines almost like vintages — as limited, special-occasion, seasonal brews, often distributed around Christmas. So if you want to have your barleywine well matured and ready for drinking in winter, you must brew with some lead time. How much lead time is a matter of opinion. Sierra Nevada's Bigfoot is not aged very much longer than their normal ales. Of course, plenty of homebrewers buy a "vintage" of Bigfoot and cellar it for a year or two before sampling.

The Trouble with Barleywine

Getting to a barleywine's daunting original gravity can take blood, sweat, tears, trepidation and above all, improvisation. Here is the problem: Your mash tun is likely to be designed for "normal" brews, that is, for the production of wort up to an original gravity of perhaps 1.060, maybe even 1.080. To brew your standard batch size of five gallons (19 L) of barleywine, however, you would have to do the impossible: to squeeze about twice as much grain into your mash tun than it can comfortably hold. This is of course based on the *ceteris paribus* assumption (the assumption that all else is equal), which unfortunately is questionable in barleywine making. When you strive for such a rich wort, you encounter all sorts of pesky process problems, because the compact, heavy grain bed is almost certainly going to make your run-off difficult. If you overstuff your mash tun (as I have done many times), you create less than perfect run-off conditions. Then it becomes difficult to wash all the sugars out of the mash, and as a result the kettle gravity might not climb above the mid-1.080 range.

There are many things you can do, however, to reach your target OG. First of all, you should strive to mash thick and collect as high-gravity a wort as is feasible. Often this means terminating the sparge at a much higher gravity — up to 1.060 — than you normally would. Terminating a sparge early results in a much lower extract efficiency. This in turn requires you to add more grain, up to 50% more, than your normal extract efficiency would indicate. (Remember, you can always run off additional wort and make one (or more) smaller beers after your barleywine wort production.)

If your kettle gravity is still substantially low after wort collection, you may to need an extended boil, up to 5 hours for the biggest brews. A much simpler route is to add malt extract to make up the deficit. As a rule of thumb, a pound of DME in 5 gallons (19 L) of wort boosts the gravity 9.0 points, for example from 1.081 to 1.090. A pound of LME in 5 gallons (19 L) of wort boosts the gravity 6.6–7.4 points.

Some homebrewers make smaller batches of barleywine, as they don't need to overstuff their mash tun. It's also possible to make wort on two subsequent brewing days and combine them to make a full five gallons (19 L).

Because it is next to impossible to predict how much high-gravity wort — if any! — your system will allow you to get from a certain quantity of grain, the specifications listed in the recipes need to be understood more as guidelines than as rigid prescriptions. To dredge up a tired phrase, brewing an authentic barleywine is clearly much more art than science. Brewers, even commercial brewers, used to "hitting the numbers" when making

UNEARTHING SOME BIG BREWS

Gigantopithecus
American-Style Barleywine

(5 gallons/19 L, extract with grains)
OG = 1.109–1.114 FG = 1.027–1.029
IBU = 73–75 SRM = 11
ABV = 10.5–11%

One million years ago, the primate Gigantopithecus *inhabited the forests of China. At a height of 8 feet 2 inches (2.5 m), and weighing up to 595 lbs. (270 kg), it was bigger than modern day gorillas or even — dare I say it? — Bigfoot. This American-style barleywine has a huge hop flavor and nose and was formulated to age well for at least two years.*

Ingredients

7.0 lbs. (3.2 kg) Briess dried malt extract
6.6 lbs. (3.0 kg) Coopers liquid malt extract
0.5 lb. (0.22 kg) Briess crystal malt (40 °L)
1/2 tsp. gypsum
1/4 tsp. yeast nutrients
1 tsp. Irish moss
10 AAU Willamette hops (60 mins) (2.0 oz./57 g of 5.0% alpha acids)
10 AAU Willamette hops (45 mins) (2.0 oz./57 g of 5.0% alpha acids)
10 AAU Columbus hops (30 mins) (1.0 oz./28 g of 10% alpha acids)
0.8 oz./23 g Cascades hops (15 mins)
1.75 oz./50 g Cascades leaf hops
Wyeast 1056 (American Ale) or White Labs WLP001 (California Ale) yeast (1 gallon/~4 L starter)

Step by Step

Yeast starter: Add 1.0 lb. (0.45 kg) DME or 1.25 lbs (0.57 kg) LME to one gallon of water, boil for 15 minutes, cool, aerate, pitch yeast and let ferment for 4–5 days at 72–75 °F (22–24 °C). **Brew day:** Carbon filter 1 quart (~1 L) of tap water and heat it to 161 °F (72 °C) in a 3 qt. (~3 L) soup pot. Add 3 gallons (11 L) of distilled water to your large brewpot and begin heating. Place crushed crystal malt in a nylon or muslin bag. Steep grains in the small pot, keeping the temperature between 150–168 °F (66–76 °C) for 30 minutes — or longer if the water in your brewpot has not reached 150 °F (66 °C). Remove grain bag from small pot with a clean kitchen strainer and hold over large pot. With a large measuring cup, scoop 1 qt. (~1 L) of hot water (150–168 °F/66–76 °C) from brewpot and rinse grains. Pour grain tea from small pot into brewpot, stir and heat to a boil. Remove brewpot from burner and stir in DME. Return to burner and heat to a boil. Once the initial foam subsides, add the first charge of bittering hops and gypsum. Boil for 60 minutes. Add remaining Willamette hops with 45 minutes left in boil and Columbus hops with 30 minutes left in boil. With 15 minutes left in the boil, add Cascade pellet hops, Irish moss and yeast nutrients. When boil is over, remove the pot from the burner and stir in the LME. Let brewpot sit for 15 minutes with the cover on. The temperature should stay above 170 °F (77 °C) for this period. Cool wort to 75 °F (24 °C) and let sit undisturbed for 45–90 minutes to let the break material and substantial amount of hop particles settle. Siphon wort to fermenter and add distilled water to make 5 gallons (19 L). Aerate wort well, preferably with an oxygen tank, and pitch sediment from yeast starter. Ferment at 70–72 °F (21–22 °C) until primary fermentation ends, about 14–17 days. Rack to secondary fermenter, preferably one with little or no headspace. Condition at 60–70 °F (16–21 °C), with temperatures at the lower end preferred, for twice as long as primary fermentation took. Add dry hops five days before bottling or add to keg. Bottle or keg beer, being careful to avoid any oxygenation from splashing or overly vigorous stirring. Bottle condition beer for two to three weeks. If possible, cold condition the beer in your refrigerator for at least four months. **Extended aging:** This beer will taste aggressively hoppy early on, but will lose its sharp edges with aging. Don't sample the batch to extinction before it matures. Label and set aside at least a couple six packs and "forget" about them for year or two.

Dunkleosteus
English-style Barleywine

(5 gallons/19 L, all-grain with supplemental extract)
OG = 1.122 FG = 1.026
IBU = 51 SRM = 15 ABV = 12.4%

Dunkleosteus *was a placoderm, an armored fish of the Devonian period. It grew up to 20 feet (6.1 m) long and was the largest vertebrate to live up to that point in Earth's history.* Dunkleosteus *used its massive, crushing jaws to tear apart prey. Its teeth marks are found in fossilized prey species of the period. This English-style barleywine — loosely based on Bass #1, another "fishy" big brew — is also a big brute.*

Ingredients

14.0 lbs (6.4 kg) Maris Otter pale ale malt
0.66 lbs. (0.30 kg) English crystal malt (60 °L)
3.5 lbs. (1.6 kg) Muntons DME
2.0 lbs. (0.91 kg) sucrose (preferably invert sugar)
1/4 tsp. gypsum
1/4 tsp. yeast nutrients
1 tsp. Irish moss
15 AAU East Kent Goldings hops (bittering/60 mins) (3.0 oz./85 g of 5.0% alpha acids)
2.5 AAU Fuggles hops (20 mins) (0.5 oz./14 g of 5.0% alpha acids)
0.33 oz./9.4 g Fuggles hops (0 mins)
Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast (1 gallon/~4 L starter for primary fermentation, make 1 pint/250 mL starter for secondary)

Step by Step

Yeast starter: Add 1.0 lb. (0.45 kg) DME or 1.25 lbs (0.57 kg) LME to one gallon of water, boil for 15 minutes, cool, aerate and let ferment for 4–5 days at 72–75 °F (22–24 °C). **Brew day:** Heat 4.6 gallons (17 L) of strike water to 163 °F (73 °C). Add crushed grains to your brew kettle, stir in strike water and mash grains at 152 °F (66 °C) for 1 hour. After the saccharification rest, heat mash slowly to 162 °F (72 °C) by adding heat in bursts of 1–2 minutes, stirring constantly. Transfer the mash to your lauter tun and recirculate the wort for 20 minutes. Runoff all wort from lauter tun. Do not add sparge water. Once the first batch of wort is collected, stir about 3.5 gallons (13 L) of sparge water at 170 °F (77 °C) into the grain bed. Recirculate again and drain off wort. Boil the just over 7 gallons (26 L) of wort down to just over 5 gallons (19 L). This should take a little over two hours. Add gypsum at the beginning of the boil. Add DME with 90 minutes left in boil. Add hops according to the schedule given in the recipe. Add Irish moss and yeast nutrients with 15 minutes remaining in the boil. After the boil, chill the wort to 68 °F (20 °C), aerate — preferably with oxygen — and pitch sediment from yeast starter. Let ferment at 68–70 °F (20–21 °C) until primary fermentation ends, which should take 2–3 weeks. Rack to secondary, add second dose of fresh yeast, and let sit for two weeks at 65–68 °F (18–20 °C). If possible, bulk condition at 40–45 °F (4.4–7.2 °C) for three months. Bottle or keg, minimizing any splashing or other aeration of the beer. **Extended aging:** With age, the malty, sweet flavors of this beer will take on sherry notes.

Pterygotus Big Brown

(5 gallons/19 L, partial mash)
OG = 1.090 FG = 1.022
IBU = 42 SRM = 24 ABV = 8.7%

In the Devonian period, the eurypterid Pterygotus *hunted on the murky bottom of the sea floor. At 6.5 ft. (2.0 m) long, it was the largest arthropod that ever lived — bigger than any scorpion, lobster or beetle living today. This massively malty brew with a hint of dark, roasty flavor is as dark as the seabed* Pterygotus *called home.*

Ingredients

9.0 lbs. (4.1 kg) DME
0.5 lbs. (0.23 kg) 2-row Pilsner malt
0.25 lbs. (0.11 kg) Vienna malt
0.25 lbs. (0.11 kg) Munich malt
0.33 lbs. (0.15 kg) crystal malt (30 °L)
0.33 lbs. (0.15 kg) crystal malt (60 °L)
3.0 oz. (85 g) chocolate malt
1.5 oz (43 g) roasted malt
1/4 tsp. gypsum
1/4 tsp. yeast nutrients
1 tsp. Irish moss
12.5 AAU Northern Brewer hops (bittering)
(1.8 oz./51 g of 7% alpha acids)
Wyeast 1028 (London Ale) or White Labs WLP013 (London Ale) yeast
(0.75 gallon/3 L starter)

Step by Step

Yeast starter: Add 0.75 lb. (0.34 kg) DME or 0.94 lbs (0.43 kg) LME to one gallon of water, boil for 15 minutes, cool, aerate, pitch yeast and let ferment for 4–5 days at 72–75 °F (22–24 °C). **Brew day:** Carbon filter 0.66–0.75 gallons (2.5–2.8 L) of tap water and heat to 170 °F (77 °C) in a 6-8 qt. (~6–8 L) stockpot. Place crushed grains in nylon or muslin steeping bag and mash at 158 °F (70 °C) for 45–60 minutes. Add 3 gallons (11 L) of distilled water in your brewpot and heat to 170 °F (77 °C) while grains mash in other pot. Remove grain bag from partial mash with a large kitchen strainer and place over brewpot. Scoop 0.5 gallons (1.9 L) of water (at 165–170 °F/74–77 °C) from brewpot and pour through grainbag, rinsing the grains. Pour partial mash wort from stockpot into brewpot and heat this wort to a boil. Remove pot from burner and stir in malt extract. Resume heating and bring to a boil. After the foam subsides, add bittering hops and gypsum. Boil for 60 minutes. With 15 minutes left in the boil, add the Irish moss and yeast nutrients. Cool wort to 72 °F (22 °C) and rack to fermenter. Add distilled water to make 5 gallons (19 L) of wort. Aerate well and pitch yeast sediment from starter. Ferment at 68–70 °F (20–21 °C) until primary fermentation ends, about 10 days. Add second dose of yeast and rack to secondary three to four days later. Let condition in secondary for two weeks. Bottle and let condition at room temperature for two to three weeks. **Extended aging:** This beer may taste "muddy" early on but should clear and reach its peak flavor in nine to 12 months.

normal-strength beers often fall short of the mark when brewing barleywine. So, even if you're a number-cruncher, be prepared to go with the flow on brew day. Your beer can be great, even if it doesn't exactly match the specification of your ProMash printout.

In many commercial brew houses, brewers mash in a jacketed, steam-heated mash tun with a powerful recirculation pump and strong mash agitator that can churn the grain at 20 rotations per minute. However, even the equipment in a commercial brewhouse doesn't ensure an easy brewday. Ashton Lewis — head brewer at Springfield Brewing (and technical editor of BYO) — says, "Brewing big beers like barleywines can be a real nightmare. Our brewhouse has an agitated mash mixer and a lauter tun with height adjustable rakes with a variable drive for the rake speed. Mash-in can be a bear because the mash thickness is typically higher in big brew mashes to keep the mash volume within our system limits. This makes agitation and even mash distribution difficult, even with our really nice mash mixer. The real fun begins in the lauter tun. Most lauter tuns are designed around "normal gravity" brews to have a grain bed depth of about 12". When the idea is to double the gravity the grist charge must increase accordingly. Slow run-offs and higher differential pressures across the grain bed means more frequent cutting with the raking machine. This in turn can cause wort clarity problems. The net result is stress in the brewhouse! Then the day ends by determining how much wort we actually were able to collect to hit the target gravity. At this point we calculate the hop weights. In our standard brews we know how much wort we'll end up with after the boil, plus or minus 2%, so we use a pre-determined weight of hops. My advice is to hang loose and be flexible with your brewing plans."

In a homebrewery, you will likewise have a challenging brewday. One thing I would suggest is, instead of overstuffing your mash tun, make either a small batch of barleywine or brew twice. If you combine two (or more) batches into the same fermenter, these should probably not be more than two days apart so that you can aerate the ferment on the second day without spoiling it.

Try to hit the correct gravity even if you cannot hit the expected volume. This requires that you adjust your hop quantities if you collect less than the expected amount of wort.

Finally, be prepared to "thicken" your wort through an extra long boil, the addition of malt extract or both.

Mash Tun Tricks for Big Brews

Given the enormous size of the barleywine grain bill and the need to produce fermentables for that enormous gravity drop that will yield the enormous amount of alcohol, I would worry mostly about the activity of beta amylase in the mash tun and about sugar extraction techniques.

We know that beta amylase enzymes from barley start showing activity at temperatures as low as 104 °F (40 °C), but that these enzymes reach their peak performance as they approach a temperature of 149 °F (65 °C). At temperatures above 149 °F (65 °C), beta amylase activity slows down. At 158 °F (70 °C), it all but stops. Most of the sugar produced by beta amylase is maltose, which is a two-molecule sugar (disaccharide). Beta amylase also produces a certain amount of other fully fermentable sugars. Because we are after these sugars, we should mash in at about 149°F (65°C). At this peak temperature, almost all beta diastatic conversion is complete after about 10 minutes, provided the mash pH is roughly between 5.2 and 5.4.

Although making a thick wort is paramount to barleywine production, there is a minimum amount of water needed to get proper conversion of the mash. As a general rule of thumb, do not mash any thicker than one quart of water per pound of grain (2.1 L/kg). And of course, don't dilute the wort by adding near-boiling water after the conversion stand for a mash out.

It may be easier, however, to create these fermentable sugars than it is to remove them mechanically from the heavy grain bed. Recirculation of the wort for perhaps as much as one hour is the only answer here. During such a long rest with prolonged recirculation, unfortunately, your mash is likely to lose too much thermal energy. So you need to re-supply your mash with heat. For brewers with RIMS or HERMS systems, this is not a problem. For brewers with manual breweries, simply draw about 1 qt. (1 L) of the run-off at a time into a pot and heat it quickly on the stove to about 190 °F (88 °C). Then carefully ladle the hot wort back over the top of the mash tun.

This infusion of heat from the recirculating wort will gradually raise the temperature of your mash and promote alpha amylase activity as well.

Alpha amylase start showing activity at around 140 °F (60 °C). They reach their peak performance in the mash as the temperature approaches 162 °F (72 °C). Their activity slows down above 162 °F (72 °C) and virtually ceases at around 176 °F (80 °C). These enzymes change starches into complex, mostly unfermentable sugars, but a large portion of these are then broken down further into simple, fermentable sugars by the still-active beta amylase enzymes.

With this trick you should be able to get the gravity of your run-off well above 1.090 or even 1.100 within the hour-long rest.

Once your run-off is at the right gravity, direct it into your kettle and start sparging with 190 °F (88 °C) water. Measure the mash temperature periodically to make sure it does not exceed 170 °F (77 °C), because you do not want to leach too many unconverted starches and grain tannins into the kettle. Also measure the kettle gravity periodically. Discontinue the sparge a few points short of your desired original gravity, unless you plan an extended boil or to supplement your wort with malt extract.

As for the grain in the mash tun, you can simply discard it even though it still contains some sugar. Or you can resume sparging, but into a separate container, until the gravity of the run-off reaches about 1.014. You can then boil this leftover wort for a separate surprise mild ale, which may still have an OG in the mid-1.030s. Just use any ale yeast and hops you have handy. Shoot for a bittering target of 4 AAU (about 0.75 oz./21 g of 5.0% alpha acid). Use about a quarter ounce each of flavor and aroma hops.

Partial-Mash Tricks

Given the vast quantities of grain involved in making a barleywine, using grain bags for partial mashing is probably a futile exercise. Instead, simply place the cracked grain into about three gallons of 190 °F (88 °C) water and let it steep for about half an hour. Then carefully strain the grain through a household sieve lined with several layers of cheesecloth. Get a helper to tilt the receiving pot during this procedure to minimize hot-side aeration. Then alternately stir in the canned malt bit by bit and add boiling water, and keep measuring the kettle gravity for guidance. Your target is at least an OG of 1.090 at five gallons (19 L), but you do not need to be exact at this stage, because you can always correct for any evaporation loss and thus for gravity after the boil.

Another way of making a barleywine is to start out with a full mash, but do not worry about your kettle gravity as you collect the wort. Simply collect 5.5–6.0 gallons (21–23 L) of wort and correct the gravity by adding malt extract until you reach your target OG. Boil this wort 60–90 minutes to yield 5 gallons (19 L).

All-Extract Tricks

As a rough guideline, consider that about 1 lb. (0.45 kg) of British-style liquid extract (such as Muntons) produces about 6.8 gravity points in a 5-gallon (19-L) batch. This value, of course, varies depending on your extract brand. Just for comparison, with a typical German-style liquid extract (such as Weyermann), the analogous number tends to be closer to 7.4 gravity points. The typical 1 lb. (0.45 kg) of DME by comparison, dissolved in 5 gallons (19 L) of wort, produces an increase of about 9 gravity points.

For a barleywine wort of at least OG 1.090, therefore, you would need at least 16.2 lbs. (7.3 kg) of British-style liquid malt extract. If you used a German-style extract, the quantity would be closer to 13.75 lbs. (6.2 kg). If you used DME only, it would be closer to 10.5 lbs. (4.7 kg). Conveniently, five 1.5 kg (3.3 lbs.) cans of extract amount to 16.5 lbs. which will give you 5 gallons of British-style wort at a hypothetical OG of 1.112. This is why this quantity of pale malt extract has been built into the partial-mash and all-extract recipes.

In general, however, do not rely just on math for your quantities. Always measure your gravities with a hydrometer to confirm that your results are indeed what you intended them to be.

Note that the IBU-values in the recipes are given as ranges. This is because hops utilization rates decline unpredictably in high-gravity worts. So, for all practical purposes, these values must be approximate and educated guesses.

The Trouble with Attenuation

You need a real cranker of a yeast to get the high-gravity barleywine to give up its sugar. Remember that pure yeast strains were isolated by the Danish botanist Emil Christian Hansen only in 1881, but big beers have been around for centuries. So, with uncontrolled yeasts, it is not unlikely that some of the heavies used to get stuck at final gravities as high as in the mid-1.050s in the old days. Instead of high-alcohol brews such beers were just sweet, high-calorie brews. So pitching the right, alcohol-tolerant yeast is essential. It is also essential to get some of that British ale flavor into the big brew.

Most successful home barleywine brewers pitch either the yeast sediment from a large starter or yeast from a previous batch of beer. A one gallon (3.8 L starter) or two cups (474 mL) of yeast slurry should do the trick for most barleywines. One trick I use is to pitch several different types of yeast right from the start, with some for the right flavor and others for the right cranking power.

Given the enormous labor that goes into making a barleywine, I tend not to be skimpy when it comes to ingredients. So I usually pitch four packages of different liquid yeasts for a heavy-duty big ale. This automatically increases the start-up yeast count, which is always important in a high-gravity wort. Second, as the brew goes through its initial fermentation phase, when the alcohol level is still fairly low, you can take advantage of those ale yeasts that have great British flavor characteristics but might have a low tolerance for alcohol. Wyeast 1028 (London Ale) is a good choice for obtaining the fruity, estery characteristics of a typical British-style ale, but it will probably be the first yeast to go dormant, i.e., to get stuck. You should expect the White Labs WLP007 (High Gravity English Ale) yeast to last a bit longer and continue to produce a British flavor profile. After the WLP007 fizzles out, you can rely on the continued fermentation power of the WLP099 (Super High Gravity Ale) yeast. Finally as the finisher in the relay fermentation race, the Wyeast 3347 (Eau de Vie) should pull the beer over the FG finish line for the desired final alcohol level. WLP099 has the reputation of producing some "Belgian" phenolic character, but I've used it successfully in big ales.

Some people may regard this four-yeast regimen excessive, but it does provide some insurance against stuck fermentations. Likewise, some homebrewers think that non-beer yeasts should not be pitched to beer. If that is the case, simply omit the Wyeast 3347 and be prepared to accept a higher FG — probably in the 30s as opposed to the 20s.

Finally, a confession: I rarely make all-grain batches of big beers — ales or lagers — and when I do, I usually have to cheat, because I tend not to get the OG in the desired target range. I usually have to "fine-tune" the wort in the kettle with some extract out of a can to make up for the deficiencies of my mash tun (or my own deficiencies). Perhaps this should disqualify me from writing about brewing barleywine. Or perhaps not. At least I know painfully well what can go wrong in practice, in spite of all the erudite theory about making such a difficult brew!

RECIPES

Lord Big Barleywine (2.5 gallons, all-grain)

Brew two batches to obtain 5 gallons
OG = 1.128 FG = 1.020–1.032
IBU = 50–70 SRM = 27 ABV = 12.3%

Ingredients

13.66 lbs. (6.2 kg) pale ale malt such as Hugh Baird, Crisp or Briess (2.5–3.5 °L)
3 lbs. (1.4 kg) light Munich malt such as Weyermann Munich Type 1 (5–7 °L)
0.5 lbs. (0.23 kg) crystal malt such as Hugh Baird, Crisp or Briess (approx. 60 °L)
7.5 AAU Galena hops (bittering) (0.7 oz./20 g of 11% alpha acid)
0.5 oz. Mt. Hood hops (flavor/aroma)
1 tsp Irish moss
Wyeast 1028 (London Ale) plus White Labs WLP007 (High Gravity English Ale), White Labs WLP099 (Super High Gravity Ale) and Wyeast 3347 (Eau de Vie) yeast
1 cup DME or corn sugar (for priming) (for both batches combined)

Step by Step

This recipe has been developed for a system that will yield 2.5 gallons of wort at an extract efficiency of about 50%, which may still be a bit optimistic. Make two batches no more than two days apart to make 5 gallons (19 L) of beer. (Optimally, you should make the second batch 16–24 hours after the first batch.) Mash in at 149 °F (65 °C). Recirculate for about an hour, heating samples of wort to 190 °F (88 °C) to maintain the grain bed temperature. Run off wort and sparge to collect around 5 gallons (19 L) of wort. During the sparge, check the mash temperature periodically, and make sure it does not exceed 170 °F (77 °C). Boil for 2–3 hours to reduce volume to just over 3 gallons (11 L). Add the bittering hops for the final 60 minutes of the boil and the flavor/aroma hops, as well as the Irish moss, about 10 minutes before shutdown. (Alternately, collect about 3.5 gallons of wort and stir in malt extract until you reach the target gravity. You will likely need around 2.5 lbs. (1.1 kg) of dried malt extract or 3–3.5 (1.4–1.6 kg) of liquid malt extract to do this, but measure the gravity rather than relying on these estimates.)

Cool the wort to a fermentation temperature of 66–70 °F (19–21 °C) , aerate well and pitch all four tubes of yeast. Rack the beer after primary fermentation ceases. After another four weeks, rack again very carefully so as not to disturb the thick layer of yeast debris. Prime and package in bottles or in a Cornelius keg. If all went well, the beer's FG should be in the 1.030s, although the addition of the Eau de Vie yeast may cause it finish lower, optimally, in the low 1.020s. If the FG is lower, your barleywine will be drier and more alcoholic. If it is higher, your barleywine will likely be too sweet. Age at least four months, but reserve some for extended aging.

Lord Big Barleywine (5 gallons, partial mash)

OG = 1.126–1.137 FG = 1.020–1.034
IBU = 50–70 SRM = 27
ABV = 12.1–13.3%

Ingredients

- 14.33 lbs. (6.5 kg) pale ale liquid malt extract (such as Edme, Maris Otter, Coopers, Muntons or John Bull) or 10.5 lbs. (4.7 kg) dried malt extract
- 6.0 lbs. (2.7 kg) light Munich malt such as Weyermann Munich Type 1 (5–7 °L)
- 1.0 lbs. (0.45 kg) crystal malt such as Hugh Baird, Crisp or Briess (approx. 60 °L)
- 15 AAU Galena hops (bittering) (1.4 oz./38 g of 11% alpha acid)
- 0.5 oz. Mt. Hood hops (flavor/aroma)
- 1 tsp Irish moss
- Wyeast 1028 (London Ale) plus White Labs WLP007 (High Gravity English Ale), White Labs WLP099 (Super High Gravity Ale) and Wyeast 3347 (Eau de Vie) yeast
- 1 cup DME or corn sugar (for priming)

Step by Step

This recipe has been designed to use just over 4 cans of 3.3 lbs. (1.5 kg) liquid malt extract. If you wish to pump up your OG and alcohol, you can do so by adding the rest of the final can of extract. Crack or coarsely mill the specialty grains and steep them in about 3 gallons (11 L) water at 150 °F (66 °C) water for about 30 minutes. Strain the grains through a household sieve lined with several layers of cheesecloth. Have a helper hold the receiving vessel at a slant to reduce hot-side aeration. Transfer the hot liquid into your brew kettle. Add the extract to the hot liquid. Top off the kettle with water. Bring to a boil. Add the bittering hops about 15 minutes into the boil and the flavor/aroma hops as well as Irish moss about 50 minutes into the boil. The total boil time is 1 hour.

Cool the wort to a fermentation temperature of 66–70 °F (19–21 °C), aerate well and pitch all four tubes of yeast. Rack the beer after primary fermentation ceases. After another four weeks, rack again very carefully so as not to disturb the thick layer of yeast debris. Prime and package in bottles or in a Cornelius keg. If all went well, the beer's FG should be in the 1.030s. If the FG is lower, your barleywine will be drier and more alcoholic. If it is higher, your barleywine will be sweet. Age at least four months, preferably longer, especially if the beer finished at an FG well above the 1.030 target. Reserve some beer for extended aging.

Lord Big Barleywine (5 gallons, extract only)

OG = 1.111–1.127 FG = 1.020–1.028
SRM = 22–25 IBU = 40–70
ABV = 10.7–13.4%

Ingredients

- 14.6 lbs. pale ale liquid malt extract (such as Edme, Maris Otter, Coopers, Muntons or John Bull)
- 1.1 lbs. (0.5 kg) Munich malt extract (such as Weyermann Munich Amber)
- 1.1 lbs. (0.5 kg) dark ale malt extract (such as Edme Maris Otter, Coopers, Muntons or John Bull)
- 15 AAU Galena hops (bittering) (1.4 oz./38 g of 11% alpha acid)
- 0.5 oz. Mt. Hood hops (flavor/aroma)
- 1 tsp Irish moss
- Wyeast 1028 (London Ale) plus White Labs WLP007 (High Gravity English Ale), White Labs WLP099 (Super High Gravity Ale) and Wyeast 3347 (Eau de Vie) yeast
- 1 cup DME or corn sugar (for priming)

Step by Step

Boil 2–4 gallons (7.6–15 L) of brewing water in the brew kettle. (The more volume you can boil the better. Boiling a larger wort volume results in better hop utilization and less wort carmelization.) Turn off the heat and stir in all the liquid malt extract. It may take awhile to dissolve so much syrup. Do not resume heating until extract is thoroughly dissolved. Boil wort for 1 hour. Add the bittering hops about 15 minutes into the boil and the flavor/aroma hops as well as Irish moss about 50 minutes into the boil (i.e. ten minutes before shutdown). Cool the wort to a fermentation temperature of 66–70 °F (19–21 °C), aerate the wort well and pitch all four tubes of yeast. Rack the beer to secondary after primary fermentation ceases. After another four weeks, rack again very carefully so as not to disturb the thick layer of yeast debris. Prime and package in bottles or in a Cornelius keg. Bottle condition for three weeks.

If all went well, the beer's FG should be around 1.020. If the FG is lower, your barleywine will be dry and very alcoholic. If it is higher, your barleywine will be sweet. Age at least four months, preferably longer, especially if the beer finished at an FG well above 1.020. Reserve some beer for extended aging. You'll be glad you did. ■

Horst Dornbusch is the Style Profile columnist for BYO and the author of "Prost!: The Story of German Beer" (1997, Brewers Publications).

Potato Beer

Harnessing potato starch as a sugar source

Story by Chris Colby

Both corn and rice are used as starchy adjuncts by brewers worldwide. These adjuncts boost the strength of a beer without increasing its body. Corn and rice also dilute the protein content of wort. As adventurous homebrewers, there is another common starchy food we can use as an adjunct — potatoes.

Types of Potatoes

The common potato comes from the potato plant (*Solanum tuberosum*), a member of the nightshade (Solanaceae) family. The nightshade family also includes tomatoes, tobacco and peppers. The edible portion of the potato plant is the tuber, a modified underground stem. There are many varieties of potatoes found on supermarket shelves and they can be grouped into two functional categories, waxy or mealy (or starchy). Mealy varieties — such as Russet, Yukon Gold or baking-type potatoes — can easily be used in homebrewing. Waxy varieties — such as Chef's potatoes or red potatoes — may be usable, but I don't have any experience with them.

Composition of Potatoes and Malted Barley

	Potatoes	Flaked Potatoes	Malted Barley
Starch	18%	60–75%	65%
Protein	2–3%	7–9%	5–11%
Water	78%	5–8%	3–6%

Potato Composition

At harvest, potatoes contain about 78% water, 18% starch and 2–3% protein. The remainder of the potato is a variety of compounds including fiber and a tiny amount (around 0.1%) of fat. Potatoes also contain relatively high levels of vitamin C.

The starch in potatoes is arranged in larger granules than those found in most plants, including barley. Potato starch is about 20% amylose and 80% amylopectin. In comparison, barley starch is 20–25% amylose and 75–80% amylopectin. Potato starch gelatinizes at relatively low temperatures, around 130 °F (54 °C) for most mealy varieties. As such, the starch is accessible to the saccharification enzymes at typical mash temperatures — 148–158 °F (64–70 °C).

Potatoes can be dried and extruded through rollers to produce potato flakes. Potato flakes are usually made from Russet potatoes and contain 5–7.5% moisture, 60–75% starch and 7–9% protein. Many potato flakes, such as those designed to make instant mashed potatoes, are salted or otherwise seasoned. When using potato flakes in brewing, be sure to check the ingredient label and select only unseasoned potato flakes. Flakes will likely contain sodium bisulfite, a chemical added to prevent non-enzymatic browning of the flakes during storage. They may also include an emulsifier, often a monoglyceride or diglyceride. These preservatives and processing agents will be diluted in your wort and should not interfere with your brewing.

The percentage of protein in potato flakes is on par with the percentage found in malted barley. So, you don't need to worry about the potatoes contributing to protein haze in your beer. However, they contain more protein than flaked maize or rice, so you can't use potatoes to dilute the protein content of your wort when using high-protein malts.

All-grain brewers can use either raw potatoes or unseasoned potato flakes in brewing. Using potato flakes is simpler, but I've always used unprocessed potatoes in my beers to avoid the processing agents in potato flakes, even though I'm almost positive that they would be harmless. Homebrewers used to extract-with-grains procedures can easily make partial mash beers using potatoes.

Don't look at potato beer as a way to get rid of potatoes that have sprouted — potato sprouts contain toxins and should therefore be discarded. If your potatoes aren't fit for cooking, they aren't fit for brewing.

Brewing with Potato Flakes

Potato flakes can be stirred into the mash just as flaked maize would be. Whenever I mash any starchy adjunct, I stir the mash a few times during the saccharification rest. Other than that, however, just follow your normal mashing procedures and finish brewing as you normally would.

For recipe calculations, expect a potential extract of about 35 points per pound per gallon. (In other words, if a pound of potato flakes are used to make a gallon of wort, that wort would register a specific gravity of 1.035.) Remember that this number will be modified by your extract efficiency. For example, if you get 65% extract efficiency, potato flakes will yield about 23 points per pound per gallon.

As when using any other starchy adjunct, don't use over 40% potato flakes (by weight) when using six-row malts. When using 2-row malts, 30% potato flakes is a good upper limit.

Using Unprocessed Potatoes

For all my "spud-braus," I've simply used plain, unprocessed potatoes.

RECIPE

Tubers for Victory
(6 gallons/23 L, all-grain)

5 gallons (19 L) base beer:
OG = 1.053 FG = 1.010
IBU = 22 SRM = 4 ABV = 5.6%
6 gallons (23 L) diluted beer:
OG = 1.044 FG = 1.008
IBU = 18 SRM = 3 ABV = 4.6%

Ingredients
4.25 lbs. (1.9 kg) 2-row pale malt
4.25 lbs. (1.9 kg) 6-row pale malt
15.0 lbs. (6.8 kg) Idaho potatoes
(or 3.0 lbs. (1.4 kg) flaked potatoes)
1 tsp Irish moss
0.5 tsp yeast nutrients
1 tsp Polyclar
2.5 AAU Clusters hops (first wort)
(0.36 oz./10 g of 7% alpha acids)
3.5 AAU Clusters hops (45 min)
(0.5 oz./14 g of 7% alpha acids)
0.25 oz. (7.0 g) Willamette hops
(15 min)
Wyeast 2112 (California Lager) or
White Labs WLP810 (San Francisco Lager) yeast (with a 2 qt./2 L starter) or else Wyeast 2007 (Pilsen Lager) or White Labs WLP840 (American Lager) yeast (with a 4 qt./4 L starter)
1.2 cups corn sugar (for priming)

Step by Step
Boil and whip potatoes. Add crushed grains and whipped potatoes to kettle. Mash in to 140 °F (60 °C). Rest for 10 minutes then slowly heat mash to 150 °F (66 °C). Hold for 45 minutes. Transfer mash to lauter tun and stir in near boiling water to raise temperature to 158 °F (70 °C). Let rest for 5 minutes, then recirculate for 20 minutes before beginning wort collection. Heat sparge water to 180–190 °F (82–88 °C). Monitor grain bed temperature while sparging. Once the upper grain bed temperature raises to 170 °F (76 °C), add cold water to your hot liquor tank to the drop sparge water temperature to 170 °F (76 °C) and finish sparging.

Collect 5 gallons (19 L) of wort, adding first wort hops after collecting the first gallon (3.8 L) of wort. Add 1 gallon (3.8 L) water and boil wort for 90 minutes, adding hops at times indicated in recipe. Add Irish moss and yeast nutrients with 15 minutes left in boil. After the boil, the specific gravity of the wort should be 1.053.

Cool wort, aerate and pitch yeast. Ferment at 65 °F (18 °C) or 55 °F (13 °C), as appropriate for yeast strain. Cold condition at 40 °F (4.4 °C) for 21 days. Add Polyclar to beer 1 day before bottling. Boil 1.2 cups corn sugar in one gallon (3.8 L) of water. Cool water to 75 °F (24 °C) or below and siphon quietly to bottling bucket. Siphon beer into dilution water without splashing. Bottle 6 gallons (23 L) of beer at a virtual OG of 1.044. Let the beer bottle condition for two weeks. Serve ice cold.

To prepare the potatoes for brewing, I peel them and cut them into small (1 inch/2.5 cm) cubes. I then boil the cubes in enough water to cover them. After 15 minutes or so, I drain the water and mash the potatoes with a potato masher. ("Mash" here means crush or whip, not the brewing term.) You could also whip the potatoes with an electric beater. At this point, I essentially have mashed potatoes, although the usual addition of salt or other seasonings have been omitted. I'll call them whipped potatoes from here on out, to avoid confusion over the word "mash."

When brewing with potatoes, I add the foundation water (the water under the false bottom) to my mash tun then fill the vessel with the crushed grains. I then stir in the whipped potatoes. Unlike when adding flaked maize or other dried starchy adjuncts, adding freshly prepared whipped potatoes to the mash adds heat and a small amount of water to the mash. However, unless you are going titanic with the tubers, this doesn't amount to a huge difference at mash in. Expect to add slightly less strike water and be prepared to add a small amount of room temperature water as you approach your desired mash thickness due to the added heat from the potatoes. If you dislike "winging it" when brewing, simply stir your whipped potatoes into your strike water prior to mashing in. That way you can heat this "soup" to your normal strike water temperature when mashing in.

Once I've mashed in, I brew the beer as I normally would except for stirring the mash a few extra times. I've never encountered any problems with the mash sticking during the runoff, even though the potatoes leave behind a small amount of solids in the grain bed.

For recipe calculations, begin with the fact that potatoes have 22% dry weight and of that dry weight, 75% is starch. Assuming that this starch is completely reduced to sugar means that raw potatoes yield about a potential extract of 7.6 points per pound per gallon. (As with the potential extract of malted barley, this number will be modified by your extract efficiency.) Looked at another way, 5.0 lbs. (2.2 kg) of potatoes, with a dry weight of 1.1 lbs. (0.5 kg), have an equivalent potential extract as 1.0 lb. (0.45 kg) of 2-row pale malt.

Effects of Potato Usage

Potatoes do not add any potato flavor to your beer. They simply add fermentable sugar to the wort. Like corn or rice — or the addition of sugars to the kettle — potatoes dry out a beer. See the recipe for Left of Lefse Extra-Dry Stout (January-February 2004 *BYO*) for a recipe using Russet or Yukon Gold potatoes to produce a nice dry session beer. Potatoes can also be used to make thirst-quenching lawnmower beers. In fact, during World War II, the Lucky Lager brewery used potatoes as an adjunct because of the rationing of corn. See the recipe on page 50 for an eminently quaffable lawnmower beer.

If you want to use potatoes, but don't want your beer to turn out dry, you have a couple options. Mashing at higher temperatures (and in thicker consistencies) yields a less fermentable wort and correspondingly fuller-bodied beers. Likewise, adding more specialty malts will boost the body of a beer. Either or both of these methods can counteract the drying effect of potatoes if a fuller bodied beer is desired.

Other "Potatoes"

There are many interesting alternatives to the common potato that can potentially be used as starchy adjuncts when brewing.

Sweet potatoes (*Ipomoea batatus*) are familiar vegetables to most people. But these yellow or orange vegetables, commonly served at Thanksgiving dinner, are not true potatoes. They are actually members of the morning glory (Convolvulaceae) family. The edible part of the sweet potato plant — the "potato" — is a storage root, not a tuber. That's why sweet potatoes often have spindly roots connected to them.

Compared to potatoes, sweet potatoes have more starch and less protein. They also contain 3–6% sugar. I've used the orange variety of sweet potatoes and they add a very nice orange hue to beer. They don't, however, add any sweet potato flavor. I suspect that most of the flavor is associated with the sugars, which just ferments away. I've made a sweet potato ESB by substituting 5.0 lbs. (2.3 kg) of sweet potatoes for 1.0 lb. (0.45 kg) of pale malt in a basic ESB recipe. The substitution yields an ESB that tastes normal, but has an interesting orange hue.

It's possible that roasting the sweet potatoes will develop that flavor to the point it shows up in the finished beer, but I've yet to try this. You may also need to add some sweetness, perhaps by adding lactose, to make the sweet potato flavor recognizable.

Yams (from many species of the genus *Dioscorea* in the family Dioscoreaceae) also appear in many supermarkets, although it's not uncommon for vegetables labeled as yams to really be sweet potatoes. Yams are more closely related to lilies than they are to either potatoes or sweet potatoes. These variably colored tubers contain about 20% starch and are sweeter than sweet potatoes. I've never used them in brewing, but can't see any reason why they wouldn't work just like sweet potatoes.

Cassava (*Manihot esculenta*) is a starchy storage root from which tapioca pudding is made. Cassava is grown in the tropics, where cereals or potatoes do not grow well. As with yams, I haven't tried it, so maybe you can be the first homebrewer on your block to give it a whirl. ■

Chris Colby is the editor of BYO.

Keg lid carbonator

Why buy six carbonation stones when one will do?

story and photos by Thom Cannell

Specialize your keg with a carbonation-stone lid like the one shown here and spend the $125 in savings on brewing supplies.

Kegs, those old soda containers made by Cornelius, Firestone, and Spartanburg, appear in many brew houses around the time the brewer thinks "I really hate bottling," "I'm serious about this hobby," or "my brother's birthday party is around the corner."

Kegs are convenient, both for beer and homemade sodas for the kids. Kegs are available new and used from many local homebrew shops, some internet shops, or may be found in the basements of old restaurants and bars. Kegs discovered in salvage yards are often there for a good reason — don't buy damaged kegs unless they are for other projects! Once cleaned and checked for leaks (a whole 'nother story or three), see February 1996, September 1997 or May 2003 *BYOs*) the question is, "how do I get the bubbles into my brew?"

About carbonation in kegs: methods

Carbonation is a natural phenomenon. Every homebrewer has used fermentable sugars, whether pure corn sugar, molasses or malt extract, to create carbonation in the bottle.

Kegs can be easily carbonated in exactly the same way, but usually with about 15–20% less fermentables added; this is primarily due to the fact that there is less headspace in a keg than there is in a couple cases of bottles. Also, Kegged beer is hard to pour when carbonation is above approximately 2.5–2.6 volumes. Bottled beer on the other hand, is much easier to pour, even when the carbonation is 3.0 or slightly higher. German weizens and Belgian ales have different CO_2 levels in the bottle versus the keg exactly for this reason.

The alternative carbonation method is "forced carbonation." Carbon dioxide, under pressure, is added to the keg. After a suitable time — it varies with temperature and pressure — CO_2 has dissolved into solution.

While most homebrewers simply pressurize their keg and wait a few days for the correct volume(s) of CO_2 to dissolve (see volumes chart in the 2000 *BYO* Reference Guide), others have discovered the value of bubbling their gas through the beer using a 2–5 micron sintered stainless steel carbonation stone. This is the same kind of stone many of us use when oxygenating sweet wort prior to pitching a healthy quantity of viable yeast.

Microbrewers and craft brewers also use stones to aerate wort with oxygen and to speed up the process of carbonation. Advocates of stones claim two benefits when carbonating; reduction of time to carbonation, and the better creation of those dancing bubbles we all prize so highly.

Why do carbonation stones save time? If the CO_2 is simply filling the empty headspace of a container, it has a surface contact equal to pi times radius squared (πr^2). But if CO_2 is bubbled up from the bottom of the tank, it has the external surface area of each bubble. That provides thousands of times more

These barbed fittings make for an easy and secure connection for all of your tubing. This will prove a worthwhile investment when it comes time for dissembly and sanitizing.

contact area. Thus the CO_2 is more easily and quickly absorbed.

Carbonation stones are available from a number of homebrew supply shops. By far, the easiest way to employ a carbonation stone is to purchase a stone joined to a stainless steel tube. You'll need one for every keg you own. Connect the stainless tube to the gas-in dip tube with a 2-inch (50 mm) length of beer tube. Wait a minute! I have six kegs, so that would cost thrifty me $150 to equip my kegs!

PARTS LIST

MIP barbed adapter ¼" x ½"	$1.50
#10 O-ring	$0.47
Teflon tape or NSF teflon pipe dope	$1.00
Gas ball-lock connector	$4.50
Gas-in keg connector (used)	$6.00
Requires Poppet	$2.50
O-ring	$0.50

TOOL LIST:

Drill bits: ⅛", ¼", ½"
Drill motor
Round files (or rotary grinder)
Adjustable wrench or deep sockets

You will need to drill a 1/2-inch opening for the male adapter. (Hint: medium pressure, low speed and titanium drill bits work best for stainless steel.

Surely there is a way to avoid this expense — can we assemble a device that can carbonate multiple kegs? You bet; we propose modifying one keg lid and using it for the kegging stage of all of your beers, then racking the well carbonated brew into your various kegs for dispensing. For $125 in savings, I'll do just that.

Using barbed fittings will require you to make a thick, approximately 1/4-inch or 7 mm, washer. This is because the threads, male and female iron pipe threads, do not join flat-to-flat.

I realized that substituting a gas-in ball-lock (or pin-lock) fitting (new or used) to connect to the keg's CO_2 source would be much more effective. Either method requires a lid, female barbed hose fitting, a bit of ordinary beer hose, a carbonation stone and some hand tools.

Step-by-step

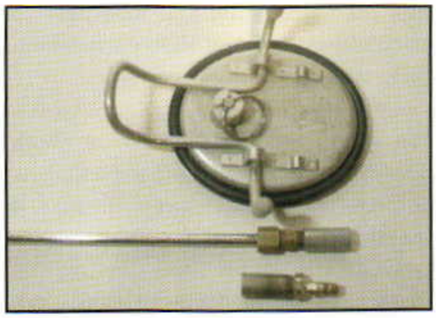
Begin with a spare keg lid that is in good condition, particularly at the edges where the O-ring seals. If there is any damage, file it smooth or straighten it. Then, before you begin modifications, remove any pressure relief valve to prevent damage from heat or accident.

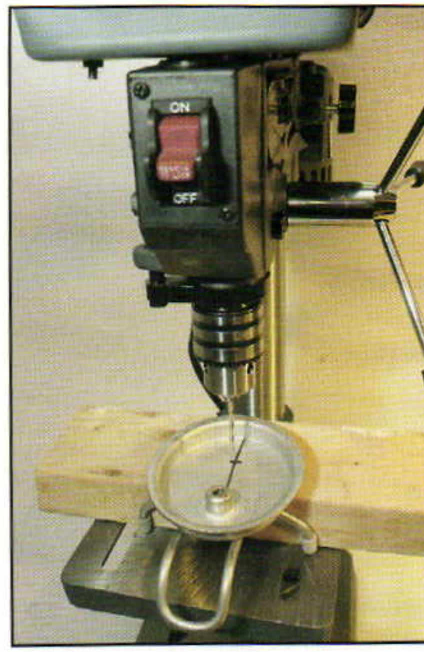
If you own a TIG or MIG welder, you may prefer to weld in a stainless steel male gas-in assembly cut from a discarded keg. For this project I'll keep the arcs and sparks out of the picture and apply a more universal solution; a brass 1/4" MIP barbed fitting and #10 (11/16 x 1/2 x 3/32) O-ring, plus a used ball-lock (pin-lock) connector.

After dissembling the lid, drill a 1/8" (3 mm) pilot hole approximately 1" (25 mm) from the edge and centered. You must avoid the bail (closure) entirely. Opinions vary about the proper procedure for drilling stainless steel. I've found that medium pressure, low speed and titanium drill bits (as opposed to ordinary high speed steel) work best.

Enlarge the pilot hole to ½" to fit the Male Iron Pipe (MIP) threaded barbed adapter in two or three steps. This ½" (approximately 13 mm) hole will not permit the fitting to slip through. You'll have to enlarge it with a file or rotary grinder. Once the hole is large enough, sanitize all the parts with liquid sanitizer. Don't use heat as there are tiny O-rings inside the ball-lock (or pin-lock) connector. Slip the O-ring over the MIP adapter and screw it into the ball-lock fitting. To seal the keg lid — it has to be gas tight — use an NSF approved thread sealant like teflon tape or teflon pipe dope. That, with the O-ring, will ensure a gas-tight connection.

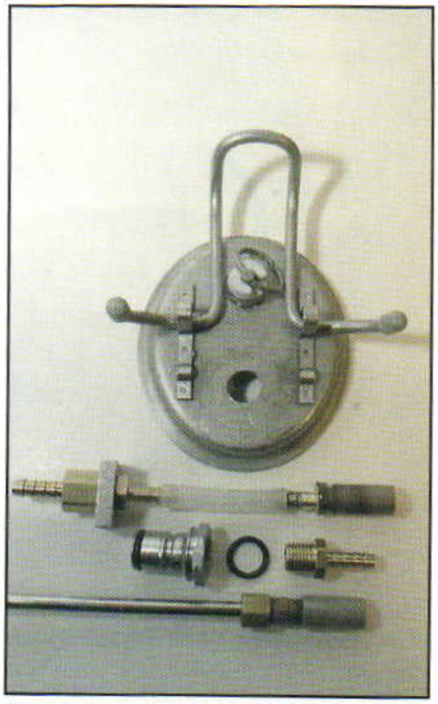
Once the lid is completed you must make a decision. Carbonation stones are available attached to a stainless steel tube, or joined to a MIP barbed adapter. If you purchase a tube or stone, join it to the MIP fitting with 2–3" (50-75 mm) of beer tube. This flexibility allows you to get the tube





(Top left): You can purchase a stone and barbed fittings like these along with stainless steel tubing for your keg lid.

(Bottom and above): You will need to drill an ⅛-inch pilot hole, and expand this opening to ½-inch.



Above find all the components of this project: The keg lid and carbonation stone, the MIP barbed adapter, the #10 O-ring, the gas ball-lock connector and the gas-in keg connector.

into the keg; the lid and tube have to bend almost 90° and slide perpendicularly into the cylinder.

Alternatively you could purchase the stone and barbed fitting (both are shown) and use stiff polyethylene tubing to make any required length. You need the stiffer tube to prevent the stone from floating up in the keg — the stone belongs close to the bottom for maximum performance. The only consideration is your ability to sanitize the stone and tube.

Preventing contamination with sanitation

The only times I've had beer go bad, sanitation was involved. Poor sanitation, that is. A stainless steel carbonation stone is like a stainless steel sponge: a hiding place for all kinds of nasty organisms.

To sanitize, first you will need to disassemble your lid, removing the stone, the stainless cane and its barbed fitting from the flexible tube. Simply pushing a sanitizing solution through the stone and tube, regardless of duration or direction is not enough.

The stone and the stainless steel should be boiled for at least 20 minutes and then soaked in sanitizing solution (bleach and water will suffice). Complete sanitation with a thorough rinse with potable water. To be even more thorough, you can pump the sanitizer and rinse water through the stone and metal tube. Of course, the plastic tube, flexible or not, can be sanitized in a liquid sanitizer, or just replaced. ■

Thom Cannell is a master of trades and writes "Projects," in every issue of Brew Your Own magazine. When he's not homebrewing or creating brewing masterpieces in the shop, he makes time to enjoy his career writing about cars.

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Brewing professors

A formula to make science fun

by Adam Johnston & John Settlage

PHOTOS COURTESY OF ADAM JOHNSTON & JOHN SETTLAGE

Anna and her inquiring eyes gaze upon a hop rhizome. It is the authors' belief that brewing can be used as an essential tool for teaching science.

It's one of those lazy winter Saturdays when nothing really needs doing. I ask Anna, my four-year-old, if she wants to go downstairs to see if the beer is bubbling. As I've come to expect, she responds with an enthused "Yeah!" Moments later she and I are gazing at five gallons of dark muck in an oversized bottle.

The airlock capping the mess is blub-blub-blub-ing along and we are ecstatic. We get individual satisfactions from watching the bubbles: I recognize that fermentation signifies healthy yeast activity, she delights in something coming to life, breathing the bubbles that rattle my carboy's airlock.

Anna is also eager to accompany me to "the beer store." Utah brewers rely on The Beer Nut, which provides all kinds of grain, hops and brewing paraphernalia. The store is a fascinating place for a kid — the equipment, the multi-colored grains, the kits and the refrigerators — so I guess it isn't strange that Anna wants to come along. She helped choose ingredients on our last trip, including the wheat I added to my holiday brew's grain bill.

About two years ago I introduced John Settlage to the world of homebrewing. Like Anna and me, John is enchanted by beer coming to life — so much that he keeps his fermenter where he can hear the airlock jiggling.

The discussions I've had with John since he began brewing reflect our shared fascination with the whole process: how the beer is made, how it changes in the bottle and the science behind the process.

John and I are both "science educators." This means that we teach science courses, teach other teachers how to teach science courses and research ways to improve how science is taught . . . in science courses. At times it's a depressing state of affairs. We know what should happen in science classrooms but it doesn't always match the reality.

Too many have suffered the stereotypical science class where the teacher employs a pointer to illustrate his lecture about the periodic table on a giant chart behind him. If the students do an experiment, they already know what's supposed to happen, and they worry they will get the "wrong" answer. This "science" not only is stale, daunting, and uninteresting, it isn't even really science.

In contrast, the work of homebrewers is authentic, exciting, creative — and by most accounts, truly scientific. It would be a beautiful thing if homebrewers across the country used their knowledge to teach science. It is my hope that many of you already do and that you portray and advocate the true spirit of scientific inquiry.

> **Our society needs to change the way it thinks about science. Homebrewers already know what science is really about.**

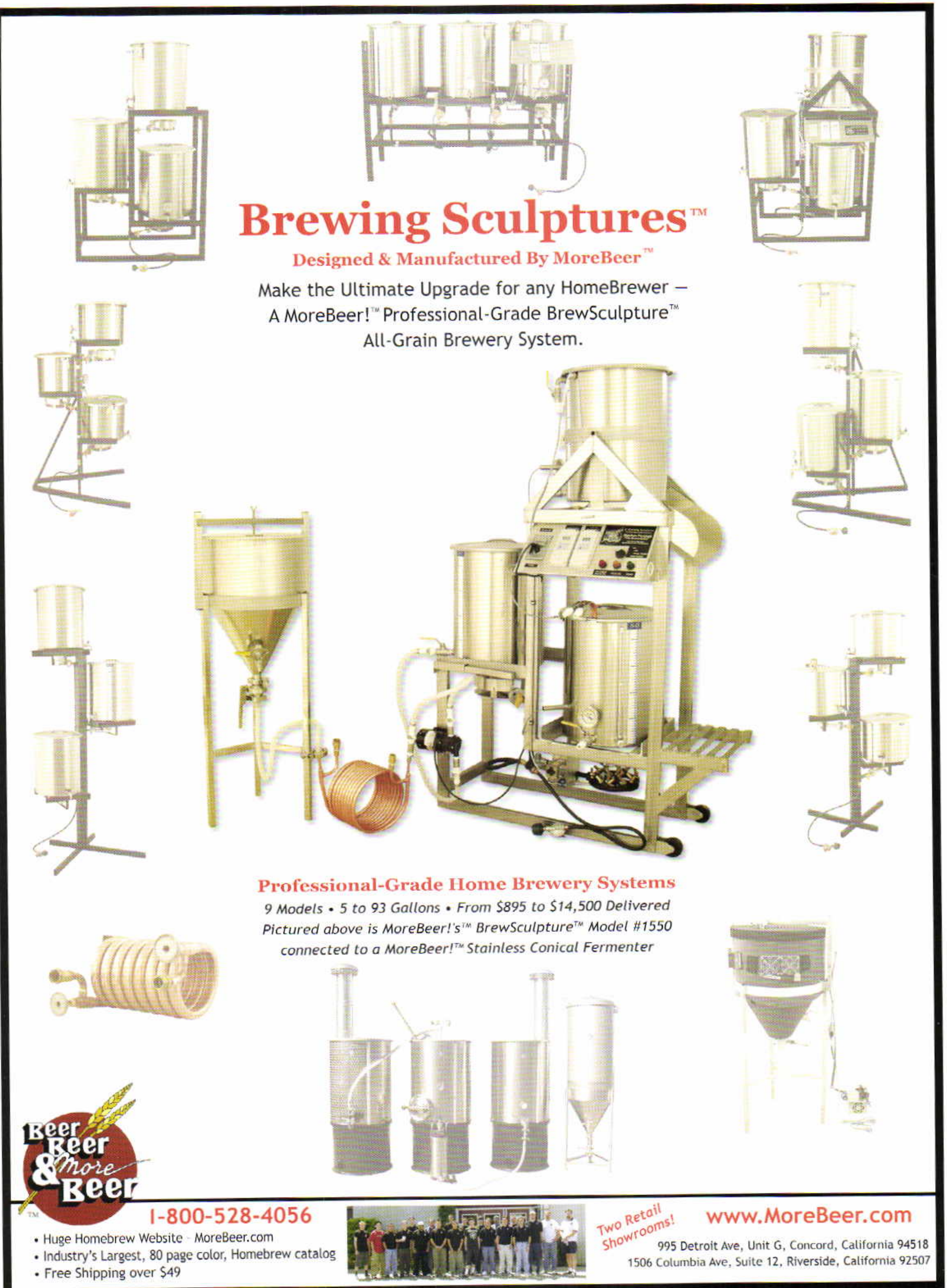
But recently our conversations have taken a different twist. We wonder if homebrewers should be reaching out to more people. We believe homebrewers, in a small way, can help make the world a better place.

Each homebrewer has the ability to go beyond simply sharing brews with other people and to pass on some of the science that created it. By your modest yet wise example, you can reveal, especially to children, what is so incredibly scientific about your hobby.

Show them how you play with nature by adjusting variables. Let them measure specific gravity with a hydrometer. Ask them why they think the density changed and why the yeast fell to the bottom of the carboy. Imagine with them how yeast "eats" sugars. Speculate on the amount of carbon dioxide that is released from a fermenter. Use your brewing to instill some wonder.

Our society needs to change the way it thinks about science. Homebrewers already know what science is really about. After all, we don't make beer just to have something to drink — there are far easier ways to get a bottle of ale. We homebrewers take up this hobby because we like to play, create, invent and inquire. In other words, we do all of the things that "real" scientists do, including making mistakes, refining techniques, talking with others and making adjustments.

Despite all kinds of reforms and efforts by scientists and science educators, society still finds science unapproachable and evil. Few people realize that science is something that can be done everyday, by ordinary people. There may be an "Anna" living in your own home, or a kid next door, or a nephew — somewhere there's a youngster who will be fascinated by what you do and inspired by the scientist that you are. Show people that homebrewing isn't just about the product, but also the process, and you'll introduce them to genuine science. ■



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